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Causes and Kinds in Aristotle's Embryology

By

Jessica Louise Gelber

A dissertation submitted in partial satisfaction of the

requirements for the degree of

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in

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Committee in charge:

Professor Alan D. Code, Chair Professor John G. MacFarlane Professor Anthony A. Long

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#### Abstract

Causes and Kinds in Aristotle's Embryology

by

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### Doctor of Philosophy in Philosophy

#### University of California, Berkeley

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In comparison with the reductive theories of Aristotle's predecessors, Aristotle's ontology is very full. He takes it as an undeniable fact that mediumsized objects of experience really do come to be and perish. Their appearing to do so is not reducible, as the materialists would have it, to changes in position of more basic material particles. Medium-sized objects are "substances."

Living organisms are paradigm instances of Aristotelian substances. Aristotle takes it as a further, undeniable fact that organisms regularly produce other organisms that are the same in kind or species: Human begets human, not dog or fish.

These facts are not explicable by the movements of more basic materials, nor are they explained by the relation that material substances stand in to an immaterial, separately existing Platonic Form. Rather, Aristotle explains the regular reproduction of conspecific organisms of the same species in terms of the transmission of form from one generation to the next. A form at the level of the species, present to the matter as an organizing principle, plays an indispensable causal explanatory role.

Given this indispensable role for forms in explanations, Aristotle's confidence in the superiority of his ontology – one that countenances forms in addition to matter that the forms organize – appears warranted. The inclusion of form in his ontology is justified by the explanatory work that forms do. This justification for forms is threatened, however, by the current consensus on Aristotle's *Generation of Animals*. Scholars think that the form that is actually used in Aristotle's scientific explanation of animal reproduction is not the same as the form in his *Metaphysics*. The dominant reading of *Generation of Animals* is that it employs a "sub-specific" form, one that varies from one individual to the next. This reading is not only in tension with Aristotle's *Metaphysics*, but I argue, internally inconsistent. I argue for an interpretation of the theory of reproduction in *Generation of Animals* that avoids these problems, by assigning to species form a privileged causal role in generation.

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### CHAPTER ONE METAPHYSICS AND NATURAL SCIENCE

#### 1. Introduction

This dissertation argues that the concept of form that Aristotle employs in his biological account of animal reproduction is precisely that form he discusses in the *Metaphysics*. As traditionally understood, form in the *Metaphysics* is identified with essence, and shared by members of a species. It is this common, species-level form that I argue is employed in *Generation of Animals*. In this first chapter, I explain why that view is worth defending.

The commonly received view about the concept of form employed in Aristotle's account of reproduction in *Generation of Animals* is that it cannot be the same as that found in the *Metaphysics*, at least as traditionally understood. If that is right, this seriously weakens a plausible justification for positing forms at all. In the remainder of my dissertation I show how, precisely, form shared by members of a species is given a privileged causal role in Aristotle account of animal reproduction.

#### 2. Aristotle's Materialist Predecessors

Compare Aristotle's ontological picture with two forms of materialism. According to Democritean atomism, all that exists are atoms and the void. Atoms are the eternal, indivisible, imperceptible building blocks of the universe, having no intrinsic properties save size and shape. There are an unlimited number of atoms, coming in unlimited numbers of shapes. These atoms, moving in the void, combine and separate to form the sensible objects of experience, but do not undergo any qualitative change. All changes in the compounds of those atoms that we perceive, including apparent generation and destruction, are reducible to changes in the position of those tiny, imperceptible atoms.

Out of these as elements, [Democritus] generates and combines visible and perceptible bodies. (Simplicius, *Commentary on Aristotle's On the Heavens* 295.8-9, Diels-Kranz 68A37; trans. R. D. McKirihan, slightly modified)

Democritus "generates" perceptible compounds by explaining that atoms, being of different sizes and shapes, lock together in different ways. Atoms that are entangled with one another remain so until they are knocked apart by other atoms moving eternally in the void. This atomist ontology is extraordinarily simple. With very few principles (only two, in fact!), the atomist theory strives to explain the complex objects of experience. Even the movement and behavior of animate compounds, including thought and sensation, is explained in terms of the alterations in position of very small, round atoms that never stop moving. All there is are atoms crashing around in the void.

Slightly more complex is the theory attributed to Empedocles, according to which there are six principles:

Fire and water and earth and the immense height of air, and deadly Strife apart from them, equal in all directions and Love among them, equal in length and breadth. (Empedocles' poem as quoted by Simplicius, *Commentary on Aristotle's Physics* 158.17-9, Diels-Kranz 31B17; trans. R. D. McKirihan)

According to Empedocles, there are the four elements or "roots" – earth, air, fire, and water – as well as two forces, Love and Strife, that make those elements come together and pull them apart, in turn. The elements, like atoms, are eternal; they are neither generated nor destroyed, and they undergo no qualitative changes.

For these [the four elements] are all equal and of the same age,
but each rules in its own province and possesses its own individual character,
but they dominate in turn as time revolves.
(158.26-8)

Sensible objects such as humans – "mortal things" – arise in virtue of the mixture of the elements, and perish on account of the separation of that mixture.

And these never cease continually interchanging, At one time all coming together into one by Love and at another each being borne apart by the hatred of Strife. (158.7-8)

According to both of these materialist theories, the medium-sized objects of experience are compounds of the more basic stuff that composes them. The appearance of generation and destruction of medium-sized objects is explained by the combination and segregation of that more basic stuff. The only genuine substances or "things that are" are the eternal, unalterable materials that comprise all else.

#### 3. Aristotle's Substance Ontology

By comparison with these parsimonious materialist theories, Aristotle's ontology is very full. Aristotle thinks that medium-sized objects like trees and horses really do come to be and perish, and are not merely aggregates of more basic stuff. He must, consequently, explain why this is the case. In order to do so, Aristotle posits a principle that organizes the matter, substantial form, a different from for each kind of substance. These medium-sized objects are "substances," and their coming to be is explained by the presence of form.<sup>1</sup> These substances are composed of both matter and form.

Natural organisms are paradigmatic instances of substances (1032a19, 1034a4, 1041a28-30, 1043b21-22). Substances are things that are said "to be" in the most fundamental way. There are many senses in which something can be said to be, but all are all said to be by reference to one, primary sense of being (*Metaph* IV.2, V.7).

We speak in many ways of what is, i.e. the ways distinguished earlier in our work on the several ways in which things are spoken of. On the one hand it signifies what a thing is and a this, and on the other of what quality or quantity or any of the other things thus predicated. But while what is is spoken of in these various ways, it is clear that the primary thing that is is what a thing is, which signifies substance. (For when we say of what quality a thing is we say that it is good or bad, but not that it is three feet long or a man; but when we say what it is we do not say that it is pale or hot or three feet long, but that it is a man or a god.) And other things are said to be by being either

<sup>&</sup>lt;sup>1</sup> I am here giving only a simplified version of Aristotle's settled metaphysical position by treating composite particulars, rather than the form of such composites, as substances. Aristotle's discussions of primary substance in the middle books of the *Metaphysics* do not clearly identify medium-sized objects as primary substances. M. Frede (Frede 1985) for instance, has convincingly argued that primary substance in the middle books of the *Metaphysics* is form, and not the composite particulars. But composite particulars are still derivatively substances on Frede's view, and so I am glossing over this complication. I am also not discussing non-sensible substance, since this is not relevant here.

quantities of what is in this way, or qualities, or affections, or something else of this sort. (*Metaph* VII.1, 1028a10-20)

Every non-substance is ontologically dependent on substances. A color, for instance, only exists insofar as it is the color of some substance. And "accidental beings" exist in virtue of coinciding with some substance; the white thing exists only insofar as it coincides with the log.

One can say truly that the white thing is walking, and that the large thing is a log, and again that the log is large and that the man is walking. Well, speaking in the latter and in the former ways are different. For when I say that the white thing is a log, then I say that that which is accidentally white is a log; and not that the white thing is the underlying subject for the log; for it is not the case that, being white or just what is some white, it came to be a log, so that it is not a log except accidentally. But when I say that the log is white, I do not say that something else is white and that that is accidentally a log, as when I say that the musical thing is white (for then I say that the man, who is accidentally musical, is white); but the log is the underlying subject which *did* come to be white without being something other than just what is a log or a particular log. (*Past Anal* I.22, 83a1-14)

No non-substantial entity "is of a nature to be in its own right, or is capable of being separated from substance" (1028a22-4). Substances, on the other hand, do not depend on anything else for their existence. And substances, Aristotle says, are primary "in knowledge." It is through knowing what substances are – knowing their definitions – that knowledge of all non-substances is possible, and not vice versa.

In definition too [substance] is primary, since in the definition of everything there must occur the definition of substance; and we think we know a thing most fully when we know what the man is or the fire, rather than when we know its quality or quantity or place – since it is also true that each of these themselves we know only when we know what that quantity or quality is. (*Metaph* VII.1, 1028a34-b2)

Unlike the beings that depend upon them, substances are beings "in their own right" (*kath'hauto*). What a substance is "in its own right" is its essence.

The essence of each thing is what it is said to be in its own right. For being you is not being musical, since you are not by your very nature musical. What, then, you are by your very nature is your essence. (*Metaph* VII.4, 1029b13-6)

Of all of the true descriptions of any substance, there is only one that picks out the essence, the "what it is" (*to ti ên einai*). The account that specifies the essence of a substance is its definition; the definition of some substance signifies what that substance is, essentially.

Unlike the materialists, the principles in Aristotle's ontology that account for medium-sized objects coming to be and perishing are not just the atoms or four roots and Love and Strife. Aristotle countenances both the matter out of which these medium-sized substances come to be, and form, the principle that organizes that matter. In the *Metaphysics*, a substance's form is identified with its essence. "By 'form' I mean the essence of each thing" (1032b1-2; see also 1035b32). In *Metaphysics* VII.17, Aristotle says that form is the "substance of" a substance, and the "substance of" a thing is what makes it *what it is.* What makes something a house or a human being, he says, is its *form* (1041b7-8). In living organisms, the form is the source of movement, it is the end, it is the cause as substance (*ousia*) of living bodies" (*DA* II.4, 415b10-12).

In his discussions in the *Metaphysics* and *De anima*, Aristotle is evidently thinking of forms as common to members of a species. This is the natural way to read claims like the one at *Metaphysics Z.*8, 1034a5-8 that Socrates and Callias are the same in form *(eidei)*, or the one at *De anima* II.4, 415b3-7 that natural organisms partake in immortality the only way they can, namely, by producing something that is the same in form *(eidei)*. So, Aristotle's ontology includes both matter and forms that are common to members of a kind.

#### 4. Justification for Forms

Given the simplicity of the materialist views and the apparent profligacy of Aristotle's, it would seem that the burden of proof is on Aristotle to defend his ontology. He criticizes his predecessors for "not positing the substance, i.e. the essence, as the cause of anything" (*Metaph* I.8, 988b28-9). He faults them on the grounds that "no one has expressed distinctly the essence, i.e. the substance of things" (*Metaph* I.7, 988a34-5). Why are they in error for not doing so? What is the advantage of countenancing forms in addition to matter?

A plausible answer can be gleaned from passages in which Aristotle criticizes those materialist theories. A central complaint that he has about those materialist theories is their failure to explain the regularities that occur in nature. According to Empedocles as I have represented him, an organism like Socrates is really nothing more than a combination of elements arranged in certain way. What would account for the elements that make up his body coming to be in the highly ordered and well functioning way that they do? Perhaps, as Aristotle considers in *Physics* II.8, this arrangement just results by chance. It is not because Socrates' substantial form is organizing the process of Socrates' production, but rather the fact that when beneficial parts come to be formed, "such things survived, being organized by chance in a fitting way; where as those which grew otherwise perished and continue to perish, as Empedocles says his 'man-faced ox progeny' did" (*Physics* II.8, 198b30-2).

Empedocles' only explanation for the production of beneficial parts and organs in natural organisms, according to Aristotle, is that "that the parts of animals mostly came to be as the outcome of chance" (*Physics* II.4, 196a23-4). Aristotle argues that this cannot be right, and he appeals to some very apparent facts about nature as evidence. The apparent facts are the regularities with which well-organized natural organisms like Socrates come to be and behave in the ways that they do. So, for instance, Socrates has parts and organs that are well suited to the various vital activities in which he engages. If an organism like this were to come to be just once, we might be inclined to think that this was solely due to chance; the apparently beneficial parts and organs came to be formed out of the combination by Love or random crashing of the atoms. But, Aristotle argues, these useful parts and organs come together *regularly* in the ways that they do, and what occurs regularly cannot be by chance.

This [i.e., Empedocles' account], or something like it, is the account which might give us pause. It is impossible, however, that this should be how things are. The things mentioned, and all things which are due to nature, come to be as they do always or for the most part, and nothing which is the outcomes of luck or an automatic outcomes does that. (*Phys* II.8, 198b32-36)

In the first place, then, since we see some things always, and others for the most part, coming to be in the same way, it is plain that luck or its outcome is not called the cause of either of these – of that which is of necessity and always, or of that which is for the most part. (*Phys* II.5, 196b10-13)

And it is far more difficult for [Empedocles] to account for natural generation. For the things that come to be by nature all come to be either always in the way they do or for the most part, while things besides those that come to be always or for the most part are from chance and luck. What, then, is the cause of the fact that human comes from human always or for the most part, and wheat from wheat and not an olive from wheat? Or also, if put together in this way, bone? For nothing comes to be having been put together however it chanced, as he says, but in a certain proportion. What then is the cause of this? For it certainly isn't fire or earth. Moreover, it can't be Love or Strife, for Love is only the cause of aggregation and Strife of segregation. This [i.e., the cause of things being put together in a certain proportion] is the being of each thing, but not only "mixing and putting asunder of things mixed" as Empedocles says. (Generation and Corruption II.6, 333b3-15)

Thus at least part of what Aristotle thinks he can do with his forms, and that his predecessors who had no notion of a form or essence could not, is account for the highly ordered regularity with which natural phenomena takes place. Forms common to members of a kind can be used to explain the regularities with which instances of the kind come to be and behave, whereas materialist theories leave these regularities unexplained. So, it is reasonable to suppose that Aristotle considered the explanatory fruitfulness of forms to warrant their inclusion in the ontological inventory.

#### 5. Forms in Scientific Practices

If their explanatory power is a reason for positing forms at all, as the passages just cited suggest, it is important that Aristotle employ them in explaining regularly occurring natural phenomena. That is, insofar as an advantage to Aristotle's positing of forms is that they allow him to explain that which he faults his predecessors for failing to explain, he had better use those forms in his scientific explanations of regularities.

One such regularity is the generation of animals with well-functioning parts and organs. Aristotle explains animal reproduction in terms of the transmission of form from parents to offspring. In *Generation of Animals*, Aristotle explains in greater detail how that form is passed on in animal reproduction. However, as most scholars read the details, a serious problem emerges.

As already mentioned, the concept of form in *Metaphysics* appears to be a form common to members of a species. But it is generally agreed that the common, species level form that is identified with essence in the *Metaphysics* is not adequate to explain the range of phenomena that Aristotle is explaining in *Generation of Animals*. Rather, it is thought that there he uses a different conception of form – a "sub-specific" form that varies from one individual to the next. The consensus view is that in that theory of reproduction, Aristotle "makes no use of and has no need at all for those species-forms – the form of a human being in general, for example, shared by all the human beings – that are the staple of much contemporary discussion of Aristotle's metaphysics" (Cooper 1990: 84). D.M. Balme dismisses the idea that "Aristotle's biology either identifies form and species, or recognizes individual forms merely as variations from a basic specific form" (Balme 1987a: 291). If the view that these scholars express is correct, then the form identified with essence in the *Metaphysics* is not the form that is employed in Aristotle's scientific practices.

Cooper notes that this notion of form as sub-specific stands in conflict with the two "currently most favoured interpretations of the theory of substantial form to be found in Aristotle's metaphysical writings" (Cooper 1990: 56). Cooper is here alluding to an ongoing debate about the ontological status, so to speak, of form. Some scholars have argued that forms are universals. Some have argued that forms must be individuals, one for each individual substance. It is worth making explicit that this issue about ontological status is separate from the issue with which I am presently concerned, which has to do with the degree of determinateness – the "thickness," as Reeve 2000 puts it – of form; is Socrates form qualitatively distinct from that of Callias, or do each of these have the same kind of form?

The view that form is qualitatively distinct for each individual organism, Cooper is noting above, is in tension with both conceptions of the ontological status of form. If the form that two co-specific individuals share in universal, then it is clear that this form does not vary from one individual to the next. And those who advocate individual forms still "have tended to hold that the features that distinguish one individual form from another, for members of the substance whose form it is" (Cooper 1990: 56-7). That is, even advocates of individual forms agree that the forms of two individual substances of the same species have the same kind of form. Michael Frede, one of the prominent supporters of the individual forms view, writes:

It is a non-trivial fact about the world that things come with forms which are exactly alike, and not just sufficiently similar to class them together in one kind. The reality of kinds amounts to no more than this: that the specification of the form of particular objects turns out to be exactly the same for a variety of objects. (Frede 1985: 23) According to both parties, forms are general or "thick." Forms are common to members of a kind, and so are not the qualitatively distinct, subspecific forms that scholars think Aristotle is employing in *Generation of Animals*.

It would be unfortunate if it turned out to be the case that Aristotle is not using "thick" forms in *Generation of Animals*. For, natural science and philosophical investigations are not, for Aristotle, divorced areas of inquiry. They are parts of a general project that aims at a comprehensive understanding of reality. The sort of understanding – *epistêmê* – that both the scientist and philosopher seek is a matter of knowing why things are the case.<sup>2</sup> And we know why things are the case when we have grasped the "causes and principles."

In all disciplines in which there is systematic knowledge of things with principles, causes, or elements, it arises from a grasp of those: we think we have knowledge of a thing when we have found its primary causes and principles, and followed it back to its elements. (*Phys* I.1, 184a10-14)

Both natural science and philosophy aim at understanding causes and principles. Natural science (*epistêmê phusikê*) is a first-order investigation into the causes and principles of natural substances considered as *natural*, i.e., considered insofar as these are the type of substance that has "in itself a source of change and staying unchanged, whether in respect of place, or growth and decay or alteration" (*Phys* II.1, 192b14-15). Philosophy aims at a more general level of understanding of those same principles and causes of substances. The subject matter of the books now called the *Metaphysics* is an investigation of those same substances, now considered as beings.

The attributes of being insofar as it is being, and the contrarieties in it *qua* being, it is the business of no other science than philosophy to investigate; for to natural science

<sup>&</sup>lt;sup>2</sup> "We think we understand a thing *simpliciter* (and not in the sophistic fashion accidentally) whenever we think we are aware both that the explanation because of which the object is is its explanation, and that it is not possible for this to be otherwise. It is clear, then, that to understand is something of this sort; for both those who do not understand and those who do understand – the former think they are themselves in such a state, and those who do understand actually are." (*Post Anal* I.2, 71b9-15)

one would assign the study of things not *qua* being, but rather *qua* sharing in movement; while dialectic and sophistic deal with the attributes of things that are, but not of things *qua* being, and not with being itself insofar as it is being; therefore it remains that the philosopher studies the things we have named, insofar as they are being. (*Metaph* XI.3, 1061b4-11)

Aristotle does think that the forms that he treats as causes and principles in metaphysics are causes of substances, considered as natural. The form that he posits in his ontology is a cause of natural substances in several ways. As is well known, Aristotle that there were four types of causal relations, or perhaps it is better to say that there are four ways of being responsible for something. These are the four *aitia* introduced in the *Physics*: the formal, final, moving and material causes.

The formal cause of a substance is simply what it is, essentially. So the formal cause is the essence of a thing, by definition. And as we have seen, Aristotle thinks that the essence of a thing is its form. The formal cause of a substance is its form.

The final cause is what something is for. This, too, is the essence of a substance. For, as Aristotle makes clear in *Parts of animals* I.1, final cause explanations of natural phenomena, e.g., a certain sort of organism having certain features, begin with the definition of the form or soul of the kind of organism that it is, and explain by reference to that definition why it has those features. So the final cause of substance, too, is its form.

The moving cause, "primary source of movement or rest" (194b29-30) is the same "in form" as the formal and final cause. That is, the moving cause is two "in number" or numerically distinct, but the same in kind as the substance that is coming to be. So, for instance, a builder's knowledge of building – the *logos* that he has in his soul and in virtue of which the builder is said to have the building art – is the moving cause of a house, and the father is the moving cause of his child. The builder's art, that knowledge in his soul, is the same in form as the essence of the building that will come to be. The father's essence is the same in form as the essence of the offspring that he produces.

No one denies that the form that is the essence of substance is a form common to members of the kind to which each substance belongs. Aristotle certainly uses *eidos* to pick out the essence and formal cause. But as I have said, many scholars think that the form passed on by the moving cause must be a sub-specific form, qualitatively distinct for each individual substance. So subspecific form is not the form identified with the essence, which plays both formal and final causal roles. It will not do to say that Aristotle uses one sense of *eidos* for the essence that plays the formal and final causal roles, and another sense for the form that the moving cause has. For, it is important to Aristotle that form, identified with the essence and so the formal and final cause, also be a moving cause, the source of change. This is one of his main complaints with Platonic Forms, which are separate from the substances of which they are supposed to be the cause. Platonic Forms, Aristotle thinks, are causally inert, and so metaphysically superfluous.

Above all one might discuss the question what on earth the Forms contribute to sensible things, either to those that are eternal or to those which come into being and cease to be; for they are neither the cause of movement nor change in them. But again they help in no way towards the knowledge of other things (for they are not even the substance of these, else they would have been in them), nor towards their being, at least if they are not *in* the individuals which share in them... But further all other things cannot come from the Forms in any of the ways that are usually suggested. And to say that they are patterns and the other things are share in them is to use empty words and poetical metaphors. For what is it that works, looking to the Ideas? (*Metaph* XIII.4, 1079b5-18, 23-7)

In general, though philosophy seeks the causes of perceptible things, we have given this up (for we say nothing of the cause from which the change takes its start). (*Metaph* I.9, 992a24-6)

Consequently, in the face of an apparent tension between Aristotle's actual scientific practices and his discussions in the metaphysics, it is unattractive to simply saddle Aristotle with two conceptions of form. Instead, I will argue that the form in *Generation of Animals* is the same as that in *Metaphysics*.

#### 6. Remainder of the Dissertation

Let me briefly summarize what is to come in the rest of the dissertation.

In Chapter Two, I discuss three principles of scientific explanation and explain how the account of animal reproduction satisfies them. In brief, Aristotle's theory assigns to the female parent the role of providing the matter for the change, and to the father the role of providing the form. The form, once present to the matter, is what makes it the case that a new living substance is generated. Because this is a form common to parents and children, the transmission of this form explains the regularity with which "human begets human."

In Chapter Three I explain why the details of Aristotle's account of generation lead scholars to conclude that it cannot be species form that is transmitted in animal generation. In Generation of Animals, Aristotle takes himself to be explaining not only why human begets human, but also why offspring resemble their parents and ancestors more than other members of the species. Species form, it is thought, cannot possibly explain this. The dominant view is that the form in the embryological theory is sub-specific form, a form particular to the individual who has it, rather than a common species form. However, the sub-specific forms interpretation of Generation of Animals renders the embryological account internally inconsistent. If inherited features are part of form, as the sub-specific forms interpretation would have it, then form must also be responsible for maternal resemblance. But according to Aristotle's theory of reproduction, as described in Chapter Two, only the male provides form. There are two main strategies for resolving the tension between maternal resemblance and what I call "causal hylomorphism." Some scholars deny that Aristotle's theory restricts the contribution of form to the father, while others try to attribute maternal resemblance to the form that the father provides. Neither strategy is successful. Consequently, in addition to being in tension with Aristotle's metaphysics, the sub-specific forms interpretation is independently unattractive.

In Chapter Four, I offer an interpretation of the account of likenesses to parents and ancestors given in GA IV.3 that assigns direct responsibility for those features of an offspring that are below the level of the species to causal factors other than the form. According to the interpretation I give, "movements" that are in the generative residues are the *per se* causes of inherited characteristics. These movements are the tools used by the form or soul of the male parent and are subsidiary causes in generation. The fact that Aristotle describes these movements as tools is more significant, I argue, than has been appreciated. For, by doing so he makes clear that form has a privileged role in generation. On my view, form can explain the regularities that we expect it to explain – the regular reproduction of offspring the same in kind as its parents. For, in general, tools can have effects that are more determinate that the first mover that uses them. Thus, form can be the species level form, even though the tools the agent uses to convey it result in very determinate features.

Consequently, according to the interpretation of Aristotle's explanation of animal generation that I offer, the form used in that explanation is the same as that in his *Metaphysics*. This is what we would hope, given the justification for positing forms that I think is plausible. Forms earn their place in the ontology in virtue of their usefulness in explaining regularities in nature. Subspecific form, on the other hand, does not explain regularities. In fact, if it were sub-specific form passed on from parents to offspring, Aristotle would have to say that each attempted act of generation is a partial failure – the father never fully succeeds in conveying his form to the matter. For, since offspring are never perfect replicas of the parents (as Aristotle is aware, and which his theory accounts for on my reading of it), Aristotle would have to say that the sub-specific form is distorted in each act of reproduction. This, for obvious reasons, is very un-Aristotelian. The interpretation I argue for in this dissertation is a step towards defending the line of justification for forms sketched in this chapter. Forms, identified with essences, are the forms that are passed on in generation.

# CHAPTER TWO SEXUAL REPRODUCTION AND THE PRINCIPLES OF NATURAL SCIENCE

In this chapter, I discuss three principles of explanation, which I shall refer to as "causal hylomorphism," "agential synonymy," and "contact." I then explain how the account of animal reproduction in *Generation of Animals* satisfies them.

#### 1. Causal Hylomorphism

As discussed in Chapter One, Aristotelian natural substances (mediumsized objects like horses, trees, humans) have both matter and form as their "principles" of coming to be and persisting. Although Aristotle frequently cites the material elements as examples of principles countenanced by his predecessors, principles are not necessarily constituent parts. Rather, Aristotle describes principles quite generally as "that from which things originate" (*Metaph* V.1, 1013a7). We can think of principles as causes or "things responsible" (*aitia*). And accordingly, we can think of Aristotle's "hylomorphism" as the view that both matter and form are causes of substances, both of their coming to be and their continuing to exist.<sup>3</sup>

The canonical statement of this "causal hylomorphism," as I will call this view that both matter and form are principles or causes, is in the first book of the *Physics*. The *Physics*, as a whole, contains a treatment of the general framework for the investigation of nature. Aristotle's immediate aim in *Physics* I is to determine facts about causes and principles of natural things that are subject to change. How many principles are needed to explain natural changes? Is there merely a single principle of nature, or more than one? If there is more than one, are there infinitely many, or is the number of principles finite? If the number of principles is finite, how many principles are there, and what are they?

<sup>&</sup>lt;sup>3</sup> Hylomorphism is often characterized as the view that medium-sized objects are comprised of matter (the stuff of which they are made) as well as form. C. Shields, for example, writes that "Hylomorphism = df ordinary physical objects are complexes of matter and form" (Shields 2007: 57). There is a sense in which this true, but there is also a way in which this is misleading: this way of characterizing hylomorphism encourages the thought that Aristotle countenanced a dichotomy between features or properties that are "material" and those that are "formal," and such a division among features or properties is not clearly found in Aristotle's writings.

Aristotle's investigation begins with a survey of the reputable beliefs about the principles. Aristotle remarks that nearly all of his predecessors countenanced "opposites" as principles. For instance, Parmenides posits hot and cold as principles, Democritus posits "full and empty" (*Phys* I.5, 188a20-23).

That opposites are principles is universally agreed. (*Phys* I.5, 188a19; cf. *Metaph* I.5, 986b2-3)

Aristotle thinks this is quite plausible, and that it follows from a consideration of the *logos (epi tou logou*).<sup>4</sup> While it is not entirely clear what *epi tou logou* is supposed to mean, it seems as though in this case it has to do with how we typically speak: We do not say that just anything whatsoever becomes X, but rather that what is not-X becomes X.

Our first point must be that nothing whatever is by nature such as to do or undergo any chance thing through the agency of any chance thing, nor does anything come to be out of just anything, unless you take a case of concurrence. For how could pale come to be out of knowing music, unless the knowing music coincides with the not pale or the dark? Pale comes to be out of not pale – not, that is, out of just anything other than pale, but out of dark or something between the two; and knowing music comes to be out of not knowing music, that is, not out of just anything other than knowing music, but out of ignorant of music, or something in between if there is anything in between. (*Phys* I.5, 188a31-b2)

<sup>&</sup>lt;sup>4</sup> See Ross 1936: 488-9 and Charlton 1992: 65-6 for a discussion of this use of *epi tou logou*. Ross takes this as meaning "from a consideration of the argument," as opposed to by appeal to authority. Charlton suggests that it means that the point follows from considering the way that we speak. What Aristotle goes on to say might seem to fall short of a rigorous argument. However, Aristotle considers the way we speak to be a good guide, and it is a commonplace that Aristotle does not draw a sharp distinction between what we would think of as ontological relations and what we take to be merely linguistic or semantic ones. So, for example, in Aristotle's *Categories*, he seems to slide back and forth between talking about linguistic predication and ontological predication, i.e., between talking about a predicate applying to a subject and a property possessed by an object.

Aristotle's reasoning in this passage is as follows. We speak as though change occurs between opposites. For instance, we usually say that light things become dark, but not that smooth things become dark. Of course, we do not always describe changes as occurring between opposites. Suppose a smooth, dark, wooden table is painted white. We might say in such a case that the table, or even the smooth thing, becomes white. In this case, Aristotle thinks, we are picking out the dark thing "concurrently," i.e. by referring to something with which the dark thing coincides.

Moreover, even in cases where there is no common word for one of the opposites, such as when a house or a table comes to be out of the "nothouse," we can still describe this as a change between opposites. The change into a house is a change from something "unformed" or "shapeless" into something that has form or shape.

The same holds of other things also: even things which are not simple but complex follow the same principle, but the opposite state has not received a name, so we fail to notice the fact. What is in tune must come from what is not in tune, and vice versa; the tuned passes into untunedness – and not into any untunedness, but into the corresponding opposite. It does not matter whether we take attunement, order, or composition for our illustration; the principle is obviously the same in all, and in fact applies equally to the production of a house, a statue, or any other complex. A house comes from certain things in a certain state of separation instead of conjunction, a statue (or any other thing that has been shaped) from shapelessness – each of these objects being partly order and partly composition. (*Phys* I.5, 188b8-b21)

Aristotle generalizes from the particular pairs of opposites that others had treated as principles of natural change, and refers to the opposites as "privation" or "lack" on the one hand, and "form" on the other. This, he says, will be an acceptable starting point in the search for principles of natural change. Most philosophers, anyway, countenanced some particular pair or pairs of opposites, so in saying that principles are generally describable as "opposites" he thinks that "most people are prepared to go along with us" (*Phys* I.5, 188b26).

If opposites are principles, how many are there? Aristotle quickly dispenses with the idea that there is only one principle. If we assume that the principles are opposites, there must be at least a *pair* of principles: "They cannot be one, since opposites are not one and the same" (*Phys* I.6, 189a11-12).

So, there must be more than one principle. And there should not be an unlimited number of principles, either. If the principles of natural things were unlimited (as Anaxagoras apparently thought), they would be "unknowable" (*Phys* I.6, 189b12-15).<sup>5</sup> But the point of searching for principles is to acquire knowledge. So, the assumption that there are an unlimited number of principles would make scientific inquiry futile. Insofar as positing an unlimited number of principles makes the enterprise that Aristotle is undertaking self-undermining, it is rejected.

There cannot be an unlimited number of principles, and principles must be opposites. The assumption that change is always between opposites, however, generates some puzzles about the very possibility of change. One of the difficulties, discussed in *Physics* I.6, is that opposites do not seem to be capable of acting on one another.<sup>6</sup> About Empedocles' opposites, Love and Strife, Aristotle claims that "Love does not gather up Strife and make something out of it, nor does Strife act thus with Love, but both must act on a third thing distinct from them" (*Phys* I.6 189a24-26). This applies generally; the lack and the form are not principles in virtue of acting upon one another, since in general, it appears that "opposites cannot be acted upon (*paschein*) by one another" (*Phys* I.7, 190b33). Since opposites do not act upon one another, there must be some third thing upon which each of them acts.

The discussion of the problems with positing only a pair of opposites, construed generally as the lack and the form, sets the stage for the introduction of the *matter* that undergoes the change, which is "one in number" with the opposites. In *Physics* I.7, he establishes that in any change, there is not just something that comes to be, but something that comes to be that. For example, when some cool water becomes hot, there is both what comes to be - hot - and something that becomes that - the water.

So, in addition to the opposites, matter is a principle needed to explain change. Insofar as the matter for any change is a cause and principle of the change, there are constraints on what can be the matter for any change. A

<sup>&</sup>lt;sup>5</sup> Aristotle seems to be alluding to an argument from the fact that "being is one kind of thing," which he mentions again at *Physics* I.6, 189b22-27. It is not clear to me how this criticism of an unlimited number of principles should be filled out. It is enough for my purposes to note that he is giving a reason for thinking the principles cannot be unlimited, whatever that reason is.

<sup>&</sup>lt;sup>6</sup> Aristotle first puts the point in terms of a puzzle about how density can produce (*poiein*) something rare or rarity can produce (*poiein*) something dense That is, he first describes the problem as being about how density can make or produce rarity, and vice versa, rather than how they can act upon one another. But it seems from the subsequent examples that his general concern is about how opposites can act upon on another.

minimal condition on the matter is that it be able to undergo that change. The way that Aristotle puts this point is that the matter must have the form "potentially"; the matter for some change must have the passive potential to take on the form that the change is a change into.<sup>7</sup> There are grades of potentiality. So, for instance, clay has a lower grade of passive potential to become a house than do bricks that are made from the clay. The bricks have a passive potential to take on house form to a higher degree than the clay does, because the clay must first be turned into bricks in order to take on house form. The matter specified must be not only capable of eventually taking on the form, it needs to have a high level of passive potential to do so.

Aristotle thinks that both opposites and the matter that underlies the change are principles. So, it seems as though there are *three* principles of change: There are the two opposites (the "privation" and the "form") and the underlying thing – the matter for the change. The matter is "one in number" with the opposites. Before the change, the water is one in number with "the cool," and after that change the water is one in number with "the hot." Of course, what it is to be water and what it is to be hot differ in account – water and the hot thing are two "in form." But since the water is always one in number with one of the opposites, Aristotle thinks that, in a way, there are only two principles. There is the matter that has the form in potential, and the form that it will come to have.

Positing something that underlies the opposites and which is one in number though two in form with them is the innovative move that allows Aristotle to resolve not only the difficulties adduced in *Physics* I.6, but also the Parmenidean challenge to the intelligibility of change (whatever that was, precisely) discussed in *Physics* I.8.<sup>8</sup> Aristotle thinks that conceiving of changes as involving both form and matter is crucial for making change explicable. Accordingly, adequate explanations of change must be "hylomorphic" – explanations must identify both the form of the change, and the matter that underlies the change and takes on the form. This is the first principle of scientific explanation:

<sup>&</sup>lt;sup>7</sup> A more complete characterization would be that the matter is potentially F insofar as it will become actually F in the appropriate circumstances, should nothing interfere. The principles I go on to discuss in this chapter specify those appropriate circumstances.

<sup>&</sup>lt;sup>8</sup> For reasons I will not discuss here, Aristotle thinks that this move allows one to resist the arguments against the explicability, and perhaps impossibility, of change.

**Causal hylomorphism:** Explanations must specify not only what the change is a change into (the form for the change), but also that which, while being one in number with the opposite, underlies the change (the matter).

From what has been said, then, it is clear that that which comes to be is always composite, and there is one thing which comes to be, and another which comes to be this, and the latter is twofold: either the underlying thing, or the thing which is opposed. (*Phys* I.7, 190b10-13)

### 2. Causal Hylomorphism in Generation of Animals

Given Aristotle's commitment to causal hylomorphism, his explanation of animal reproduction in *Generation of Animals* must identify, in addition to opposites, the matter underlying the change that has the passive potential to take on the form. As with any case of generation, the form for the change is a substantial form. The substantial form of a living organism is its soul. The matter for animal generation, then, must be something that has soul potentially.

The matter that Aristotle identifies is the *katamênia* – the menstrual fluid – that the female provides. So, Aristotle needs to say why *katamênia* has soul potentially – why it is "potentially such as that from which it came" (GA IV. 1, 762b4) – namely, a living organism. He does so by appealing to the way it is formed. The female's *katamênia* is potentially a living organism, Aristotle explains, because it is a "residue" produced by a natural process Aristotle calls "concoction" (*pepsis*).

"Concoction" is Aristotle's name for the process whereby the natural heat in a body acts upon the matter proper to that body, making the "indeterminate" moisture evaporate. In general, heat, like cold, is an active power that effects changes by "mastering" the passive powers, moist and dry.<sup>9</sup> Concoction is a type of such mastery. The result of concoction is something with a determinate form or nature (*Meteor* IV.2, 379b25ff).

All living organisms have nutritive soul, whose activities – digestion, growth, and reproduction – take place by means of concoction. Living organisms, in order to engage in concoction, must have a source of internal,

<sup>&</sup>lt;sup>9</sup> At the most basic level, the action of heat and cold on moist and dry gives rise to the elements – earth, air, fire and water (*GC* II.3, 330a30-b1). Those four elements are the physical constituents of all other bodies (*De Caelo* III.3, 302a12).

natural heat (DA II.4, 416b28-30).<sup>10</sup> Once food is broken up in the mouth, it is first concocted in the stomach (*PA* II.3, 650a13-14). The nutriment that results from the initial concoction then passes into the blood vessels that attach to the intestines, where it is concocted into its blood. The blood that results from concoction by the heat from the heart is then carried through blood vessels and is converted by means of further concoction into the limbs and organs. This is why blood (in blooded animals, or its analogue in non-blooded animals) is the "final form of nourishment" from which come all the parts of the body.<sup>11</sup>

Now every one of the parts is formed out of the blood as it becomes concocted and in some way divided into portions. (*GA* I.19, 726b5-6; trans. Peck)

The transformation of blood into limbs and organs takes place both in the initial embryonic development of the organism as well as throughout its life; blood is constantly being concocted in order to maintain healthy limbs and organs. Since concoction of blood results in the formation and maintenance of limbs and organs, the blood (in blooded animals) is the *matter* for the body parts. Blood is the living body *in potential* (*PA* III.5, 668a23-4).

Since there is usually more blood than is needed for the maintenance of the organism, the excess blood is further concocted into residues that provide some benefit to the organism – "useful" residues. The generative fluids, the semen from the male and the *katamênia* from the female, are two such useful residues. The *katamênia* collects (during certain times) in the uterus, where the embryo's generation and development will take place. Because it is derived from nutritive blood, the *katamênia* is, in potential, all the parts of the organism that will come to be formed out of it, and so is well suited to be the matter for the change into a living organism.<sup>12</sup>

<sup>&</sup>lt;sup>10</sup> In blooded animals, this heat has its origin in the heart, which is the seat of the nutritive soul.

<sup>&</sup>lt;sup>11</sup> See also PA III.5 668a1-4: "The reason why the blood vessels are distributed all over the body is that blood (and in bloodless creatures, its counterpart) is the material out of which the whole body is constructed, and blood vessels (and their counterparts) are the channels in which this material is carried."

<sup>&</sup>lt;sup>12</sup> "The female's contribution, of course, is a residue too, just as the male's is, and contains all the parts of the body *potentially*, though none *in actuality*; and 'all' includes those parts which distinguish the two sexes." (GA II.3, 737a22-25)

Given this account of the formation of the *katamênia*, Aristotle's theory succeeds in identifying the matter that has the form in potential. The form that the matter for generation must have in potential is the soul. The matter for generation must be, consequently, potentially ensouled. The fact that the *katamênia* is produced by concoction is supposed to explain why the *katamênia* has the passive potential to become ensouled. Nutritive blood, in adult living organisms, is potentially all of the ensouled body parts that it becomes as it travels through the blood vessels and is concocted by the organism's internal heat. That passive power present in nutritive blood is also present in the generative fluids concocted out of it, and so the *katamênia* has the passive potential to become the ensouled body parts that it will become.

#### 3. Agential Synonymy

In order for the matter that has the form of the change in potential to come to actually have it, there must be something that conveys the form to the matter.

For everything that changes is something and is changed by something and into something. That by which it is changed is the primary mover; that which is changed, the matter; that into which it is changed, the form. (*Metaph* XII.3, 1069b36-1070a2)

The primary mover or agent of any change is that which conveys the form to the matter. That primary agent must, accordingly, actually have the form that it is conveying. So, for instance, only something that is actually hot can convey the form of heat to the potentially hot water.

The mover already is in actuality. For example, that which is hot heats, and generally what has the form generates. (*Phys* VIII.5, 257b9-10)

The agent must have the form in actuality not only for qualitative changes (changes in which a qualitative form like heat is transmitted) and quantitative changes (changes in size), but for substantial changes as well.

The mover will always carry some form, either "this" or "such" or "so much," which will be the source and cause of the movement, when it moves. For example, the human in actuality makes a human from what is in potential a human. (*Phys* III.2, 202a9-12)

This thought – that change is effected by something actually F making something else come to be F by transmitting F to it – is sometimes referred to as the "transmission theory of causality"<sup>13</sup> or the principle of "causal synonymy."<sup>14</sup> The intuitive idea is that for an agent to be able to make something else become F, where that F is the form for the change (the property or feature that the change is a change *into*), the agent must itself have that feature. It is not only the effect that is F; the cause must also be F.<sup>15</sup> I call this second principle of explanation "agential synonymy":

**Agential synonymy:** Explanations of change must specify the agent having the form in actuality that conveys that form to the matter.

It is clear from what has been said that in a way everything comes to be from something synonymous. (*Metaph* Z.9, 1034a21-30)

That which is in actuality always comes to be out of something that is in potential by (the agency of) something that is in actuality, e.g. human begets human, and a musician produces a musician; there is always some first mover, and the mover is already in actuality. It has been said in our discussions about substance that the thing coming to be comes to be out of something and by the agency of something, and this is the same in form. (*Metaph* IX.8, 1049b24-29

<sup>&</sup>lt;sup>13</sup> Kahn 1996: 333-4 describes the transmission theory of causality as "the assumption that an effect must resemble its cause in the relevant respect, since the cause could not give what it does not have." Kahn does not attempt any explanation for this assumption, but claims that it was "Greek common sense" and taken for granted by Plato and Aristotle. Makin 1990/91 discusses an argument for this view in *GC* I.7. See also Lloyd 1976.

<sup>&</sup>lt;sup>14</sup> R.J. Hankinson says that "PCS" (as he refers to it) is "the intuitive idea is that if an agent *a* is causally responsible for some property *F* holding of *b*, then *a* must itself possess *F*, and make *b F* in virtue of its *F*-ness" (Hankinson 1998: 30-31). Hankinson claims that this principle is implicit in pre-Socratics thinkers like Alcmaeon, at least as Aristotle reconstructs Alcmaeon's argument for the immortality of the soul in *De Anima* I.2, 401a30-b1.

<sup>&</sup>lt;sup>15</sup> This assumption is reflected in several claims about causality throughout the works of Plato and Aristotle, most perspicuously in Plato's arguments for "safe" explanations at *Phaedo* 100b-101d. See Annas 1982: 317 for a discussion of this principle in the *Phaedo*.

After these things [we note that] each substance comes to be from something synonymous. (*Metaph* XII.3, 1070a4-5)

Aristotle's favorite and often repeated example of a synonymous agent of substantial change in nature, which we will soon consider in great detail, is the parent who is the agent producing the offspring.

In some cases it is even obvious that the better is of the same sort as the begotten (not, however, the same thing nor one in number, but in form), such as in the case of natural products – human begets human. (*Metaph* VII.8, 1033b29-32)

Insofar as a human being produces a human being, the agent of animal generation is a paradigmatic instance of complete agential synonymy. But Aristotle also allows for weaker cases of synonymy. So, for example, the builder can be said to be the agent producing the house. But the builder and the house are not the same in form. How, then, can the builder satisfy the principle of agential synonymy?

Aristotle thinks there is a sense in which the builder does have the form of the house. The builder is a builder insofar as he has some knowledge, a *technê* in his soul, in virtue of which the builder can build houses. That knowledge in his soul is the *logos* of the form of the house. And so, in a way, the form of a house is in the builder: the knowledge in the builder's soul is the "house without the matter" (*Metaph* VII.7, 1032b11).

In addition, Aristotle allows for partial exceptions to agential synonymy.<sup>16</sup> For instance, when someone spontaneously becomes healthy (i.e. when they are not healed by the doctor but simply become well on their own), this is because part of the form of health is already in the patient (*Metaph* VII. 7, 1032b23-1033a1). Similarly, spontaneous generations of living substances are also partial exceptions, and Aristotle will try to show that even here the principle holds, although in an attenuated sense.<sup>17</sup> Animal generation, however,

<sup>&</sup>lt;sup>16</sup> Burnyeat 2001: 33-7 discusses such exceptions, as well as the way this principle supports the priority of form over matter in Aristotle's *Metaphysics*.

<sup>&</sup>lt;sup>17</sup> See GA III.11, 762b5ff for Aristotle's attempt to explain how even in cases of spontaneous generation, the principle of agential synonymy is in some sense satisfied. Also, in GA II.8 Aristotle tries to explain why a horse and an ass produce a mule. It seems that his strategy, or his suggestion anyway, is to locate the wider kind that horse, ass, and mule fall under, such that the agent is still the same in kind as the offspring. It seems that he is motivated by the need for the agent to have the form of the change in actuality. This is problematic, however. Insofar as each substance has only *one* substantial form, for we would

should be a clear case in which something the same in form with the offspring – something synonymous – is the agent. The synonymous agent identified in *Generation of Animals* is the male parent; his soul is the same in form as his offspring's.

#### 4. Agential Synonymy in Generation of Animals

Among animals in which the male and female are separate, reproduction takes place by means of intercourse between a male and a female.<sup>18</sup> By means of copulation, the male and female jointly produce the seed (*sperma*).<sup>19</sup> Because seed comes to be "out of" (*ek*) the male and female, they

<sup>19</sup> Aristotle refers to the idea that natural things come from *sperma* as a commonly held view in both *Physics* II.8, 199b7-9 and *PA* I.1, 641b29. It is repeated at GA I.17, 721b6-7: "It seems to everyone that coming to be is out of seed, and that seed is from the generators." Although Aristotle uses *sperma* in a number of ways, early on in *GA* it refers to this common conception of *sperma*. The *sperma* of animals, like the seeds of plants, is "the sort of thing out of which naturally constituted things are produced in the first place" (724a17-18). *Sperma* is also used to refer to the earliest stage of the fetus (also called the *kuêma*), as well as generative fluids from both parents. From later discussions it clear that Aristotle does not think that the male and female make the same sort of contribution to generation, and will sometimes use *sperma* to refer

expect the horse or ass to have as their substantial forms horse form and ass form, respectively.

<sup>&</sup>lt;sup>18</sup> The sexes are not separate in all animals, for instance those animals that do not move (such as testacea). (Cf. 730b33-34, where Aristotle says that among animals that move around the male and female are separate.) Although nonlocomotive animals possess sentient soul and so are not, strictly speaking, plants, they resemble plants in that they do not have separate males and females except by "similarity and analogy" (GA I.1, 715b20). Individual members of these types of animals that do not have separate males and females still might exhibit some small differences, just as some trees bear fruit and some don't bear fruit but only "contribute to the ripening in those bearing fruit" (GA I.1, 715b23-5). In plants, Aristotle thinks the two principles exist in the same organism. Cf. GA I.23, 731a1-2 and 731a24-29: "In all her workmanship herein Nature acts in every particular as reason would expect. A plant, in its essence, has no function or activity to perform other than the production of seed; and since this is produced as the result of the union of male with female, nature has mixed the two and placed them together, so that in plants male and female are not separate." (trans. Peck)

are the principles (*archai*) of generation; they are the sources from which the new offspring comes to be.<sup>20</sup> Among the senses of *ek* that Aristotle lists at GA I.18, 724a20-30 are "as statue from bronze" (as out of matter) and "as from the source of movement, like from slander comes abuse." The seed comes to be "out of" the female in the way that the statue comes to be "out of" the bronze; these are that out of which "as matter" something comes to be. The seed comes to be "out of" the male insofar as he is the source of movement and the agent of change; the male is that "by which" (*hupo*) the organism comes to be.

The male and female are principles or sources out of which the seed comes to be. But they contribute to the seed in fundamentally different ways. The male is the active principle, and the female is the passive principle. The male provides the *arché tês kinêseôs*, which is the formal nature that the offspring will inherit.<sup>21</sup> The female provides the matter, which in blooded animals is the *katamênia* out of which the embryo first will be formed:

As we mentioned, we may safely set down as the chief principles of generation the male and the female; the male as possessing the principle of movement and generation, the female as possessing that of matter. One is most likely to be

exclusively to the male's contribution. For example, in I.19, during a sustained criticism of his predecessors' views bout the nature of the seed, Aristotle denies that the female contributes *sperma*: "Since there is something which comes to be among females like the semen (*goné*) in males, and it is impossible for two spermatic secretions to be made at the same time, it is clear that the female does not contribute seed (*sperma*) in generation" (727a25-28). The target of his criticism is the pangenesis view that each parent contributes half of the seed that is drawn from the whole body, each parent making the same sort of contribution. See Bolton 1987 for a discussion of the definition of *sperma* in *GA*.

<sup>20</sup> Compare Aristotle's gloss on *arché*: "That from which (not as an immanent part) a thing first arises, and from which the movement or the change naturally first proceeds, as a child from the father and the mother, and a fight from abusive language." (*Metaph* V.1, 1013a7-10)

<sup>21</sup> Aristotle thinks both the matter as well as the form of a hylomorphic living substance is its nature, in a way: both are internal sources of motion and rest that belong to the organism in itself. Since the matter is nature insofar as it is receptive of the formal nature, it is really formal nature that is most properly speaking, the organism's nature. Cf. *Metaph* V.5, 1015a13-17. See also Code 1997: 373 note 28. When I use "nature" I will mean the formal, not material nature.

convinced of this by considering how the seed is formed and whence it comes. For while things that are constituted by nature come to be out of this, we must not fail to notice how the seed turns out to have come to be from the male and the female. Since it is because this part is begotten from the male and the female, and because its secretion takes place in them and out of them, that the male and the female are the principles of generation. (GA I.2, 716a4-10; trans. Peck, modified)

It is important that there be a division of labor between the male and the female. For there cannot be two agents, each of which supplies part of the form. Aristotle rejects the view (which he attributes to Empedocles) that the seed is a sort of tally – one part from each parent. Rather, the female contributes matter, and not form. Aristotle announces that this follows from a "general" (*katholou*) consideration, namely, that:

... it is necessary that there be a generator and that out of which, and even if this should be one, at least they must differ in *eidos* and the *logos* of these must be different. But in those [organisms] having separate *dunameis* both the body and the nature of the agent (*poiountos*) and patient (*paschontos*) must be different. (GA I.20, 729a24-33)

As with any change, in substantial generation there must be an agent and a patient, and these must be distinct.

Throughout GA, Aristotle treats the male and female as the active and passive principles. Aristotle even defines male and female in terms of their respective roles in reproduction. For instance, it is not a contingent fact that generation takes place inside the female: what it is to be a female is to be that which generates in itself (730b1).

The female always provides the material, the male that which fashions it, for this is the power that we say they each possess, and this is what is meant by calling them male and female. (GA II.4, 738b20-24; trans. Platt)

The male is the active principle supplying the source of movement and generation (716a5-6, 729b12-14, 732a4-5), and is the principle that generates "in another" (716a14, 716a20-21). The female provides the principle of matter (716a7), and is the principle that generates "in itself" (716a14-15, 716a22-22). That this distinction between the roles each sex plays is both non-trivial and

indispensable is also evident in the way Aristotle employs it in achieving one of the main aims of GA, namely, to explain the "parts for generation."<sup>22</sup>

In order to account for the differences between male and female reproductive organs in general and of variations among types of animals in particular Aristotle offers teleological explanations that appeal to the purposes for which these parts are present. Throughout GA, this way of understanding what it is to be male and female – i.e., to have one or the other reproductive role – serves as a starting point for explanations of other differences between the sexes. Since male and female differ in "capacity and function" (*dunamei* and *ergo*), they have different "instruments" (*organa*).<sup>23</sup>

Since [male and female] are differentiated by a capacity (*dunamis*) and by their function, and since instruments are needed for all functioning, and since the bodily parts are the instruments for the capacities, it follows that certain parts must exist for union and production of offspring. And these must differ from each other, so that consequently the male will differ from the female. (*GA* I.2, 716a23-27)

Since [the male and female] differ in capacity, they have different organs. (GA IV.1, 766a22-23)

For instance, the fact that the male generates in another and the female generates in herself is appealed to in explaining why the female uterus is

<sup>&</sup>lt;sup>22</sup> At *PA* IV.4, 678a23-4 Aristotle says that parts for generation by which male and female differ will be "left to discuss later," and announces in the opening lines of GA that he will here discuss them.

<sup>&</sup>lt;sup>23</sup> I say "instrument" rather than "organ," because in addition to the reproductive organs, what Aristotle calls differences in the internal heat of each sex are also explained by male and female having different functions. Since the male must provide the source of movement, he must be hot enough to concoct his nutritive blood into a residue that is potent enough to do so (one that is *gonima*). Since the female provides the matter, and not the active principle, her *katamênia* need not be as well concocted. Thus the female need not be as hot as the male. Since "nature does nothing in vain," females are, in fact, less hot. In some passages, male and female are distinguished by the respective ability and inability to concoct blood into semen that has an active power; e.g., at *GA* I.20, 728a18-21, Aristotle says that "the female, in fact, is female on account of inability of a sort, viz., it lacks the power to concoct semen out of the final state of nourishment…because of the coldness of its nature." See also 766a30-33.

"wide" while the male has only "narrow" passages (738b36-739a1). The reason for this is that the male need only have a narrow, "bloodless" passage to make his contribution, whereas the female must supply some bodily mass. So the female must have a place to contain the material – the *katamênia* – that the male's contribution acts upon.

So, it is clear that the male and female have different functions. The male provides the form; the female provides the matter. This feature of the embryological theory is not restricted to some idiosyncratic remarks, but is central to Aristotle's explanation of reproduction.<sup>24</sup> The male is the agent of the substantial change which provides form. The female provides the matter, the *katamênia*, which undergoes the change by taking on the form.

Since the male, e.g. Socrates, is an actual living organism with the same sort of soul or form that the offspring will have, the mover or agent of generation is something that has the form in actuality. The male is "in actuality what that which is coming to be is in potential" (GA II.1, 734b35-6). Thus, the principle of agential synonymy is satisfied in the explanation of animal generation.

## 5. Contact

So far, we have seen that changes are understood as involving an agent, which has the form in actuality and so has an active potential to convey the form, and a patient, which has the passive potential to take on the form. This is not all that change involves, however. It is not enough that there be something with an active potential to change something else and something with a passive potential to be changed. In addition, the right conditions must obtain. The active and passive factors must be appropriately related or situated such that, if nothing interferes, the change will occur. Aristotle's general term for the appropriate conditions is "contact."

Like nearly all of his contemporaries, and like most people until Newton discovered the existence of gravitational forces, Aristotle does not think that it is possible for one physical body to move another at a distance.<sup>25</sup>

<sup>&</sup>lt;sup>24</sup> That this distinction is so central will be important in assessing interpretations of Aristotle's account of inherited characteristics in Chapter Three.

<sup>&</sup>lt;sup>25</sup> As an aside, it is unclear whether or not Newton thought bodies act on one another at a distance, even though the discovery of gravity appears to be responsible for subsequent acceptance of action at a distance: "... I have not as yet been able to deduce from phenomena the reason for these properties of gravity, and I do not feign hypotheses. For whatever is not deduced from the phenomena must be called a hypothesis; and hypotheses,

A mover can only move by making contact with that which is moved. Aristotle takes this to apply generally. When an agent who has some form imparts that form to the matter and makes the matter undergo the change of taking on that form, it must make contact with the matter:

It is not possible to move something without touching, and nothing can be affected in any way by another if it does not move it. (GA II.1, 734a3-4)

Aristotle clearly thinks that affection (*poiesis*) requires contact. This passage suggests that this is because affection only occurs if there is also a movement (*kinesis*), and movements require contact. It is not clear what the reasoning is. It might be that Aristotle is making a somewhat substantive point: All affections, understood as changes in which the result is a *pathos* – a quality like white or heat (cf. *GC* I.6, 323a19-20) – must also involve at a more basic level a change in the bodies – the elements – that constitute those *pathê*. This would be a plausible assumption for Aristotle to be making. Alternatively, Aristotle may just be making the point that affection is a type of movement, when "movement" is construed quite broadly to cover all types of changes. That is, the reasoning would be that if any affection takes place, and movement requires contact. This, too, would be a reasonable thing for Aristotle to say. He says something similar in *GC* I.6: "Every affection is a narrower class of changes

whether metaphysical or physical, or based on occult qualities, or mechanical, have no place in experimental philosophy" (*Principia*, General Scholium, in Newton 2004: 92).

<sup>&</sup>quot;It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation in the sense of Epicurus, be essential and inherent in it. And this is one reason why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum without the mediation of any thing else, by and through which their action or force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, is a question I have left to the consideration of my readers." (Letter to Richard Bentley, 25 Feb. 1692/3 in Newton 2004: 102). I am grateful to Jasper Reid for pointing me to these passages.

than movement; movement is applied to "more things" (*epi pleon*) (323a20). On either construal, Aristotle is at any rate claiming that affection requires contact.

Action and passion properly understood are not possible between things which cannot be in contact with each other. (GC I.6, 322b22-4)

This is the third principle of scientific explanation:

**Contact:** Explanations must make clear how the agent makes contact with what it acts upon.

As with the agential synonymy principle, the contact principle can be satisfied in stronger and weaker ways. There is a strict or full sense of contact – contact in the *kuriôs* sense – which involves reciprocal interaction of the agent and patient.

Hence it is clear that those things are by nature in contact with one another, which, although being separate magnitudes have their extremes together at the same time and are capable of moving, or of being moved by, one another. (GC I.6, 323a10-11)

Every mover that is capable of being moved and for which immobility is rest is also moved, just as has been said. (For motion belongs to that of which immobility is rest.) For to act on the movable as such is just to move it. But this it does by contact, so that at the same time it suffers. (*Phys* III.2, 202a3-7)

This sort of contact is applicable to physical bodies and is the sort of contact that we encounter "for the most part" (GC I.6, 323a25). Ordinarily, when one thing moves another, the mover is also touched and so moved by that which it moves.

Aristotle thinks there are weaker senses of contact (contact not in the *kuriôs* sense), however. In many cases, the agent does not directly touch the patient, but does so by means of some intermediary movers. For example, a man might move a rock not by touching the rock directly, but by means of a stick. In cases where there is a causal chain of movements of this sort, the first mover can be said to touch, and so move, the thing that the last mover also touches.

Aristotle also describes in GC a still more attenuated sense in which contact can occur. For in the causal chain cases, it is reasonable to think that
the first mover in the chain might still make reciprocal contact with the next mover in the chain. But Aristotle also thinks it is possible for contact to be "one-way."<sup>26</sup>

It is possible, though, as we sometimes say, for the mover "just to touch" the thing moved, while the thing touched does not touch the thing that touches it.  $(GC I.6, 323a28-30)^{27}$ 

In cases of one-way contact, the mover is not moved in return. That is, the contact is not reciprocal.

Not everything that moves something moves it in the same way, but in some cases the mover, in moving, is also itself necessarily moved, while in other cases it is unmoved. (GC I.6, 323a12-14)

According to what I will call the "standard reading" of the discussions of one-way contact in GC I.6 and I.7, one-way contact is invoked to show that there can be, analogous to a first unmoved mover, a first unaffected agent.<sup>28</sup>

 $<sup>^{26}</sup>$  It is not clear whether the point in the *GC* passage is that the patient does not touch the first mover in return, or whether the last movers do not touch the agent when it touches them.

<sup>&</sup>lt;sup>27</sup> Aristotle provides as an example someone who grieves us. This person touches us, but he is not touched in return. On the face of it, this appears to be a metaphorical sense of "touching." But as Natali notes, there is a sense in which the man who grieves someone "provokes a physical movement, the boiling of the blood in his victim" (Natali 2004: 216).

 $<sup>^{28}</sup>$  I am not sure whether the standard picture is correct. First, Aristotle speaks of both the doctor and the medical art as a first mover in *GC*. He says that both the doctor and wine cure people (324a29-30). Second, this picture saddles Aristotle with a view about agency that is precisely the sort of view that Aristotle criticizes Plato for holding; the un-enmattered Platonic Forms, Aristotle thinks, are causally inert and nothing more than metaphorical causes, as we saw in Chapter One. It would be strange to find Aristotle endorsing such a Platonic view given that this is one of the main points of Aristotle's departure from Plato. In addition, I think that the "automata" passage at 734b5-17, which I will discuss below, could be used to construct an argument against the idea that it is the male's soul, rather than the male human being, who is the agent in generation. It is a bit hard to see why animal generation should cause the specific worry for Aristotle that it seems to, if the agent is the soul. The automata passage might, instead, provide reasons for giving a non-

Scholars disagree about what that first unaffected agent is, but there is some consensus that immaterial entities such as *technai* are examples of unaffected agents that make one-way contact with the patients.<sup>29</sup> When Aristotle explains how one-way contact is possible, he says that these unmoved movers and unaffected agents are not "in the same matter" (*GC* I.7, 324a34), or are not "in matter" (*GC* I.7, 324b4-5). It is not entirely clear what this is supposed to mean. But one obvious candidate for something not "in matter" or "in the same matter" in the soul of the craftsman (*PA* I.1, 640a31-2). According to the standard view, it is not strictly speaking the doctor or the man that is the first mover, but his *technê*. And this is an example of an unaffected agent that Aristotle gives:

If agent and patient have not the same matter, agent acts without being affected: thus the art of healing produces health.  $(GC \, I.7, 324a34-5)$ 

The *technê*, the "*logos* without the matter" in the craftsman's soul, can make contact with the patient, while remaining untouched. A *technê* is a "first agent" that acts on the body without itself being acted upon (GC I.7, 324a30). And more relevant for the purposes here, an organism's soul is also an unaffected agent, not "in the same matter" as the body on which it acts. A soul is "distinct from a spatial magnitude... although in it" (*De Motu* 9, 703a2-3).

According to the standard reading of the discussion of one-way contact in GC, the first unaffected agent will be something like a soul or *technê* which is not in matter (or not in the same kind of matter) as the patient, and so that agent can be wholly unaffected in acting upon the patient. Given the standard reading (according to which the first unaffected agents are immaterial agents), it seems as though almost any instance of the exercise of the craftsman's skill would need to involve intermediate agents that are

standard reading of the GC discussion of contact, according to which it is motivated not by the need to identify an unaffected first agent that is not "in matter," but rather by the need to explain how something that is not even in indirect contact at the same time as it acts can still be the agent. I will not give that argument here. I am going to assume that the standard picture is correct, and that first movers include incorporeal items like *technai* and souls. If this assumption is not correct, I will have to determine how this affects the interpretation I give in Chapter Four of the account of inherited characteristics in GA IV.3.

<sup>&</sup>lt;sup>29</sup> For scholars voicing the consensus view see Williams 1982: 123, Gill 1989: 199, and Joachim 1922: 154. For a dissenting opinion, see Wildberg 2004: 241.

reciprocally affected.<sup>30</sup> Although I know of no passages where Aristotle says so explicitly, it is reasonable to think that whenever there is a first, unaffected agent acting, there must also be "last agents," intermediate agents that make contact in the strict sense (GC I.7, 324a32).<sup>31</sup> That is, insofar as the effect that the unaffected agent has on the patient will consist in physical changes, there will also need to be physical bodies that make strict contact with the patient. So, for instance, whenever the medical art heals the patient, it does so by bringing about some change, say a change in temperature of the patient's blood. This change in temperature might be brought about by wine or food. These intermediate agents, such as wine or food used to produce health, can also be said to heal (GC I.7, 324a29-30), and do so by making contact in the strict sense:

For [the food] is heated or cooled or in some other way is acted upon while it is acting. (GC 324b2-3).

It is reasonable to think that unaffected agents can only act on the patients if there are also affected agents – last movers that make strict contact with and so also act on the patient. But conversely, affected agents or last movers only can be agents in virtue of there being a first, unaffected agent whose work they are accomplishing. Again, I know of no passage (save, perhaps, the arguments for an unmoved mover in *Physics* VIII) that makes this point explicit. But this certainly seems to be behind both the distinction between first and last movers (why is there any need for a first, unaffected agent at all, if the last movers are sufficient?), and remarks that Aristotle makes about the inadequacy of intermediate movers used in the production of crafts. These can only bring about the changes that they do insofar as they are related to a first mover.

This is what we find in the products of art; heat and cold may make the iron soft and hard, but what makes a sword is the

<sup>&</sup>lt;sup>30</sup> M.L. Gill, for instance, claims that "the doctor is the agent of health because he possesses the art of medicine; the art, which the doctor possesses, is the first cause or principle of health (324b3). Both the doctor and his art are movers. In addition, changes often include a cause that Aristotle calls the "last mover (324b28-29); for instance, the wine or bread prescribed by the doctor in effecting a cure (324b3-4). The last mover comes into direct physical contact with the entity moved and is itself moved by the moved" (Gill 1989: 199).

<sup>&</sup>lt;sup>31</sup> This would be the thought behind the *GA* passage cited above, where he claims that there is no affection without movement, on the first of the two readings I suggested.

movement of the tools employed, this movement containing the principle of the art. For the art is the starting-point and form of the product; only it exists in something else, whereas the movement of nature exists in the product itself, issuing from another nature which has the form in actuality. (GA II.1, 734b36-735a2)

Let me summarize this discussion of the principle of contact. Contact, quite generally, is simply the name for the conditions required for agents to act and patients to suffer, should nothing interfere. But there are stricter and weaker senses of contact. In the strict and most typical cases, contact is direct and reciprocal. In some cases, the agent can touch the patient indirectly, by way of intermediate last agents. The last agents make strict contact, and are also acted upon in return by the patient. Because the last agents make strict contact, they can be said to act upon the patient, despite not being the primary agent in which the principle of the change resides. Because the first unaffected agent does have the principle of the change, it can be said to act upon the patient, even though it does not make strict contact.

As we will see, Aristotle will make use of this distinction between first and last agents in GA in order to explain how the male (or his soul) can be the first agent, despite not making direct, reciprocal contact with the matter. But in addition, we will see that he relaxes the contact requirement even further in this case, in order to deal with some obvious facts about generation.

# 6. Contact in Generation of Animals

Earlier we saw how Aristotle's explanation of substantial generation applies the first two principles of explanation in a fairly straightforward way. The matter for the change is the *katamênia*, provided by the mother, which has, in potential, the soul or form. Thus the explanation satisfies causal hylomorphism. The male parent, having the form in actuality, passes on that form to the matter when the male and female copulate. Thus the explanation satisfies agential synonymy. In this section, we will see how the embryological account also satisfies the principle of contact.

Aristotle's explanation must satisfy the contact principle, but neither the male nor his soul makes strict contact with the *katamênia*. Like other complicated changes such as craft productions, the source of movement in animal generation makes only one-way contact. The male (or his soul) effects a change, but is not acted upon in return. The organism comes to be made from what the male provides just as the "healed patient comes to be out of the medical art" (729b20-21). Neither the medical art nor the soul is in strict contact with that upon which it acts.

What makes strict contact with the *katamênia*, analogous to the food or drugs that the doctor prescribes, is the male semen. Semen, like *katamênia*, is a result of concoction of nutritive blood. These residues, like blood, carry a natural heat that masters its moisture. The process of concoction – the mastery of moisture by heat – gives rise to "movements" both in the blood and in the generative fluids. Semen, like in nutritive blood, has a "movement and power in it" (729b5) that enables it to concoct the *katamênia*. Once the male's semen makes contact with the *katamênia* in the womb, it "sets" the passive potential in the menses, concocting it and making it assume its determinate form.

There are, then, some animals which are not formed from semen, as I have in fact said already. All blooded animals are formed from semen, as many as are formed as the result of copulation, with the male emitting semen into the female; when this has entered the female, the animals are "set" and take on their proper form. (GA II.1, 733b18-21)

Aristotle likens this initial "setting" to the coagulation of milk by fig-juice or rennet:

The male provides the form and the principle of the movement, the female provides the body, in other words, the material. Compare the coagulation of milk. Here, the milk is the body, and the fig-juice or the rennet contains the principle which causes it to set. The semen of the male acts in the same way as it gets divided up into portions within the female. (GA I.20, 729a9-14; trans. Peck)

When the material secreted by the female in the uterus has been set by the semen of the male (this acts in the same way as rennet acts upon milk, for rennet is a kind of milk containing vital heat, which brings into one mass and sets the similar material, and the relation of the semen to the *katamênia* is the same, milk and the *katamênia* being of the same nature) – when, I say, the more solid part comes together, the liquid is separated off from it, and as the earthy parts solidify membranes form all round it; this is both a necessary result and for a final cause, the former because the surface of a mass must solidify on heating as well as on cooling, the latter because the fetus must not be in a liquid but be separated from it. (GA II.4, 739b20-30; trans. Platt, modified)

Once the initial setting is complete, there is a rudimentary heart with an active power present in it to continue concocting the nourishment it receives from the mother, converting that nourishment into parts and organs as the body is developing. The ensuing development of the embryo occurs in stages, from less to more determinate.<sup>32</sup> The sequential of masteries of moisture – the changes or movements occurring in that first mixture of semen and *katamênia* – result in the sequential production of body parts.

Well then, the semen is such, and has such a movement and principle in it, such that when the movement stops, each of the parts comes to be and is ensouled. (GA II.1, 734b22-24)

The movements in the semen are the last movers, analogous to the last movers in craft cases.<sup>33</sup> The form that the male provides is conveyed by way of the last movers, just as the motions of the tools convey the *logos* of a *technê*.

<sup>&</sup>lt;sup>32</sup> "After the *archê* is formed, the other parts are formed, the internal ones earlier than the external, as I have said" (GA II.6, 741b25-26; trans. Peck). First, the umbilicus is sent to the uterus, like roots (GA II.7, 745b25). The umbilicus – "blood vessels in a sheath" (GA II.7, 745b26) – then carry the blood from the uterus that will nourish the new organism while it is still "incomplete" and cannot take in nourishment on its own. The heart is the first organ to be completed, from which blood vessels extend out (like "skeleton drawings on the walls"), and it is around these that the parts are formed (GA II.6, 743a1-2). As Aristotle explains in GA II.6, 743a2-17, once the blood vessels are formed, blood travels through them to form the rest of the parts. First the parts are formed only "in outline." When the nourishment "oozes" (*diapiduo*) through the pores and the blood vessels (like water through pottery), it becomes flesh (or its counterpart) as it cools. Sinews and bones are formed as moisture evaporates on account of the internal heat.

<sup>&</sup>lt;sup>33</sup> Among animals that do not emit semen, the movement is transferred directly: "For some of them do not emit semen but, just as those which do emit it fashion by the movement in the semen the mass forming from the material supplied by the female, so do the animals in question bring the same to pass and exert the same formative power by the movement within themselves in that part from whence the semen is secreted" (GA II.4, 738b10-15; trans. Platt)

The male does not emit semen at all in some animals, and where he does this is no part of the resulting embryo; just so no material part comes from the carpenter to the material, i.e. the wood in which he works, nor does any part of the carpenter's art exist within what he makes, but the shape and form are imparted from him to the material by means of the motion he sets up. It is his hands that move his tools, his tools that move the material; it is his knowledge of his art, and his soul, in which is the form, that move his hands or any other part of him with a motion of some definite kind, a motion varying with the varying nature of the object made. In like manner, in the male of those animals which emit semen, nature uses the semen as a tool and as possessing motion in actuality, just as tools are used in the products of any art, for in them lies in a certain sense the motion of the art. Such, then, is the way in which these males contribute to generation. (GA I.22, 730b9-24; trans. Platt)

Like a *technê*, the soul or nature of the male is the first mover, synonymous with that which it will bring about. In order to do so, both *technai* and souls use intermediate agents, "last movers," that make contact in the strict sense. These intermediate agents convey the form to the matter and make strict contact with it.<sup>34</sup> The intermediate agents are the "tools" of the first movers. They do the work, so to speak, of the first mover that uses them.<sup>35</sup>

<sup>&</sup>lt;sup>34</sup> The fact that the movements are last movers that make contact with the patient is exploited in Aristotle's account of resemblance, or lack of resemblance, to parents and ancestors in GA IV.3, as is discussed in Chapter Four. Aristotle explicitly refers to reciprocal affection in explaining why movements "relapse": "The reason why movements relapse is that the agent in its turn gets acted upon by that upon which it acts (e.g., a thing which cuts gets blunted by the thing which is cut, and a thing which heats gets cooled by the thing which is heated and, generally, any mover except the first mover is moved in return in some way, e.g., that which pushes gets pushed somehow in return, and that which squeezes gets squeezed in return" (768b15-20).

<sup>&</sup>lt;sup>35</sup> G. Freudenthal attempts to identify nutritive soul with "vital heat," which he thinks is "heat carrying informing movements" (Freudenthal 1995: 28). He notes that Aristotle will speak both of the vital heat as the agent responsible for the same vital activities that he also ascribes to nutritive soul. But it should not be inferred from this that vital heat and nutritive soul are *identical*, as Freudenthal does. Rather, Aristotle can treat both soul and heat as agents of

And as the products of art are made by means of the tools of the artist, or to put it more truly by means of their movement, and this is the activity of the art, and the art is the form of what is made in something else, so is it with the power of the nutritive soul. As later on in the case of mature animals and plants this soul causes growth from the nutriment, using heat and cold as its tools (for in these is the movement of the soul), and each thing comes into being in accordance with a certain formula, so also from the beginning does it form the product of nature. For the material by which this latter grows is the same as that from which it is constituted at first; consequently also the power which acts upon it is identical with that which originally generated it; if then this acting power is the nutritive soul, this is also the generative soul, and this is the nature of every organism, existing in all animals and plants. (GA II.4, 740b25-741a2)

There is one important disanalogy between the motions of a craftsman's tools and the movements in semen, which Aristotle is quite concerned to address. In a difficult passage at 733b23-735a29 Aristotle announces that there is a "considerable puzzle: about how plants and animals come to be out of (*ek*) seed – the first combination of semen and *katamênia* (733b23).<sup>36</sup> He refines the question to make clear that this is a puzzle not about the matter for generation, but about the agent. What is that "by which" the parts of the new organism are formed (733b31-32)?

He begins by posing a dilemma. The agent must be something either external to the seed and seminal fluid or something existing internally in it (733b32-33). He first dismisses the possibility that the agent is something external, alluding to the principle of contact: "it is impossible for something to move anything without making contact, and it is impossible for anything to be

the same effects because the heat, and movements it gives rise to, are subsidiary agents of soul; heat, or the movements it produces, perform the work of soul at a physical level. Also, I disagree with his description of vital heat as heat that has or carries movements. When Aristotle says that the movements are "in" (*en*) heat, this is the *en* of dependency. See *Physics* 210a14-24 for senses of *en*.

<sup>&</sup>lt;sup>36</sup> Since he is including plants, it seems that he means by *sperma* the first combination of the male and female principles, since these are not separate in plants. This is further confirmed by his use of *kuêma* at 734a5 to refer to the same thing that he uses *sperma* for elsewhere in the passage.

acted upon if something does not move it" (734a3-4). (He eventually reconsiders this rejection, as we will see.) The possibility that there is some agent in the seed is then also rejected. If there were some agent in the seed, it would have to be something that has soul, given the agential synonymy principle. But Aristotle denies that there can be anything that satisfies the agential synonymy principle in the seed.<sup>37</sup> So, the seed does have not an agent in it (734b2-3), and it seems that the agent cannot be something external (734b3). But these two options seem to be exhaustive (734b4). Aristotle's resolution of this puzzle involves showing how it is possible, in a way, for the agent to be external (734b5-7).

Recall that according to Aristotle's discussion of the weaker sense of "contact," he makes clear that an agent can make only one-way contact with the patient, and in this case the agent acts by way of intermediate last agents.

<sup>&</sup>lt;sup>37</sup> Aristotle's long argument for this denial goes as follows: He first establishes that if the agent were in the seed, it would have to be a part of the embryo that is being formed. He does so by setting up a dilemma and arguing against the possibility of embracing either horn. If the agent were something existing in the seed (he uses kuêma here), it would have to be either a part of it, or something separate from it (734a5-6). The idea that it is something separate is unreasonable (alogon) (734a5-7). For if that were the case, once the animal has been generated, then that separate part either remains or perishes (734a7-8). It is evident that nothing remains in the new animal or plant that is not a part of it (734a8-9). So it would have to be something that perishes, which is also absurd (atopon) (734a10). If it perished, it would have to do so either after having made all of the parts or after making some of them (734a9-10). If it perishes after making some of them, then how are the other parts formed (734a10-11)? Aristotle's reasoning seems to be that if we said that this separate part makes some of the internal organs, say the heart and liver, and then perishes, how are the rest of the parts and organs formed? If we say that it is the heart and liver that forms the rest of the parts, then what prevents these from also perishing after they make the next organ? By parity of reasoning (according to the same "same logos"), the parts that make the other parts would also perish, but they survive (734a11-13). Thus, the agent would have to be a part in the seed, and not something separate (734a13-14). And since there is no part of the body that does not have soul, some ensouled part would have to be present from the outset (734a14-16). He rejects this for the following reason: That ensouled part must have been made by that which made the seed, presumably the male's soul (734a36-b1). But seed, everyone agrees, is supposed to be made earlier than the parts that come to be out of it (734b1-2). That is, nothing can be made simultaneously with seed such that it is both present in the seed from the outset and also comes to be out of seed.

Those last agents, as well as the first unaffected agent, are agents. The discussions of contact in GC are ready-made for accommodating the sort of case that Aristotle describes in GA: The male (or his soul) is the agent who satisfies the synonymy principle. The last agents – his semen – need not satisfy the synonymy principle but can be agents in virtue of the way they are related to the first agent which does satisfy it, namely, by being a tool or last mover. So why is Aristotle so concerned about how the male, who does not make contact in the strict sense, or the semen, which does not satisfy agential synonymy, can act?

Aristotle's concern here is not that the male's soul does not make strict contact. The same reasoning would apply, after all, to the medical art, or any *technê* in the soul of a craftsman, since these can be said to act without making strict contact with the matter. And we know from GC I.6 and I.7 that Aristotle does think that a *technê* such as the medical art is an agent. The particular problem in the development of the embryo is not that the male's soul does not make strict contact. Rather, the problem is that the analogy between craftsmen and male parents breaks down. For in animal generation, the male is no longer even making one-way contact while the embryo's parts are being formed. The male can be miles away, or even dead, long before the embryo is brought to perfection.<sup>38</sup> So Aristotle needs a model for thinking about intermediate agents that are capable of continuing to move long after the first mover sets them going. For this purpose he points us to the "amazing puppets."

Perhaps something that was said cannot be said without qualification, for example how in the world it is not possible to come to be by something external. For in a way it is possible, and in a way it is not. Surely, to speak of semen or that from which semen comes makes no difference insofar as semen has the movement in it that the other [i.e., that from which the semen comes – the male parent] moved. And it is possible for A to move B, and B to move C, and to be like the amazing puppets. For the parts, while resting, have in a way a power. Whenever something external moves the first of the parts, straightaway the next one comes to be in actuality. Just as in the puppets, then, in a way that one [i.e., the external mover] moves not *now* being in contact with anything, but *having been* in

<sup>&</sup>lt;sup>38</sup> I am not sure why this would not be a problem for doctors healing patients as well. Suppose my doctor prescribes some regiment that I am to follow for one year, but then he dies before the year is over. I still follow the regiment, and I get well. Is the doctor not still the agent of my healing? It seems that the same worry should arise for cases like this, as well.

contact. And similarly that from which the semen came to be or that which made the semen, although *having made contact* with something, is *no longer* in contact. And in a way the internal movement [moves], just as the house-building [produces] the house."(GA II.1, 734b5-17)

Like the amazing puppets, the movements in the semen can continue to move long after the male sets the initial movements going. The male, the first "external" mover can continue to be the agent, even though he is no longer in contact. The movements in semen are more like movements of the amazing puppets than the motions of the craftsman's tools. In order for the craftsman's tools to be in motion, the first mover – the craftsman or his *technê* – must be in contact with those tools for the entire duration of the motions. The movements in the semen, on the other hand, can continue to be moved by the male (or his soul) even when he is no longer in contact with them.

The male – or his soul – satisfies the principle of contact by using semen as a tool or subsidiary agent in generation. The male's internal heat concocts his blood into semen and endows the semen with movements. Just as these movements in the adult's blood maintain the adult's body parts, when they are transferred to the *katamênia* by the semen, they produce the embryo's body parts. In both self-maintenance and generation, these movements are last agents used by soul, analogous to the motions of the craftsman's tools.

### 7. Conclusion

As a treatise of natural science, Aristotle's explanation of animal generation is an application of three general principles of scientific explanation. It reflects his strongly held commitments to hylomorphic causation, agential synonymy, and contact.

The female provides the matter, and the male provides the form. The *katamênia* is a residue concocted from the female's nutritive blood, and so is potentially all of the ensouled parts of the body it will become. The male, or his soul, is the agent, and has the form that he conveys to the matter in actuality.

The male provides the active principle, analogous to the way form is conveyed in craft productions, by way of movements in his semen. These movements are the subsidiary causes by which the male acts on the matter. The *technê* in an artist's soul – the form of the craft – does not cause some material to take on the form of the craft automatically when the craftsman comes into contact with the material, nor does the doctor who has knowledge of health cause sick patients to become healthy by touching them. In neither case does the first mover make strict contact with the patient. The form of the craft is conveyed from the craftsman's soul by way of the movements of his tools, and the knowledge of health in the soul of the doctor is conveyed by the treatments he prescribes. Both the form in the craftsman's soul and the subsidiary causes are agents that make the product, but the former is the primary agent. So too, the form that the *katamênia* comes to have in actuality (from having only in potential) is not conveyed directly, and so Aristotle's explanation in *Generation of Animals* identifies intermediate "last" agents that bring about the substantial change. The movements in the semen are the agents that make strict contact with the matter, conveying the form from the male.

# CHAPTER THREE INHERITED CHARACTERISTICS

### 1. Introduction

In Chapter Two, I treated Aristotle's explanation of animal reproduction as an application of a general framework for scientific explanation. I emphasized that the explanation is *hylomorphic*. The male provides the form or *eidos*, while the female provides the matter.<sup>39</sup> The male, who has the form in actuality, conveys it to the matter in a manner analogous to that in which house-form comes to be present in the bricks and stones.

Aristotle says at 715b3-4 that this theory is meant to account for the generation of animals that are the same in kind (*suggeneian*) as their parents (who are the same kind (*suggenôn*) as one other). At 730b33-731a1 he says that the male and female parent are the same in *eidos*. Thus it is reasonable to think that that the *explanandum* in this context is the production of organisms of the same species as the male and female parents, and thus that the form passed on is *species* level form. However, *Generation of Animals* explains more than the regular reproduction of animals the same in species. With the general theory of animal generation in place, Aristotle turns his attention at 767a35-b5 to the following phenomena, all of which are due to the "same causes":

Some offspring take after their parents and some do not; some take after their father, some after their mother, both with respect to the whole body and with respect to each part, and they take after their parents more than their earlier ancestors, and they take after their ancestors more than after any chance persons. Males take after their father more, females after their mother. Some take after none of the ancestors, although they take after some human being at any rate; others do not take after a human being at all in their appearance, but have gone so far that they resemble a monster.

<sup>&</sup>lt;sup>39</sup> This is repeated in a number of passages throughout GA, for example: 729a9-12 (where the action of the male's semen on the female's menstrual fluid or *katamênia* is compared to rennet coagulating milk), 729b18-21 (where the father's form is compared to what the doctor conveys to the patient), and 732a3-6 (where, in giving the reason for the separation of males and females, he says that it is better for the primary cause "to which belongs the *logos* and *eidos*" to be separate from the matter).

The causal explanation Aristotle goes on to provide shows how some of the features that vary among members of a species can be systematically traced back, through a mechanism of inheritance, to those same features in their ancestors. Aristotle does not say exactly which features are inherited, but it is clear that at least some of them will be features below the level of the species – features that vary from one individual to the next.

In this chapter, I discuss the problem that this account presents for our understanding of Aristotle's explanation of reproduction as a straightforward application of the general framework for scientific explanation outlined in Chapter Two. The most common response to this problem is to read GA as employing what I will call "sub-specific form." I will argue in this chapter that this is not a promising solution.

#### 2. Sub-specific Forms

Although the word for form (*eidos*) does not even occur in GA IV.3, the prevailing view in recent literature on Aristotle's embryology is that the only way to accommodate that account of inherited features within the framework of that earlier hylomorphic explanation is to see these features as included in the form that the offspring receives. For, it is clear from his discussion that variations among inherited features that are below the level of the species are not a function of differences in the matter in which the form is realized. The male, who certainly passes on his particular features, contributes no bodily part of himself to the embryo. Just as there is no part of the carpenter in the bed, nor any part of the doctor in the patient who is healed, the male's contribution to the generation of the offspring is form and not matter. Even if some material conveys the form – i.e., his semen – that form, and not the material, is the male's contribution. No bodily part needs to pass from the male to the female for the male to work upon the female residue, and even if it does, it is not *that* which is responsible for what is generated.

So it is clear that neither is it necessary that something go forth from the male, nor – if something does go forth – that the offspring has been generated on account of this, out of this (*ek toutou*) as an inhering thing (*enhuparchontos*), but as from the mover and form, like also the one having been made healthy by the art of healing. (GA I.21, 729b18-21)

Sub-specific, inherited variations are not due to matter. And since they are sub-specific, these cannot be due to species-level form either. Aristotle's treatment of inherited characteristics in *Generation of Animals* IV.3 has, consequently, led many scholars to conclude that the form passed on in reproduction cannot be a form shared by members of a species. A number of recent interpreters have claimed that if form is to play the causal role Aristotle assigns to it in generation, it must be a sub-specific form that includes features specific to the particular individual, and not just those common to all members of the species. M.L. Gill, for instance, writes that "in his treatment of inheritance in G.A. IV.3, Aristotle builds all material accidents (such as eye color) into the individual essence of the male parent to explain their replication" (Gill 1989: 125). C.D.C. Reeve remarks that "species form seems far too thin to explain the inheritance of specific traits" (Reeve 2000: 84). John Cooper expresses this sentiment in the introduction of his discussion of Aristotle's account of inherited characteristics with the following:

As is well known, Aristotle holds that it is a parent's form (more specifically, the father's form) that controls the offspring's formation as a member of the same species. But in that process, it also regularly happens that there come to be parental and more generally familial resemblances in the specific ways in which form becomes realized in the offspring. It is perhaps less well known that Aristotle holds that the parental form controls<sup>40</sup> those resemblances, or some of them, as well... (Cooper 1990: 56)

Cooper argues that the account of inherited features in GA IV.3 is evidence that Aristotle's biology makes no use of species form, but rather that all the work that species form might do "is already done by these more particular forms" (Cooper 1990: 84). Similarly, D.M. Balme claims that the account in GA provides evidence that the notion of a form common to the species is not one that Aristotle actually makes use of in his biological theories. Rather, the form used in biology is an individual, sub-specific form, whereas "the common form of the species is only a generality which 'accompanies' that likeness" (Balme 1987a: 291).

This conception of form as sub-specific conflicts with commonly received views about form in Aristotle's metaphysics. As discussed in Chapter One, form in metaphysical contexts is identified with essence. And subspecific features like snub-noses are not part of an organism's essence. Rather, Aristotle's conception of form outside of biology is most naturally understood as being at the level of generality of the species. Given that Aristotle's

<sup>&</sup>lt;sup>40</sup> Although Cooper says here only that form *controls* inherited resemblances, he is explicit elsewhere (such as in the passage quoted from Cooper 1990: 84) that he means that form *includes* inherited resemblances – i.e., that form is subspecific.

metaphysics and science are not divorced areas of inquiry, it would be unfortunate if we were forced to conclude that he is using a different conception of form in his actual scientific practices. The concepts and distinctions that the metaphysician employs earn their keep, so to speak, by being fruitful in scientific explanation.

Regardless of what we make of the apparent threat that this interpretation of form in embryology poses for the prevalent conception of form in metaphysical contexts, this interpretation faces a problem internal to the embryological theory as well. For, as Aristotle is fully aware, inherited traits can come from both parents. And so on the assumption that familial resemblance is due to form, maternal resemblance would also be due to form. However, Aristotle cannot consistently hold that (i) the form transmitted in animal reproduction includes all the sub-specific, inherited features, (ii) only the male provides form and only the female provides matter, and (iii) females also transmit sub-specific features.<sup>41</sup>

There are two strategies for resolving this tension that defenders of the sub-specific forms interpretation tend to adopt. Some attempt to deny (ii) by offering additional textual evidence that the mother provides form,<sup>42</sup> while others attempt to argue that the *father* is ultimately responsible for resemblance to the mother, denying (iii).<sup>43</sup> Neither of these strategies for defending the sub-

<sup>&</sup>lt;sup>41</sup> It is arguable that we could avoid inconsistency by changing (i) to (i\*): "The form transmitted in animal reproduction prescribes inherited, sub-specific features." For (i\*) leaves open the possibility that the offspring's form will include only those sub-specific features it inherited from the father. In this case, the features the offspring inherits from the mother might be conveyed by and due to the matter while only those that are inherited from the father are conveyed by and due to the substantial form. The triad of claims would not be inconsistent, but merely odd for the following two reasons. First, the mother contributes the same sorts of features as the male (e.g., a particular nose shape), so Aristotle would be saving that the same sort of feature will be a feature prescribed by form only if it was inherited from the father, but not when it was inherited from the mother. Further, even if we accept this asymmetry, it seems that after some finite number of generations, what the father would pass on would be only species-specific features anyway. Granted that maternal resemblance occurs fairly often, each successive generation will have fewer and fewer sub-specific features prescribed by or included in its form. I will not consider this alternative here; it is not one that defenders of the sub-specific forms interpretation adopt, as far as I am aware.

<sup>&</sup>lt;sup>42</sup> Balme 1987a; Henry 2006a; Peck 1942; Morsink 1982.

<sup>&</sup>lt;sup>43</sup> Cooper 1990; Reeve 2000. Furth 1988: 132 (with note 22) on the other hand, thinks that Aristotle's theory of reproduction simply breaks down once it is

specific forms interpretation are successful, and I think it is instructive to see why this is so.

After discussing these strategies, I will conclude by arguing that we should reject an assumption that gives the sub-specific forms interpretation its appeal. For it is commonly thought that inherited features must be due to the organism's substantial form since they are not merely accidental. But this inference relies upon an overly simplistic dichotomy between effects that are due to substantial form and those that are accidental. As I will argue, inherited sub-specific features can be non-accidentally caused, though not part of the form that the father conveys in sexual reproduction.

### 3. Inherited Characteristics are Not Accidental

Inherited features are importantly different from other sorts of variations that could be called "accidental." Inherited features are not, for instance, like the property of living in Athens, which has nothing to do with the reproductive process. Nor will an organism's sub-specific inheritable features include those sub-specific variations that are solely due to environmental contingencies, e.g., cold winds that affect the temperature of the parents' spermatic fluids, or the amount of the menstrual fluid that was available. An example of this sort of accidental variation is thickness of hair in humans. The reason that humans have hair at all, Aristotle tells us, is that hair protects us, and so mere possession of hair can be traced back to human form – i.e., they are traced back to what a human being is.<sup>44</sup> However, human hair comes in degrees of thickness, and human form will not prescribe anything more determinate than an acceptable range of hair thickness.<sup>45</sup> Rather than

<sup>&</sup>quot;confronted with some fairly apparent facts about heredity" (Substance, Form and Psyche: An Aristotelian metaphysics (Cambridge, 1988), 132 with n.22).

<sup>&</sup>lt;sup>44</sup> *PA* II.14, 658a18-19 with a21-24. For instance, humans walk upright and so need more protection for the "nobler" front side, and walking upright is traceable to human form. The need for protection also explains why humans have eyelashes on both upper and lower eyelids.

<sup>&</sup>lt;sup>45</sup> J. G. Lennox distinguishes between two ways of thinking about essential features or properties, and I am assuming that he is correct in attributing to Aristotle what he calls a "non-typological" model of essentialism (Lennox 2001a: 160-181). According to this model, kinds are constituted by "features with range": An essential feature is to be understood as one 'with range' in that what members of a kind share are features that all fall within some acceptable range of "more and less." This model is to be contrasted with that which countenances some set of qualitatively identical "basic" or "stock" features

being due to human form, the determinate thickness of one's hair is traced back to factors like the type of moisture and degree of heat that happened to be present while the skin was forming or when the pores were opening.<sup>46</sup> Thick hair, for instance, is due to the loose and thick skin having larger passages and being more "earthy" together with the oily fluid that was present, since hair grows when the fluid evaporates (GA V.3, 782a30-b5). Whether a human has loose and thick skin is in turn due to contingent features of both the environment and the materials available during generation. Thus, variations in hair thickness are caused by environmental contingencies, and not the organism's form. We can think of this type of sub-specific variation as the "byproducts" of animal generation.<sup>47</sup>

By contrast, in GA IV.3 Aristotle identifies movements (*kinêseis*) in the reproductive fluids from the parents as the *per se* causes of inherited features. These movements are drawn from (*apo*) certain potentials (*dunameis*) that belong to the generator "*qua* generator," and not accidentally:

and treats variations of more and less (e.g., thinner or thicker hair in humans) as "add-ons" to, rather than determinations of, the essential feature.

<sup>&</sup>lt;sup>46</sup> Of course, in organisms for which thick hair is either necessary or better for performing some essential function, the moving causal explanation of the production of that thick hair would also, presumably, be given in terms of the type of moisture and degree of heat that effects the size of the pores and type of skin. But in these cases, thick hair would not be an accidental variation, but would be for the sake of the form of the organism, and so would be included in the form. This raises a question about what difference being useful for some function makes to what we might think of as the physical mechanism by which some part is produced. This, I take it, is part of a larger issue about how to understand Aristotle's claims (e.g., in GA V.8, 789a8-789b2) that some phenomenon occurs both because it is better (i.e., for the sake of some function) and because it happens "of necessity" (i.e., it is due to factors like thickness and thinness of jawbone). This is not the place to address questions about the relation between formal and material natures, though any treatment of these would hopefully shed light on the contrast between features like thickness of hair in humans that are solely due to "material" factors and features that are due to form as well.

<sup>&</sup>lt;sup>47</sup> These are the *pathêmata* that Aristotle discusses in GA V which do not "contribute to the account of the being" (*pros ton logon sunteinei ton tês ousias*) of the organism (GA V.1, 778a34-b1). These, he says, have causes that must be traced back to the "matter and source of motion" and do *not* contribute to the *logos tês ousias*. For the view that even these *pathêmata* are due to the form, see Balme 1987a.

I speak of each potential in this manner. The generator is not only a male but also such a male, e.g. Coriscus or Socrates, and he is not only Coriscus but also human. And in this sense, some things that belong to the generator are closer and some further *qua* generator and not accidentally, like if he should be literate or someone's neighbor... For this reason, movements are present from the potentials in the spermatic fluids of all such things. (767b23-29, b35-36)

As Aristotle here explains, Coriscus *qua* generator is a human, a male, and a particular human male, and there are corresponding movements in his semen for forming parts and features that look like his. As we will see, because of the way that both semen and menstrual blood are formed, there will also be movements in the mother's contribution, the matter. Aristotle describes the mechanism by which the offspring comes to resemble one parent rather than the other in terms of these movements prevailing or failing to prevail. The movements that prevail will be the causes of the new organism's body parts and organs. If the male's movements prevail, the offspring will resemble him. If the male's movements are too weak, the movements from the mother will take over and the offspring will resemble her.

A movement can fail to prevail in two ways; it either "departs from type" (*existasthai*), or is "weakened" (*luesthai*). When a movement departs from type, it degenerates not into any chance thing, but into its opposite (768a2-3). For instance, a movement for male will degenerate into its opposite movement, which is a movement for female.

A movement departs from type either because of some deficiency in the *dunamis* of the active principle (*pettontos kai kinountos*), or on account of the coldness and bulk of the passive principle (*pettomenou kai diorizomenou*) (768b25ff). Both in the initial formation of body parts as well as their maintenance, nutritive blood is the matter that gets acted upon and portioned off into the body parts. If an organism's nature is unable to properly concoct the nourishment it takes in, the body parts will grow disproportionately. Aristotle elucidates this sort of failure by describing what happens when an athlete overeats. When an athlete takes in more nourishment than is needed to maintain his body parts, those parts will become disfigured because his nature – the active principle – is unable to prevail (*kratein*); his nature cannot effect proportionate growth by distributing the overabundance of nourishment evenly.

When a movement is "weakened" (*luesthai*), it changes into what is "nearest in line":

Less weakening is into a near [ancestor's movements], more weakening is into more distant [ancestor's movements]. (GA IV.3, 768b9-10)

The most minimal weakening of a male parent's movement, for example, is into a movement for resemblance to his father. Greater weakening results in a change into a movement for resemblance to his grandfather. In the most extreme cases of weakening, the movement will result in something that is "only human," i.e., the offspring does not resemble any of its ancestors.

The movements weaken (*luesthat*) during the process because of the interaction between movements from the male and female. As with all other changes, this productive process requires an agent and patient. When the agent and patient make contact, as we saw in Chapter Two, the patient reciprocally affects the agent.

...the agent is itself acted upon by that on which it acts; thus that which cuts is blunted by that which is cut by it, that which heats is cooled by that which is heated by it, and in general the moving cause (except in the case of the first cause of all) does itself receive some motion in return; e.g. what pushes is itself in a way pushed again and what crushes is itself crushed again. Sometimes it is altogether more acted upon than acting, so that what is heating or cooling something else is itself cooled or heated, sometimes having produced no effect, sometimes less than it has itself received. (This question has been treated in the special discussion of action and reaction, where it is laid down in what classes of things action and reaction exist.) (GA IV.3, 768b16-25)

According to the account in GA IV.3, when the male's movements prevail, the offspring will resemble him. If the male's movements depart from type, they change over (*metaballet*) into those corresponding movements from the female, and the offspring will generate parts that resemble hers. This is meant to explain why children will often bear a resemblance to one ancestor with respect to some features, and to other ancestors with respect to other features (768b1-3). And although Aristotle thinks that the natural occurrence (*malista pephuken*) is for the movement with respect to the male *dunamis* and the movement with respect to the particular father's *dunamis* will prevail or fail to prevail together,<sup>48</sup> sex and morphology may come apart:<sup>49</sup>

<sup>&</sup>lt;sup>48</sup> Henry 2007: 8) is right to note that the phrase "malista pephuken" in this passage does not mean that male offspring who resemble their fathers is the

If the movement drawn from the male (*apo tou arrenos*) prevails but that from Socrates does not prevail or the one from Socrates prevails but the one from the male does not, then it turns out that a male resembling his mother comes to be and a female resembling her father. (*GA* IV.3, 768a28-31)

The description of this mechanism explains why a son can look like his mother and a daughter can look like her father. Since there are movements drawn from the father insofar as he is not only male but also a particular male, in some cases the movements corresponding to his gender might prevail – yielding a male offspring – while the movements corresponding to his being a particular male do not.<sup>50</sup> In such cases the mother's movements (presumably corresponding to her being a particular female) take over, and the result will be a son who resembles his mother.

Moreover, the mechanism is supposed to explain resemblance to more remote ancestors on either the maternal or paternal line. For instance, there may be no degeneration with respect to the male *dunamis*, and so the offspring is male. But there can be failure of the movement drawn from the father insofar as he is a particular father (Socrates or Coriscus). Since the particular father is opposite to the particular mother, the degeneration is into the movement with respect to the mother insofar as she is a particular mother. But sometimes there is also a weakening, and in that case the movement from the mother can weaken into the movement from mother's mother. That maternal grandmother's movements will then be used to form the offspring's own body parts, and the offspring will resemble its maternal grandmother in certain respects.

#### 4. Maternal Resemblance and Sub-specific Form

<sup>&</sup>quot;ideal" reproductive outcome as scholars like Morsink, Balme, and Freudenthal have claimed. Rather, Aristotle is reporting what he takes to be an empirical fact: the male movements and particular father's movements usually prevail or fail to prevail together. Consequently, sons usually look like their fathers and daughters usually look like their mothers.

<sup>&</sup>lt;sup>49</sup> It is not clear that we should take sexual differences to be just differences in reproductive organs, since Aristotle says that whether the embryo is male or female depends on the degree of heat in the heart (since male and female are defined in terms of the ability and inability to fully concoct nutritive blood into semen). Cf. 728a18-21 and 765b8-17.

<sup>&</sup>lt;sup>50</sup> Or, conversely, the particular movements might prevail while those for being male do not, resulting in a daughter that looks like her father.

Although the details of the mechanism Aristotle describes in IV.3 are obscure, it is clear from his discussion of inheritable traits that these features are not simply accidental by-products. These inherited features are not due to contingencies in the available matter or the environment, and they are not the accidental results of some other process or processes. Inherited features are the *per se* results of certain movements, which movements are said to be drawn from potentials that the generator has non-accidentally *qua* generator, unlike being literate. Thus, inherited features are not, as some scholars say, "material accidents" – i.e., accidents due to the matter.<sup>51</sup>

Scholars tend to infer from this that those potentials that belong to Coriscus *qua* generator and non-accidentally must be part of his *form* and so part of the *form* he passes on to his offspring.<sup>52</sup> And since some of these non-accidental potentials are clearly not species-specific, the notion of form Aristotle uses to explain inherited characteristics seems on this view to be subspecific.

Females, as well as males, can pass on particular features to their offspring, however. As the account of inherited characteristics in GA IV.3 has it, the offspring will resemble the female whenever those from the male do not master her movements.

If the movement derived from being male prevails, but [the movement] derived from being *Socrates* does not prevail, or the latter prevails and the former does not, then it will turn out that a male comes to be who resembles the mother in the one case and a female who resembles the father in the other. But if the

<sup>&</sup>lt;sup>51</sup> Witt claims that "one point of almost universal agreement is that the form or essence does not include accidental, material features of the object" (Witt 1985: 46). According to R.W. Sharples, "it seems that both for Aristotle and for Alexander there is in principle a distinction between what is essential to every member of a species and what is not, the latter being accidents due to the matter in each individual" (Sharples 2005: 104) The English expression "material accident" has no strict equivalent in Aristotle's Greek, and it is unclear what sort or sorts of effects scholars mean to pick out by that expression. It appears to be used to refer to features that are not due to form, but as we will see below, not all features that are not due to substantial form are accidental, nor are they all due to matter. In my view, the mistaken assumption that there is an exhaustive dichotomy between effects that are due to form and those that are accidents is the motivation for the sub-specific forms interpretation.

<sup>&</sup>lt;sup>52</sup> I discuss this inference in the last section of this chapter.

movements weaken, and the movement with respect to being male remains, but [the movement] from *Socrates* weakens into the movement of his father, there will be a male resembling the grandfather or some other of the remote ancestors, according to this account. But if the [movement] with respect to being male is mastered, there will be a female usually resembling the mother. But if also that movement [with respect to being a particular female] weakens, there will be a likeness to her mother or some other of the remote ancestors, according to this account. (*GA* IV.3, 768a28-b1)

If inherited characteristics are part of the form, it seems that the resemblances to females would also have to be due to form. A common reaction among scholars is to take this as an indication of a need to qualify or amend our understanding of Aristotle's reproductive hylomorphism. Morsink, for example, takes this "admission" of a contribution from the mother to be a qualification of the causal hylomorphism (Morsink 1982: 138) Balme tries to downplay this tension by claiming that Aristotle's statement that the male provides form and the female provides matter is "only true when carefully qualified" (Balme 1987a: 294 note 4). Devin Henry has recently defended a view according to which reproductive hylomorphism is really the thesis that the male provides sensory soul (Henry 2006a). Like Henry, Peck argues that the female's role is more extensive than Aristotle's more general comments might lead us to think; in fact, the female provides not just matter but also nutritive soul (Peck 1942). Since a living organism's form is its soul, this means that the female provides at least part of the offspring's form. Peck thinks this is evident in Aristotle's discussion of a phenomenon he calls "wind eggs." In the next section we will look more closely at the evidence that Peck adduces in order to see whether there is, as Peck thinks, good evidence for revising the earlier hylomorphic account according to which the mother is said to provide matter, and not form.

## 5. Wind Eggs

Is there any evidence that Aristotle thought that females contribute form? There are at least some respects in which the female's contribution might be thought of as involving form. The matter that she provides – the menstrual blood – is far from inert or featureless. In his preface to GA, Peck points out that the matter in the context of biological reproduction has a quite complex form (Peck 1942: xiii). As Aristotle explains, the menstrual fluid or *katamênia*, like the father's semen, is a residue "cooked up" from the blood that nourishes and constructs the organism's body. Because it is a residue from this blood, the *katamênia* has, in potential, all the parts of the living body that come to be formed out of it (GA II.3, 737a22-4). In fact, even though that residue will not be potent enough to allow her to reproduce on her own (since females are less hot than males and so the female's *katamênia* is not as well concocted as the male's semen), Aristotle does seem to think that in some cases, females can generate up to a point (GA I.21, 730a30-1). Some female animals, Aristotle claims, can make "wind eggs," which are a sort of unfertilized egg (GA I.21, 730a4-7) that is nevertheless alive in some way (GA II.5, 741a19-21).

The topic of wind eggs arises prominently in GA II. At the end of GA II.4 Aristotle concludes that for reproduction "among the animals in which [the males and females are separate], the female needs the male" (741a4-5). He then begins GA II.5 by asking why that should be the case:

And yet someone might puzzle about what the cause of this is. If indeed the female has the same soul and the matter is the female's residue, why does she need the male and not generate all on her own? (741a6-9)

In living organisms, the form is the soul. Among animals, adult females have the same sort of soul as the male. Since the female provides the matter, she seems to have both the form and the matter *herself*. So, Aristotle asks, why does she need the male at all in order to reproduce? His answer is given at 741a9-15:

The reason is that an animal differs from a plant with respect to sensation. It is impossible for a face or hand or flesh or any other part to exist if it does not have sentient soul either in actuality or in potentiality or in some way or just simply. For it will be like a corpse or part of a corpse. If then the male is the agent of this sort of soul, wherever the female and male are separate it is impossible for the female to generate an animal all by herself.

Aristotle here suggests that the reason a female cannot generate a new animal all by herself is that she cannot provide *sentient* soul, the possession of which differentiates animals from plants.<sup>53</sup> For Aristotle, even plants have soul, but there is a hierarchy of types of soul and plants have only the lowest kind – nutritive soul. Nutritive soul is the set of capacities an organism has for performing basic vital activities like nutrition and maintenance. In addition to nutritive soul, animals have sentient soul. And humans will have not only nutritive soul and sentient but also rational soul. In the passage above,

<sup>&</sup>lt;sup>53</sup> Cf. De anima II.2, 413b1-4

Aristotle says that males are necessary for animal generation because males provide sentient soul; being able to provide sentient soul is "what it is to be" the male (741a13-16).

Still, Aristotle acknowledges that there is reason to be puzzled, particularly since females of some bird species produce what he calls "wind eggs." Although these wind eggs are not alive in the same way that fertilized eggs are, they do perish, which seems to indicate that they were alive in some sense. Wind eggs are not completely devoid of life like wooden or stone eggs (741a18-23).

Peck takes this to show that the female must also contribute form:

Hence, the meaning of the statement that "the male supplies the Form" can only be that the male supplies that part of the Form known as sentient Soul: everything else, including nutritive Soul, can be, and is, supplied by the female. (Peck 1942: xiii)

Yet Peck's suggestion that the female provides everything except that part of soul in virtue of which an organism is an animal – sentient or perceptive soul – is questionable. It is doubtful that the mother supplies the nutritive soul in an unqualified way. While Aristotle does say that wind eggs have soul, he adds that it is clear that they have soul only potentially (741a23).<sup>54</sup> Wind eggs do not *actually* have nutritive soul.

There are living organisms that have nutritive soul in actuality but lack sentient soul, namely, plants. But Aristotle does not think that the mother makes a plant that can then become an animal once sentient soul is added.<sup>55</sup> Although it is *like* a plant in that it has nutritive soul, the wind egg is not, strictly speaking, a plant. Wind eggs are not generated in the way that plants are, and will not develop further (as a plant would).

For neither has [the wind egg] come to be as a plant simply (*haplôs*), nor as an animal by copulation. (*GA* III.7, 757b26-7)

<sup>&</sup>lt;sup>54</sup> In the subsequent lines Aristotle makes explicit that he means they have *nutritive* soul in potential.

<sup>&</sup>lt;sup>55</sup> Aristotle does liken the embryo's life to that of a plant at 736b12-13. However, in this passage Aristotle's point is that the newly forming animal is at this stage in possession of nutritive soul only potentially, and not actually, since it does not digest its own nourishment. It is thus like a plant insofar as the plant's "digestion" takes place in the soil in which it is living. It is only in this respect that Aristotle thinks embryos are like plants. The embryo at this stage is certainly unlike a plant that has nutritive soul in actuality.

Moreover, Aristotle says that nothing *actually* living – nothing ensouled (*empsuchon*) – is made by the mother (737a32). Thus, even if wind eggs are plant-like, an organism only has nutritive soul *in actuality* when it has the parts or organs that are needed to perform nutritive soul functions, which parts and organs a wind egg does not have.<sup>56</sup>

# 6. The Matter for Change

There may still be room to argue that this discussion of wind eggs shows that the female can sometimes contribute nutritive soul on her own. This nutritive soul would presumably not be the same sort of nutritive soul that a plant has, and might even include the potential presence of sentient soul. However, even if it were the case that sometimes females can contribute an animal's nutritive soul, this still would not show that Aristotle thinks this is what *usually* happens or that it happens among animals other than birds; more argument is needed for the claim that her role always extends as far as contributing something that actually has nutritive soul. Moreover, even if it could be shown that the mother's contribution – the *katamênia* – is something that has form, there is a more general worry about inferring from this that she provides part of the offspring's form. This inference makes use of too crude a picture of what it is to be the matter for some change.

As Aristotle conceives of matter, it is not just physical stuff of the sort studied in Materials Science departments today. Matter is one of the four causal factors Aristotle introduced in the *Physics*, where it is called the cause as "that out of which something comes to be as a constituent" (194b23-4). Bronze, for example, is the matter of the statue that comes to be formed out of it.

What counts as the matter for any given change depends upon what that change is a change *into*. Aristotle calls that which the change is a change into in this sense the "form" for the change. As Aristotle tells us explicitly in the *Physics*, "matter is relative; for there is different matter for a different form" (194b8-9). For instance, clay might be the matter for the bricks, while bricks are the matter for the house, but clay is not, strictly speaking, the matter for the house. The clay takes on brick form and the bricks take on house form,

<sup>&</sup>lt;sup>56</sup> Cf. 734b24ff. This is also why the *sperma* and *kuêma* have nutritive soul only *potentially* at 736b8-12: "Well then, it is clear that the *spermata* and *kuêmata* which are not yet separate on the one hand have nutritive soul potentially, but on the other hand do not have it in actuality until, just as the separated *kuêmata*, they draw in nourishment and do the work of this sort of soul."

but the change into a house is not a change of which the clay is the matter. So whether something is the matter for some change or not depends upon what the form of the change is.<sup>57</sup>

That which plays the role of the matter for a change will itself be something of some sort, a hylomorphic composite of form and matter. Thus, the matter for a change will have some formal cause of its own, as well as features and properties that belong to it non-accidentally.<sup>58</sup> But that does not imply that it cannot play the role of matter in a particular change. Bricks, for instance, have form, and they have features or properties that can be manifest in the completed house (e.g., their color or texture) without thereby making a "formal" contribution to the house in the sense of contributing the form of the house. Aristotle may have thought that the brick maker provides form brick form – to the clay the bricks are made from. But he does not think that for this reason the brick maker provides part of the house form; this is what the house builder provides. Similarly, the mother's role is to provide the matter for animal generation, and this matter is quite complex - perhaps even to the point of having nutritive soul in a qualified way.<sup>59</sup> But this does not change the fact that the mother is contributing the matter for the substantial change, and not form. When Aristotle says that the mother is the passive element that provides the matter and the father is the active element that provides the form, he is distinguishing their *roles* in the substantial change. To say that "matter qua

<sup>&</sup>lt;sup>57</sup> Cf. *Metaphysics* IX.7, 1048b37-1049a18. The point that clay is not, properly speaking, the matter for the house might alternatively be put by saying that bricks are potential houses to a greater degree than is the clay that the brick maker uses to make the bricks. The matter for a change must have the form potentially, and it is common Aristotelian doctrine that there are grades of actuality and potentiality. Cf. also DA II.5, 417a21-b2. This Aristotelian doctrine is discussed in Code 1987: 56-7. As Code points out, both the form and the matter for the developing embryo can exist at varying levels of passive and active potentiality, respectively. What I want to emphasize here is that the matter the mother provides can be at a high level of passive potentiality without thereby playing an active, rather than passive, role.

<sup>&</sup>lt;sup>58</sup> If Aristotle believed in prime matter, then it would only be in most cases that the matter is a hylomorphic composite.

<sup>&</sup>lt;sup>59</sup> Even if it were the case that wind eggs had nutritive soul unqualifiedly – and I do not think they do – that would not blur the distinction between the female's contribution and the male's. In this case, what would be potentially an animal, in need only of contact with the appropriate active potential, would be not her menstrual fluid but that wind egg that she makes. She would still provide only the matter for the substantial change.

matter is passive" (GC I.7, 324b18) is to say something about *how* matter contributes to some change, and not *what* matter contributes.<sup>60</sup>

Aristotle's discussion of wind eggs does not provide the textual evidence needed for rejecting or amending Aristotle's repeated claim that the female does not contribute form. First, the textual evidence adduced is questionable, since it is not clear that Aristotle thinks that wind eggs are actually ensouled. Second, even if they were, Aristotle's views about the relation between matter and form would not preclude the mother from providing solely the matter for animal generation, even if that matter were "informed" to a high degree. If those movements in the female's *katamênia* are the *per se* causes of those inherited features by which the offspring resembles its mother, then those features cannot be due to the form.

## 7. Potential Movements

An alternative strategy for resolving the tension between maternal inheritance and sub-specific forms is to deny that the movements responsible for maternal resemblance come from the mother. Rather, we might suppose that on Aristotle's view, reproductive hylomorphism is supposed to go all the way down to those inherited characteristics. The father is responsible for all the features of its offspring, including those features by which the offspring resembles its mother and maternal ancestors. Consequently, since all those features that are passed on to the offspring are due to the male, there is no tension between reproductive hylomorphism and the interpretation of forms as sub-specific.

If we are to adopt this view we must explain *how* the father is responsible for all those features, in particular for those that seem to be traced back to movements in the mother's menstrual fluid. One influential strategy, which John Cooper has employed, is to appeal to GA 768a11-14 where Aristotle says that the mother's movements, as well as those of the ancestors, are present *in potential*:

Some of the movements are present (*eneisi*) in actuality, and some in potential; in actuality are those of the generator and of the universal like human and animal, in potential those of the female and of the ancestors.

<sup>&</sup>lt;sup>60</sup>Cf. GA I.21, 729b12-13: "Of course the female *qua* female is passive, the male *qua* male is active."

Cooper reads this passage as claiming that those movements that will be responsible for maternal resemblance, if actualized, are potentially *in the male semen*. Consequently, the father is responsible for those maternal-resembling features in the offspring by being responsible for those movements that are potentially present (wherever they are) becoming actually present. In this way, maternal resemblance creates no problem for maintaining both that forms passed on in animal reproduction are sub-specific and that Aristotle endorses reproductive hylomorphism.<sup>61</sup>

Cooper gives a controversial interpretation of that passage at 768a11-14 that I just cited, and it is worth taking a moment to go through the points of controversy. First, it is not clear *which* movements are present potentially. Devin Henry argues that rather than movements for resemblances to the particular mother, the potentially present movements are movements, at best, that determine the organism's sex. According to Henry, "throughout GA IV 3 Aristotle uses *mêtêr* to signal such [sc. particular] resemblance, whereas *thêlu* is used exclusively in connection with the sex of the animal" (Henry 2006a: 287).

Henry cites the passage at 768a5-9, where Aristotle contrasts movements for male (*arren*) and female (*thêlu*) with those from *Socrates* and the particular mother (*mêtêr*). Henry argues that the passage Cooper appeals to says only that the movements for sex, and not those for the particular features, are in the male's semen. This would greatly minimize the extent to which that passage at 768a14 is evidence for Cooper's view. For, that passage would at most be evidence that the male's semen has movements for determining the offspring's sex.

It is not clear that Aristotle strictly maintains this distinction between *thêlu* and *mêtêr*, or *arren* and *patêr*. At least, it is not clear that Aristotle always uses *mêtêr* to refer exclusively to particular mothers. At 768a6-9, for instance, just after the passage Henry cites, Aristotle explains why departure of the male's movements from type involves a change into movements for a female,

<sup>&</sup>lt;sup>61</sup> C.D.C. Reeve offers a slightly different strategy for attributing those movements to the father that appeals to Aristotle's view that females are deformed males. According to Reeve, the movements in the female's menses alter and so deform the male's movements, which movements are transmitted to the offspring: "Generalizing, we can say that whenever a movement deriving from a male form is altered or deformed by the natural tendencies in the female menses, the resulting fetus itself be deformed (GA IV 3 767a36-b15). But it will be deformed, as opposed to having an undeformed form contributed by its mother, precisely because it is always the father who contributes the actual movements that concoct the menses" (Reeve 2000: 53-4).

and why the particular male's movements will turn into those for the particular female:

For just as generally the mother (*mêtêr*) is opposite to the father (*patri*) also the particular (*kath'hekaston*) female generator (*gennôsa*) is opposite to the particular (*kath'hekaston*) male generator (*gennônti*). (*GA* IV.3, 768a6-9)

In this passage, Aristotle seems to be using *mêtêr* and *patêr* more generally than the distinction Henry that draws between females and mothers suggests. For, the sense of the contrast here is between the *particular* generators and generators considered in general. That is, Aristotle seems to be contrasting mothers and fathers considered generally with the particulars that are the mothers and fathers. Mothers and fathers are opposites in reproduction, considered generally, and so, too, the particular mother is opposite the particular father. Since Aristotle here uses *mêtêr* to refer to mothers in general, it is not the case that he only uses it to refer to the particular mother. This is not very damaging to the idea that there is a distinction between mothers and females, however, which is all Henry needs to make his point: It is the *female* movements that are said to be present in potential. An objection to that distinction would require evidence that Aristotle uses *thêlu* to refer not to female *qua* sex, but that he ever uses it to refer to mothers or a particular mother.

Another problem for Henry's interpretation is the occurrence of *thêleiôn* at 768a19. In that passage, Aristotle is explaining how weakening works on the side of the *thêleiôn*, parallel to the way it works on the male's side:

In this way [both on the side of the males and] also on the side of the females (*thêleiôn*), the movement from the female generator (*gennôsês*) weakens into the movement from her mother (*mêtêr*), and if not into that movement then it weakens into that of her grandmother. (768a18-21)

Here it appears that Aristotle is using *thêleiôn* to refer to the particular mother. It is the particular male and female's movements that weaken, so talk of male and female here must mean particular fathers and mothers. However, all mothers are *female*. So, it would be reasonable for Aristotle to distinguish between females and mothers, yet occasionally speak of males and females (the father and mothers in generation), elliptically for fathers and mothers.

These passages are not decisive, and I am not inclined to press further, since Henry's suggestion does have a good deal of plausibility: It is plausible that Aristotle means only to indicate female sex rather than the particular mother if for no other reason than that *thêlu* means "female," not "mother." Although it could be the case that Aristotle is simply speaking about the female in generation, namely, the mother, it is not the case that he must be speaking of the particular mother, and he does not seem to be using *thêlu* and *mêtêr* indiscriminately in this chapter.

The second problem with Cooper's interpretation has to do with where the movements (whether for female sex or for resemblance to the particular mother) are supposed to be. For it is not clear that these movements are *in the male's semen*, as Cooper insists:

Now the sentence at 768a11-14 is the only explicit indication in his text that Aristotle postulated movements somehow potentially present in a male's fluid capable of imposing on an embryo bodily resemblances to its mother's side of the family. Regrettably, he does not pause to explain how we are to understand this "potential" presence (and how we are to relate it to the "potential" presence of the movements for resemblances to the male's own ancestors). (Cooper 1990: 71)

Pace Cooper, it is not explicit at 768a11-14 that those movements are in the male's semen. All that this passage says is that they are "present in" something, but does not say what. Cooper claims that the dative spermasi at 767b36 is the only candidate for the verb eneisi at 768a11. Just before 767b36 Aristotle has been talking about the movements derived from (apo) the dunameis that belong to the generator qua generator and non-accidentally, and says these movements are in the spermasi (hai kinêseis en tois spermasi). So Cooper thinks that when, roughly fifteen lines later, Aristotle speaks of movements being in something, it is obvious that we are to understand they are in the spermasi.

There is an alternative that Cooper does not mention, namely, the dative *genesei* at 768a2. While Aristotle does not here speak of movements in the *genesis*, he does speak of what is "not mastered" in the *genesis*, and we know that what is or is not mastered in this context is a movement. If this is right, Aristotle at 768a11-14 is speaking of those movements as actually or potentially present during the process of coming to be – movements present in or during the *genesis*. Being "present in" would not then specify a location (in the male's semen as opposed to the female's *katamênia*, for example), but rather the circumstances or time during which those movements are present either actually or potentially.

That said, Cooper's claim that it is the *spermasi* that the movements are in at 768a11-14 is the more straightforward reading; there may seem to be

something strained about talk of movements "in the process of generation." However, even if we do take *spermasi* to complete *eneisi*, it is not uncontroversial that *spermasi* must refer to the male's semen only.<sup>62</sup> The first indication that it might not be is the use of the plural: Aristotle does not regularly refer to the male's semen as *spermata* but rather as *sperma*.<sup>63</sup> Moreover, although Aristotle often uses *sperma* to refer to the male's spermatic residue, he does not do so exclusively. He sometimes uses it to refer to the mother's menstrual fluid as well as to the first mixture of the male's and female's residues, namely, the embryo.<sup>64</sup> Insofar as we are assuming that these are the *particular* mother's movements and not simply for sex, either the embryo or the female's menstrual fluid seem a much more plausible place for these to be present, even if only potentially. For what does it mean for these movements to be present, even potentially, in the male's semen?

Cooper's answer to this brings us to our last point of controversy about his interpretation, namely, his interpretation of the claim that – wherever those movements are being said to be present – they exist there only *in potential*. As Cooper understands this, Aristotle is claiming here that these movements of the female and ancestors are potentially present until they

<sup>&</sup>lt;sup>62</sup> As claimed in Cooper 1990: 70 note 14.

<sup>&</sup>lt;sup>63</sup> Aristotle could be talking about many or all males' *spermata*. In the passage he has been talking about a particular male, though, so this would be a slight shift. <sup>64</sup> Aristotle's predecessors used *sperma* to refer to the female seed, so in contexts in which he is discussing their views, Aristotle will follow suit. This does not reflect his carefully considered view about the female contribution since he does not think it is just like the male's - so the use of *sperma* in those contexts is not good evidence against Cooper's reading. The same goes for the fact that he also uses sperma early on in Book I to refer more generally to what generation is out of, where he clearly means both parents' spermatic residues, since this use precedes the discussion in which he argues for a distinction between the female and the male contributions. However, Aristotle also uses sperma in other contexts to pick out the female residue, e.g., at 737a27-9: "For the female just like a deformed male and the katamênia is sperma, but not pure." See also 766b12-14: "The sperma of the male differs [from the female's] because it has the principle in it such as to move (kinein) an thoroughly concoct the final nourishment, but the sperma of the female has matter alone." And sperma is also used to refer to the seed of the plant, and to the first mixture of male and female residues at 724b12-22. In this passage, Aristotle distinguishes gonê (semen) from sperma, identifying the latter with the first mixture from both parents, like the seed of a plant. (Peck thinks the passage at 724b12-22 is an interpolation.)

become *actual* movements by the father's agency. Cooper thinks that the father (and only the father) is assigned responsibility for bringing about the features that those potential movements will result in if they are made actual – which movements the father's agency makes actual – simply because it was his agency that made them actual. Since the father has the potential to make those movements actual, Cooper suggests that in this "weak" way those movements are potentially in his semen.

Insofar as the mother's contribution is the passive principle for substantial generation, the movements in her menstrual fluid could never be more than the *potential* causes of anything were the father not performing his role. Among animals that have both male and female members, Aristotle insists that the mother cannot produce animals on her own. So in a sense it is trivially true that any feature that the matter for a change has is only a potential cause of that feature in the finished product. For example, a knot in some bit of wood being used to make a table is only potentially a circle in a table's surface design until the carpenter makes use of it, even if that circle is not part of the form that carpenter conveys to the matter.

Given the context in which this claim is made, it is not unlikely that it is something like this trivial sense of "potential presence" that is intended. This claim is made for the first time at 768a11-14, just after introducing the mechanism whereby certain movements may depart from type or weaken. In the context of discussing these two sorts of failure to master, it becomes necessary to draw a distinction among the movements. That is, this mechanism requires some initial asymmetry between the various movements. Some of the movements must be the ones that are supposed to prevail, but sometimes fail to do so; some of the movements are the ones that take over in the event that those others fail.

This initial asymmetry is put in terms of the contrast between actual and potential movements. The movements that are present in actuality are those "of the generator and universal like human and animal," those present in potentiality are those "of the female and ancestors" (768a12-14). Since males are the active principles in the substantial change, it is only to be expected that the male's movements are actually present. After all, if the male were not contributing the active principle for the substantial generation, those movements in the mother's menstrual fluid would remain only latent potentials. So in this way the relegation of the some of the movements to mere "potential presence" is needed to complete the account of the two types of failure, which account Aristotle needs in order to explain why there can be different permutations of familial resemblance – to some relatives in some respects, to others in other respects.

Sometimes it seems as though Cooper has just such a reading in mind:

On [Aristotle's] view, reaffirmed in this chapter at 768b16 and 25-7, the semen is the active, formative agent, the catamenia the passive material in the generative process. As being the material from which the offspring is constructed the catamenia cannot initiate any of the movements that fashion the offspring, or determine directly the course which any of these movements take. (Cooper 1990: 71)

However, Cooper's reading of "potential presence" is much stronger. On the reading that I have been suggesting, the female would still provide these movements, even if they were potential movements in her menstrual fluid until the requisite interaction with the male's semen occurs. But Cooper insists these movements are potentially *in the male's semen*.

This of course raises a question about how the female's movements could come to be present in the semen, even potentially. Cooper offers two suggestions. According to the first, it is the male's movements that will "elevate" the movements that are in the *katamênia*, making them "formal" movements that can then be used to construct the organism's body. Thus that potential presence of the female movements in the male's semen is to be understood as "the potentiality in a male's sperm to do this job: the power to work on the materials provided by the mother so as to elevate to the level of formal movements material movements already actually there (because they carried the instructions for the formation of her own bodily parts) or potentially present (as underlying traces inherited from her ancestors)" (Cooper 1990: 72).

If we adopt this explanation, it is not clear why this is a way of being present potentially *in the male's semen*. Aristotle does not say that a feature in some wood the craftsman works upon is even potentially *in* the craftsman. Cooper says this is a "weak" way of being present in potential. It is not clear that it is a sense that Aristotle countenances, however, and Cooper offers no evidence or precedents for such a sense being used elsewhere in the Aristotelian corpus.

Cooper's second suggested explanation of the potential presence of the movements in the male's semen is stronger. Cooper suggests that there is a way in which those movements present in the *katamênia* and nutritive blood are also carried in the male's semen, though only in potential:

For it seems reasonable to think that an animal's semen has movements for his own ancestors (in respect in which he does not himself resemble them) in some underlying, non-actual, but nonetheless physically realized way. So perhaps Aristotle is thinking that there is in the semen some physically realized representation of the movements of the females he can copulate successfully with (and their ancestors). (p.72)

As Cooper recognizes, one might feel some "discomfort" in attributing this view to Aristotle, given the lack of evidence for it and the substantial commitments it involves. Cooper wants to construe this as something "quite general and vague." Perhaps he means that certain males will carry potential movements for certain sorts of features, say for pointy noses, movements for which features will be present in the *katamênia* of the females (and their ancestors) who are viable mating partners. (That is, perhaps Cooper thinks that the male's semen will carry many movements in potential that are merely type-identical to the movements in the *katamênia* of his prospective mates.) But even if so construed, this second explanation is somewhat implausible. And this view is not only implausible – implausibility alone does not tell against an interpretation of Aristotle's biology – but it also lacks textual support. Even more so than the first, this explanation of potential presence should be adopted only as a last resort, if there are no further options.

Fortunately, there are other options. One option is that we understand the potential presence in the weak sense I sketched above, namely, as indicating the way that movements from the female must be present, given that they can only be actual movements if that matter that carries those movements is acted upon. On this reading, those movements would not be in the male's semen; these movements would be present in that which is the passive factor of the change. We saw earlier that Aristotle does not make explicit where the movements that are present potentially are present, and it is possible that they are in the menstrual fluid or in the embryonic heart. Either of these latter options is far preferable location for those maternal movements than the male's semen.

## 8. The Bad Inference

To recapitulate the discussion thus far, we began with the idea that those features that are neither shared by members of a species nor mere accidental differences between instances of the kind are not differences in the matter in which the form is instantiated. Scholars think that these must instead be differences in the form. But if the concept of form employed in the explanation of reproduction is of one that includes features below the level of the species, it is unclear how Aristotle can consistently explain maternal resemblance. The features by which an offspring resembles its mother and her ancestors are caused by movements that are traced back to her spermatic fluids, just as those by which the offspring resembles its paternal ancestors are traced back to movements in the male's semen. But according to causal hylomorphism, the male and female have distinct causal roles: The male provides form, and the female provides matter. Thus it seems we have an inconsistent triad:

- (i) the form transmitted in animal reproduction includes all the subspecific, inherited features
- (ii) only the male provides form and only the female provides matter
- (iii) females also transmit sub-specific features.

As we saw, the strategy employed by Peck and Balme was to deny (ii). Balme claims that reproductive hylomorphism is meant to apply, at best, to ideal cases. Peck, on the other hand, finds evidence in Aristotle's discussion of wind-eggs that the mother contributes form as well as the father; she provides all but the sentient or perceptive soul to the offspring. Cooper, on the other hand, denies (iii). He argues that the mother is not really responsible for contributing any movements that produce sub-specific features, despite appearances to the contrary.

In the last several sections we have been looking at the various problems with these approaches. In light of those problems, what prevents us from simply rejecting (i) instead?

In the passage 767b26-36 we looked at earlier, Aristotle says that those movements are drawn from potentials that the father has non-accidentally. He explicitly contrasts these features that the father can pass on to his offspring – those that belong to him insofar as he is able to reproduce or *katho gennêtikon* – from those that are accidental to him with respect to this procreative role, like being literate. Scholars who advocate the sub-specific forms interpretation tend to think this passage shows that those features that belong to Coriscus *katho gennêtikon* and non-accidentally must be part of his form and so part of the form he passes on in generation.<sup>65</sup> For instance, Cooper claims that:

By saying that there are actually in any male animal's sperm movements belonging to it as that individual qua father Aristotle commits himself to at least the relative particularity of that animal's form. (Cooper 1990: 63)

<sup>&</sup>lt;sup>65</sup> For a recent example of this inference see Henry 2006b: 431 and Henry 2006a: 276. See also Sharples 1985: 120 with note 14.
Since some of these non-accidental features are sub-specific, these scholars take this as evidence that forms conveyed by the father in Aristotle's embryology are sub-specific.<sup>66</sup>

Scholars commonly infer from the fact that in GA IV.3 Aristotle says that the potentials for inherited traits belong to the father non-accidentally that those traits are part of the father's form. I want to begin questioning this move by noting that whether or not something is accidental is relative to the subject or cause at issue.

<sup>&</sup>quot;Accidentally" (*kata sumbebêkos*) is an adverbial expression Aristotle uses to describe two broad categories of relations – predication relations and causal ones. A predicate can apply to a subject either accidentally or *per se*, and something can cause or be caused by something either accidentally or *per se*. Aristotle's discussions in *Posterior Analytics* I.4, I.19, I.22, *Metaphysics* V.30, and *Physics* I.3 give us two general descriptions of accidental predication. First, a predicate applies accidentally to a subject if it can apply *or* not apply, as being seated might apply or not apply to Socrates. Second, that which is predicated accidentally is not part of the definition (which is an account signifying the

<sup>&</sup>lt;sup>66</sup> Scholars who do not think that forms in biology are sub-specific also find it problematic that these sub-specific features are non-accidental. For there is a widespread tendency to group together material and accidental features on the one hand, and oppose these to those that are due to form. For instance, Charlotte Witt claims that "one point of almost universal agreement is that the form or essence does not include accidental, material features of the object" (Witt 1985: 46). According to R.W. Sharples, "it seems that both for Aristotle and for Alexander there is in principle a distinction between what is essential to every member of a species and what is not, the latter being accidents due to the matter in each individual" (Sharples 2005: 104). Sharples, who advocates the view that form in biology is species form, draws the further conclusion that these features ought not be the subject of Aristotelian science (Sharples 2005: 106). For if these are "material accidents", they are not the sorts of phenomena that one can grasp the causes of, and so know in an unqualified way. At Metaphysics VI.2, 1026b26-1027a28, Aristotle explicitly rules out knowledge of the accidental. Sharples laments that this places Aristotle in an "uncomfortable middle ground" between Platonist metaphysics and empirical biology (Sharples 2005: 107). That is, Aristotle's metaphysical conception of form seems to exclude features that vary among particulars, while Aristotle's practice in science does not. For the discussion of inherited, sub-specific features in GA makes clear that Aristotle thinks that the physical process by which offspring come to resemble their parents and ancestors is subject to scientific scrutiny, though if they are accidents, it should not be.

essence) of the subject. Again, being seated does not apply to Socrates in virtue of what he is, essentially, and so is not part of the definition of his essence.<sup>67</sup>

A cause is accidental in virtue of its standing in an accidental predication relation to the *per se* or non-accidental cause.<sup>68</sup> For instance, a doctor is the non-accidental cause of healing insofar as having the potential to heal is predicated of the doctor non-accidentally.<sup>69</sup> If the doctor, say Aesclepius, should also be a builder, then the builder would also be the cause of the healing, but only accidentally. The builder can only accidentally cause the healing since having the potential to heal *applies* to the builder only accidentally.<sup>70</sup> The builder is an accidental cause of the healing in virtue of standing in an accidental predication relation to the potential to heal.

<sup>&</sup>lt;sup>67</sup> This distinction is not as clear-cut as my treatment here might suggest. For Aristotle recognizes a difference between an attribute or property that belongs to a subject *per se* in the sense that it is part of the definition and one that belongs *per se* because it somehow follows from the definition. So, for instance, having internal angles that sum to 180 degrees is not part of the definition of triangle (and so not part of the form of triangle), but all triangles must have that property, and Aristotle will call this a *per se accident*. I am overlooking this point for the purposes of this discussion, since the question I am concerned to address is whether some attribute being non-accidental entails it is essential, and not whether being accidental leaves open (as the example just given shows) that it is in some sense essential (as having angles summing to 180 degrees is an *essential* accident of triangle).

<sup>&</sup>lt;sup>68</sup> As has been noted (e.g., in Freeland 1991: 49-72) Aristotle defines accidental predication and accidental causation in terms of one another, and so it is not obvious whether one or the other is primary. However, it is safe to assume here that, for example, the builder accidentally heals in virtue of being accidentally related to the doctor, and not the other way around. Cf. *Metaphysics* 1017a7-13 and 1026b37-1027a2.

<sup>&</sup>lt;sup>69</sup> While it may be most precise to speak of the potential that the builder or doctor has as the *per se* cause, I will speak of the builder and doctor as *per se* causes in virtue of having that potential. Further, for the purpose of illustration, I will limit the *relata* of causal relations to objects under a description, although Aristotle will also treat events (e.g., going to the marketplace) as causal *relata*.

<sup>&</sup>lt;sup>70</sup> Sometimes Aristotle will say that it is not the cause that is accidental but rather the effect. If the baker bakes something tasty, and the tasty thing coincides with the healthy thing (i.e., the healthy thing stands in an accidental predication relation to the tasty thing), then the healthy thing is an accidental effect of the baker. See, e.g., *Metaphysics* 1027a3-8.

I will not argue for a particular view about what it is to be a *per se* cause here. I am taking for granted that it is a fact about the cause specified – the builder or the doctor – that makes him the right sort of thing to bring about the specified effect. It is the fact that the builder has the potential to build a house and the doctor has the potential to heal the sick that renders them the non-accidental causes of houses and healed patients, respectively. So what is a non-accidental result with respect to one potential may be accidental with respect to another, even if both potentials reside in the same object.

Making this last point allows us to see how the idea that inherited traits are non-accidental results qua generator is consistent with the idea that substantial form is species-level form. For in general, what results nonaccidentally with respect to one specification of some substance like Coriscus is not non-accidental relative to every other specification of him. In particular, results that are non-accidental relative to one specification need not be nonaccidental relative to the specification that picks out Coriscus as a substance or specifies his substantial form. For instance, a well-tuned lyre might be a nonaccidental result relative to Coriscus qua musician, but accidental qua his possessing substantial form; the potential to tune a lyre belongs nonaccidentally to Coriscus qua musician, but accidentally qua substance. This should be uncontroversial whether one thinks Coriscus' form is species form or a sub-specific one; the potential to tune a lyre is surely something that can belong or not belong to Coriscus qua substance, even if we think that his substantial form is a very determinate, sub-specific form. Similarly, features of his offspring might be non-accidental relative to Coriscus qua generator but accidental qua having substantial form; the potentials that belong to Coriscus qua generator (and from which the movements derive that are the per se causes of his offspring resembling him) need not be potentials that are included in his substantial form. In this way, the assumption that it is human species form that Coriscus passes on to his offspring is consistent with the fact that potentials for sub-specific, inheritable characteristics belong to him nonaccidentally qua generator, and so form need not be sub-specific.

In the claim that the well-tuned lyre is a *per se* effect of Coriscus *qua* musician, the "*qua* musician" was supposed to signal that the well-tuned lyre results from some potential Coriscus has in virtue of his capacity to engage in a certain sort of activity, *viz*., playing music. But what is the qualification "*qua* generator" signaling in the context of a discussion of inheritable traits? After all, we might think that *qua* generator Coriscus contributes the principle of form, and so any feature that results from Coriscus' generative activity is one

that results from the form he transmits, which form is thus sub-specific.<sup>71</sup> I do not, however, think that "*qua* generator" must be read this way.

Consider the following analogy with the activity of teaching a language, e.g., French.<sup>72</sup> The goal of this teaching activity is the student's acquisition of the ability to use and understand French, which Aristotle would describe as a change from lacking to having some form, French, that the teacher possesses and that his activity aims to transmit.<sup>73</sup> The full specification of the goal of this teaching activity will include a number of the features that will belong to the student at the end of his education, and exclude others. It will include his being able to speak and read in French, for instance, but will exclude the beard the student might be wearing. Even if the student's beard were in some way connected to the French teacher's activity – e.g. if the student decided to grow a beard because his teacher, whom he respects and wants to emulate in every way, wears a beard – it is still not an integral part of the process of learning French, and so is accidental with respect to the French teacher's activity. The beard is not transmitted by means of the teaching process.

The full specification of the goal of the teaching activity will, however, exclude some features that *can* be transmitted by that teaching process. For instance, the relevant form (the ability to speak and read French) will not prescribe any one particular accent, but will simply specify a *range* of acceptable accents. Consequently, the teaching process does not aim at the acquisition of

<sup>&</sup>lt;sup>71</sup> That would follow if Aristotle said that the male parent contributes *only* form. However, he does not say this (but rather that the male alone contributes form), and it is clear that there are also movements transmitted. It is by way of (*dia*) these movements that form is conveyed. Some interpreters speak as though these movements are somehow constitutive of (perhaps the physical realization of) the father's form (e.g. Balme, "Not Essentialist," 292), but I am going to argue below that a different understanding of the relation between those movements and the form is suggested by Aristotle's analogy between those movements and the movements of a craftsman's tools that convey the form of the craft.

<sup>&</sup>lt;sup>72</sup> Sean Kelsey helpfully suggested teaching as a model for making these distinctions.

<sup>&</sup>lt;sup>73</sup> I am assuming that the change to possession of the form, French, is analogous to Aristotle's description in *Physics* I.7 of the change from unmusical to musical that the man undergoes when he acquires the form, *mousikê*. Just as there are formally unimportant but causally significant aspects of learning a language (such as the acquisition of a particular accent), there are similar aspects of learning *mousikê*, such as style of performance.

any particular accent within that range.<sup>74</sup> Still, supposing that the student will be taught how to speak French by means of mimicry and repetition, the student may come to have the same particular accent as his teacher, for instance a Parisian accent. This feature – the Parisian accent that the teacher passes on through the teaching process – belongs to the teacher *qua* French teacher in the sense that it is something that he can pass on to the student by the process of teaching French. But since French form does not prescribe a Parisian accent in particular, that accent is not part of the French form that the teacher possesses and that his teaching aims to transmit.

It is along these lines that I propose that we think of a potential belonging to the parent *qua* generator, i.e., with respect to the parent's reproductive role. The particular Parisian accent belongs to the French teacher *qua* French teacher (and not accidentally) because that accent can be non-accidentally transmitted through the process by which French is taught. Similarly, potentials that belong *qua* generator differ from those that belong accidentally to that generator in that they *can* be non-accidentally passed on in reproduction.<sup>75</sup> And just as the particular French accent can be non-accidental with respect to the teaching process despite being accidental with respect to French form (the transmission of which is the goal of the teaching process), these sub-specific potentials can still be non-accidental with respect to the transmission of which is the goal of the reproductive process).

### 9. Conclusion

I began by noting that there is a putative inconsistency between the idea that form is essence and the idea that form is the moving cause of animal generation. The form identified with essence in Aristotle's *Metaphysics* seems to be one shared by members of a species, but many scholars have held that Aristotle's account of inherited characteristics shows that he is using subspecific forms in embryology. I then argued that the sub-specific forms

<sup>&</sup>lt;sup>74</sup> A defender of the sub-specific forms interpretation might offer a competing analogy according to which it is a *Parisian French* accent that is aimed at, on the grounds that acquisition of Parisian French form is the goal, not just French form.

<sup>&</sup>lt;sup>75</sup> This, I take it, is the point of the contrast with accidental features that can be common to children and parents, but which Aristotle says belong accidentally *qua* generator. If Coriscus is someone's neighbor, then his offspring who live with him will have the same neighbor. And Coriscus, being literate himself, is likely to have a literate child. But these are not biologically inherited resemblances.

interpretation creates problems for the internal consistency of GA that are not easily resolved. If the form that the father transmits in sexual reproduction is sub-specific, there is a tension between Aristotle's reproductive hylomorphism and the idea that the mother contributes sub-specific features. I have considered two ways that interpreters have attempted to resolve this tension and argued that both involve assumptions that are questionable, given Aristotle's other commitments.

In the last section I showed that nothing Aristotle says in GA constitutes definitive evidence that forms in embryology are sub-specific. The fact that a potential belongs non-accidentally does not entail that it is included in the substantial form. Potentials that belong to the father *katho gennêtikon* and the movements they give rise to, belong to him *insofar as he is able to reproduce*.

I have not yet said anything about how the movements that result in sub-specific features are related to substantial form. In Chapter Four I will argue for an interpretation according to which the movements that are the causes of sub-specific, inherited features play causal roles *additional* to the role played by the form that the father contributes. In the interpretation that I will offer, according to which inherited features are not part of the form, there is no conflict between the theory of animal generation from GA I and II and this account of inherited characteristics in GA IV.3. On the contrary, as I will argue in the next chapter, this account of inherited characteristics is actually given within the framework of that earlier theory.

# CHAPTER FOUR NATURE'S TOOLS

### 1. Introduction

In Chapter Three, I discussed an apparent obstacle for viewing the embryological theory in *Generation of Animals* as a straightforward instance of hylomorphic explanation. The problem, briefly, is that the offspring inherits particular features that are not shared by all members of the kind from its parents and ancestors. The form at the level of the species is inadequate to explain how inherited traits are passed on, particularly since the female – who is the passive principle – passes on her traits to the offspring.

There are three main reactions that scholars have to this problem. The most pessimistic reaction is to conclude that Aristotle's account is simply inconsistent: he gives one general or "official" theory earlier in GA, and then is forced (given some fairly obvious facts about reproduction) to make exceptions to that theory. Montgomery Furth, for instance, views the account of inheritance in GA IV.3 as a "collapse of the earlier explanation" of animal generation in GA.<sup>76</sup> This would be unfortunate.

A second reaction is to deny that the explanation of reproduction is hylomorphic in the way I described in Chapter Two. Rather than restricting the contribution of form to the male parent, some scholars have argued that in fact the mother also contributes form. On this view, the earlier explanation of animal generation is not contradicted by Aristotle's account of inherited characteristics. Rather, Aristotle's view all along was that both parents contribute form.

Although this response allows the theory to account for maternal resemblance, it does so at too high a cost. For, as discussed in Chapter Two, causal hylomorphism is not an idiosyncrasy of Aristotle's theory. That his theory of reproduction identifies distinct agents and patients is a consequence of Aristotle's deeply held commitments to principles of change and scientific explanation. Consequently, the suggestion that Aristotle's explanation of animal generation assigns to the female the same role as the one assigned to the male is unappealing.

A third reaction is to insist that only the male provides form, and that the account of inherited characteristics is consistent with this, by denying that maternal resemblance results from anything the female contributes. Cooper, we saw, argues that since only the male is the agent, maternal resemblance is due to the form that the male provides.

<sup>&</sup>lt;sup>76</sup> See Furth 1988: 121-45 for an example of this line of response.

The details of the account of inherited characteristics that Cooper has to attribute to Aristotle in order to support this interpretation are *prima facie* implausible. For, as discussed in Chapter Three, Cooper has to insist that there are movements in the semen for parts and features by which the offspring resembles the female parent. Consequently, Cooper's response to the problem is also unattractive.

In this chapter, I argue for a different response to the apparent tension between maternal resemblance and causal hylomorphism in GA. Like Cooper, I think that the account of inherited characteristics does not conflict with the earlier explanation of reproduction, conceived of as an application of the general explanatory framework described in Chapter Two. But unlike Cooper, I do not think that inherited characteristics must be included in the form that the male provides. Rather, when the general framework is applied to explain more specific phenomena, additional causal factors must be invoked. So, for instance, the explanation of the generation of a horse is different from the explanation of the generation of a white horse. When Aristotle turns to the latter, the causal factors specified in Chapter Two – the principle of form from the father and matter from the mother - will no longer suffice. Aristotle must supplement those with the specification of additional causal factors. In what follows, I will discuss the additional causes involved in the account of inherited characteristics and offer an interpretation that is consistent with viewing the biological account in GA as an instance of a more general pattern of explanation.

# 2. Movements are Agents

When Aristotle discusses the details of embryonic formation – and especially when he gives the account of familial resemblances – he makes clear that the movements – *kinêseis* – are productive of the new organism's body parts. A movement, he says, is such that "when it stops, each of the parts comes into being and is ensouled" (GA II.1, 734b24-5). In Chapter Three we saw that the mechanism by which the offspring resembles one parent or ancestor rather than another in certain respects is a function of the interaction between the movements from the respective parents' generative residues. When a movement from the male prevails or masters, the offspring will take after him in whatever respect the movement was a movement for. For instance, perhaps there is a movement for the male's particular nose-shape. When that movement prevails, the offspring will have his father's nose-shape. If that movement fails to prevail, the movement for a nose-shape that the female has will produce the particular nose-shape that the female has.<sup>77</sup>

These movements were introduced, as I explained in Chapter Two, when Aristotle explains how the male makes his contribution – how he can be the agent who contributes the principle of form – despite the fact that he does not make strict contact with the matter. Aristotle says that the male contributes the principle of form by means of subsidiary agents, namely, the movements he sets up and conveys in his semen.

Those movements, recall, come to be present in the semen in virtue of the process by which semen is formed. Semen is a residue from the concoction of excess nutritive blood. Nutritive blood, which is a result of the concoction of nourishment, is endowed with movements by which it is used to maintain the parent's own body parts. Because semen is a residue from the concoction of that nutritive blood, it carries the same movements that the parent's nutritive blood did:

As semen is a residue, and as it is endowed with the same movement as that in virtue of which the body grows through the distribution of the ultimate nourishment, when the semen has entered the uterus it puts together the residue produced by the female and imparts to it the same movement with which it is itself endowed. (GA II.3, 737a18-22, trans. Peck)

<sup>&</sup>lt;sup>77</sup> I am overlooking one complication here, which I will just mention. In GA IV.3, it sometimes sounds like it is not the token-identical movement in the female residue that produces the resulting resemblance in the offspring. Rather, it seems as though the male movement turns into a movement typeidentical with that which the female provides. I do not know exactly how to think of the movement's "change into the opposite movement." One problem is that in Xanthippe and Socrates' offspring, for example, the movements from both Xanthippe and Socrates should still be present "in potential" in order to explain how their grandchildren can turn out to look like them. But if a movement from Socrates literally turns into the movement in Xanthippe's blood, it is hard to see how Socrates' movement can still be present, even in potential. In my discussion, I am going to assume that movements from either parent are used in the production of the embryo. If it turns out that this is incorrect, and that strictly speaking only the male's movements are agents and that they "turn into" those of the female, it would have to be determined to what extent this affects the main lines of my interpretation. I will not do that here.

At this point we can make two preliminary observations. Because katamênia is a residue from the concoction of the female's excess nutritive blood, the katamênia will also have movements in it. So the first point to note is that both the male and the female contribute movements. Second, the formation of semen and katamênia explains why the movements those generative residues carry are the same as those that were in the parents' nutritive blood. This is flagged by Aristotle, early on in GA, as the key to understanding why offspring resemble their parents. So the second observation to make is that the fact that productive movements are responsible for resemblances is not an *ad hoc* addition; this was prepared in the initial exposition of the general theory of reproduction, where he explicitly tells us that the presence of the same movements in the nutritive blood and generative residues is "why we should expect children to resemble their parents: because there is a resemblance between that which is distributed to the various pars of the body and that which is left over" (GA I.19, 726b15 Peck trans). When Aristotle turns to explain sexual differentiation and familial resemblance, he reminds us of this:

To resume then: We repeat that *sperma* has been posited to be the ultimate residue of the nourishment. (By "ultimate" I mean that which gets carried to each part of the body – and that too is why the offspring begotten takes after the parent which has begotten it, since it comes to exactly the same thing whether we speak of being drawn from every one of the parts or passing into every one of the parts, though the latter is more correct.) (GA IV.1, 766b7-12)

Most scholars agree that the movements involved in the mechanism described in GA IV. 3 are the agents of the very particular features by which the offspring resembles its parents. (They disagree, as we saw, about whether only the male or both the male and the female can contribute the movements.) In my view, movements are not only responsible for the very determinate parts and features by which offspring resemble both their ancestors, but there are also movements for parts and features that are shared by members of the species – movements for, e.g., "merely human" features. That is, I take it that Aristotle thinks there are also movements for parts and organs in virtue of which the offspring is an animal, or a member of its species. There are movements for species-specific features. Aristotle says this explicitly in his discussion of the causes of resemblance in GA IV.3. Here he says that there are movements and potentials not just for features particular to the parents, but general ones as well:

I speak of each potential (*dunamis*) in this manner. The generator is not only a male but also such a male, e.g. Coriscus or Socrates, and he is not only Coriscus but also human. And in this sense, some things that belong to the generator are closer and some further *qua* generator and not accidentally, like if he should be literate or someone's neighbor... For this reason, movements are present from the potentials (*dunameis*) in the spermatic fluids of all such things. (*GA* IV.3, 767b23-36)

I am taking those movement derived from potentials that belong to Coriscus insofar as he is human to be movements for generally human features. This is not a common reading of the passages where Aristotle mentions general movements. Charlotte Witt, for example, claims that the general movements are "the movements which bear the form or soul" (Witt 1985: 56). These movements "cause the offspring to be an offspring of a certain kind" (Witt 1985: 56). On Witt's interpretation, references to general movements are not to movements for body parts.

By distinguishing movements that cause the particular body parts from those that convey the form, Witt is trying to preserve a primary role for species level form. However, this is not a promising way to do so. First, the examples of the universal that Aristotle gives in the passage that Witt appeals to are "human and animal." Coriscus' substantial form is not animal form, and so it seems that Aristotle has in mind something more general than species level form when he speaks of general movements. Second, it does not seem that species level form is really assigned a primary causal role on this reading, particularly since Aristotle says that the particular movements (those for the *idion* and *kath'hekaston*) "always exert a stronger influence in generation" (*GA* IV.3, 767b29-30).

D.M. Balme, on the other hand, reads Aristotle's remarks about general movements as evidence that there is no role played by a species level form. Like Witt, Balme assumes that if form is a primary cause, it must be identifiable with some of the movements occurring in the actual process of generation. The only viable candidates would be, Balme thinks, the general movement, but these do not have the "strongest influence" in generation. Balme argues that species level form is merely a "consequential," and does no actual work in generation (Balme 1987a: 293). For, Aristotle says in GA IV.3 that if all goes well, the offspring will resemble its father. If all does not go well, the offspring will resemble the mother. And if things go even less well, the offspring may resemble its grandparents, or even more remote ancestors. But in much worse circumstances, the offspring will not resemble any of its ancestors at all. Aristotle makes a very odd remark about this case:

Finally, the movements are so blurred<sup>78</sup> that there is no resemblance to any of the family or kindred, but the only thing left is the common thing, that is, human. (GA IV.3, 768b10-12)

Aristotle says that the offspring will bear a resemblance to the "common thing," i.e., it will look merely human, when the movements responsible for particular features fail to function properly. He explains that this is because "this [the common thing, human] accompanies all the individuals" (GA IV.3, 768b12-13). Balme reads "accompaniment" as indicating that there is not a specific movement for species level form. The casually operative movements are all for the sub-specific form that the offspring is inheriting, and the species-level form is merely a "universal obtained by generalization" from the particular forms (Balme 1987a: 291). He takes this as evidence that "in the GA Aristotle holds that the animal develops primarily towards the parental likeness, including even non-essential details, while the common form of the species is only a generality which 'accompanies' this likeness" (Balme 1987a: 291).

As I read the passage at 768b10-12, Aristotle is not talking about form at all; he is talking about movements for body parts. As odd as it sounds, I think that Aristotle is saying there are, in fact, movements for something merely human. When movements for particularly shaped noses get so scrambled as to be ineffectual, the general nose movement still persists, and so the resulting body part will still look like a nose. That nose will have some determinate shape, of course, but that determinate shape will not be produced by the movements for the particular nose-shapes that the parents and ancestors had.

It is not at all clear in what sense Aristotle thinks that the movements and potentials can be general. This is probably why most scholars do not think these general movements are for body parts. But I think that Aristotle does think that there are general movements, and that there are options for understanding this in a way that is more plausible than it might at first appear.

We might try to make sense of these general movements by correlating them with early stages of development. Embryonic development proceeds, according to Aristotle, from most general to most specific:

<sup>&</sup>lt;sup>78</sup>See Euripides *Iphigenaia* 37 for the sense of *suyyeo* as "blur." Cf. *GA* I.17, 721b34 for a reference to "blurred" scars and *Phys*ics I.1, 184a22 for the thing "blurred together" as what is perceived first, and for the way that the form and the underlying thing are blended together.

...for it is not the fact that when an animal is formed at that same moment a human being, or a horse, or any other particular sort of animal is formed, because the end or completion is formed last of all, and that which is peculiar to each thing is the end of its process of formation. (GA II.3, 736b2-5)

Perhaps general movements are for parts formed in the early stages of development, whereas the particular movements are for later stages of the embryo. What are the movements at the early stages movements for?

One possibility is that the early stages, and so the general movements operative at those stages, produce merely "species-like" parts. On this reading, Socrates has a *dunamis* and corresponding movement in his semen for, say, a human nose, distinct from the movement for the sub-specific snub-nose that Socrates has. The general, mere nose movement makes the mere nose, and then the particular nose-shape movement gives that mere nose its particular nose-shape. The movement for a mere nose, for instance, might make two passages at the front of the face. While it is strange to think there can be a movement for making something that is just a nose, and not a particularly shaped nose, certain passages do make it seem like Aristotle thinks that this is what happens: Present before the actual snub-nose that Socrates offspring comes to have would be a nose-like "sketch" of a nose.

In the early stages the parts are all traced in outline; later on they get their various colors and softness and hardness, for all the world as if a painter were at work on them, the painter being nature. Painters, as we know, first of all sketch in the figure of the animal in outline, and after that go on to apply the colors.(GA II.743b20-25; trans. Peck, modified)

It is possible that Aristotle is thinking of movements for merely human features as "sketches" or "outlines" of parts. A second, perhaps more plausible option is to think of those movements for being merely human or merely animal as movements for the internal parts and organs shared by members of the kind, in virtue of which an organism is a member of that kind. We might determine which features are the general ones by mapping them on to the parts and organs that Aristotle says occur first in the order of development, since as he says at 736b2-5 (cited above), the organism is an animal before it is a particular type of animal, and it is a particular type of animal, e.g., a horse, before it is a horse with particular features. For instance, an organism might be merely an animal when it has a heart, in which sentient soul resides (743b25-6). So perhaps a movement for being merely an animal is one that is for a heart. An advantage to this option is that it does not imply the presence of any body part that is not a fully determinate body part.

I suspect that the general reluctance to read Aristotle as claiming that there are movements for general features is based on an assumption that causes can be read off from the effects, and it is difficult to makes sense of general effects. I have been suggesting a sense in which, given that the embryo develops in stages, some effects will be general. A general effect may either be the organs, like hearts, shared by members of the kind, or some early, rough stage of a particular part or organ. But I want to suggest another way to think about the movements responsible for the offspring's body parts such that these can be general, despite there being no general effects.

Consider an analogy with the sort of explanation that a Newtonian physicist might give for a body moving in an elliptical orbit. The elliptical orbit will be explained, let us suppose, in terms of gravitational and inertial forces or motions. The interaction between the two forces (depending on the mass, distance from other bodies, etc.) results in the elliptical path in which the body actually ends up traveling. The elliptical orbit is not caused by a particular elliptical motion or force. Rather, the cause of the elliptical orbit is a complex force or motion.

Similarly, an Aristotelian biologist might explain the particular nose shape of some offspring in terms of the general nose force or motion interacting with particular motions and forces in the spermatic fluids. A mere nose never actually comes to be formed, but that does not mean that such a general motion and force is not operative. The nose that is actually formed is a product of several movements, some of which are general, and some particular. Rather than assuming that the cause of a particularly shaped nose must be a movement for precisely that nose shape, we might view the movement that results in that particular nose shape that the offspring comes to have as a complex movement, a movement due to the interaction of several movements and forces in the generative residues.

In my discussion I am going to leave these options open.<sup>79</sup> Regardless of what the details are, I think that there are movements and potentials for different sorts of effects, and at varying levels of generality.

<sup>&</sup>lt;sup>79</sup> Given that the organism develops in stages, there is also a question about *whose* soul or form it is that is the moving cause of the various stages, which question I will raise, but not try to answer here. Since nutritive soul is the internal principle needed to control the process of development, in GA Aristotle says that the organ in which that principle resides must be formed first. This is why the heart must be formed first: the first principle of growth is located in the heart. Once the rudimentary heart is formed, the movements it

Let me summarize the points made so far. First, the movements carried in the generative residues are productive of the offspring's body parts as it is developing. There are movements at varying levels of generality and for different parts. Movements are present in virtue of the process by which the spermatic residues are made, namely, concoction. Because both the male and female concoct blood into those residues, both parents contribute movements. And, important for our understanding of Aristotle's account of inherited characteristics, the presence of the same movements in the generative residues and the parents' blood is what explains resemblance of offspring to parents.

Because the movements are productive of inherited characteristics, there is no need to think that the female must contribute form in order to account for maternal resemblances. The movements are a distinct causal contribution from substantial form, and so the female can contribute movements and not form. Moreover, since the movements are productive of all of the body parts, the form that the male provides need not be particular to

contains are used as tools by the embryo's nature to make the parts grow: "So too in the fetation, in a way all the parts are present *potentially*, but the first principle has made the most headway, and on that account the first to become distinct in *actuality* is the heart. This is plain not only to the senses (for after all it is a matter of fact), but also to the reason. Once the fetation which has been formed is separate and distinct from both the parents, it must manage for itself, just like a son who has set up a house of his own independently of his father. That is why it must have a principle, from which also the subsequent ordering of the animal's body is derived...On this account in all blooded animals it is the heart which can first be seen as something distinct, as this is the first principle both of the "uniform" and of the "non-uniform" parts since this is justifiably designated as the first principle of the animal or organism from the moment when it begins to need nourishment, for of course that which exists grows, and, for an animal, the ultimate form of nourishment is the blood or its counterpart" (GA II.4 740a3ff). If the presence of soul is a sufficient condition for an organism's being alive, then it seems that the organism is alive (and thus the substantial change is complete) once the heart is formed. All later stages of development – the growth of the embryo – would be controlled by the new organism's soul, not the father's. Those ensuing stages of development would not be stages of generation, but different sorts of changes. If an argument for the view that the agent of development is the new embryo's nature or soul, rather that that of the male parent were successful, I would have to see what bearing this has on the interpretation I am offering in this chapter. I will not try to give an argument for this here, and will just assume that the male parent, or his soul, is the agent of embryonic development.

him. The movements in the generative residues, not the form, are particular to the individual organisms. I return to these points below.

### 3. The Relation of Form to Movements

Since, on the interpretation I am offering, the movements in the generative fluids are agents of the offspring's body, one might naturally wonder what role the principle of form is playing in generation. The principle of form might appear to be an unnecessary explanatory posit, since the movements seem to be doing all the causal work. In what sense is the male the agent of generation, if the formation of the embryo is a result of the movements in the generative residues?

Despite the fact that at one level of analysis, only the movements are productive, formative, and generative, there is still an indispensable causal role for the principle of form supplied by the male. To understand why this is, we need to understand the relation that the movements stand in to that principle of form or soul. In short, because of the way the movements are related to the principle of form, it turns out that the movements can only be agents in virtue of their relation to the principle of form.

In several passages, Aristotle describes the movements in the semen as "tools." (He also describes just the semen, the *pneuma* in the semen, and the heat and cold in the semen as tools, but I am treating these as more or less interchangeable in these contexts.<sup>80</sup>)

In the male of those animals which emit semen, Nature uses the semen as a tool and as possessing motion in actuality, just as tools are used in the products of any art, for in them lies in a certain sense the motion of the art. (GA I.22, 730b19-23)

<sup>&</sup>lt;sup>80</sup> Semen, according to Aristotle, is moisture that has *pneuma* in it. *Pneuma*, whatever precisely Aristotle thought it was, is air that has "generative" or "vital" heat in it (736a). The heat in it gives *pneuma* its ability to contract and expand, thus effecting movements in the blood or generative residues in which it resides. So for my purposes, I am going to assume that it makes no difference whether Aristotle refers to "movements" or "semen" or "heat and cold" or *pneuma*. (I think there may be a similar slide here between speaking of semen, *pneuma*, heat and cold, and movements as there seems to be between speaking of, e.g., the heart as a tool, and the heart actually heating blood and concocting it as a tool. I think Aristotle is sometimes thinking of the process of concoction, and not the heart, as the instrument of soul.)

As the products of art are made by means of the tools of the artist, or to put it more truly by means of their movement, and this is the activity of the art, and the art is the form of what is made in something else, so is it with the power of nutritive soul. As later on in the case of mature animals and plants this soul causes growth from the nutriment, using heat and cold as its tools (for in these is the movement of the soul), and each thing comes into being in accordance with a certain formula, so also from the beginning does it form the product of nature. (*GA* II.4, 740b25-34, trans. Platt)

Cooling, again, is mere deprivation of heat. Nature makes use of both; they have of necessity the power of bringing about different results, but in the development of the embryo we find that the one cools and the other heats for some definite purpose, and so each of the parts is formed; thus it is in one sense by necessity, in another for a final cause, that they make the flesh soft, the sinews solid and elastic, the bones solid and brittle. (GA II.6, 743a36-b5)

And so there is nothing to prevent the teeth being formed and being shed in the way he [Democritus] says; but it is not on that account that it happens, but on account of the final cause, the end; those other factors are the cause *qua* causing movement, *qua* tools, and *qua* material, since in fact it is probable that nature makes the majority of her productions by means of *pneuma* used as an tools. *Pneuma* serves many uses in the things constructed by nature, just as certain objects do in the arts and crafts, e.g. the hammer and anvil of the smith. (*GA* V.8, 789b5-12)

Movements are tools used by nature or soul in animal generation in at least two ways. First, movements are tools by which the male conveys the form, analogous to the way the motions of the craftsman's tools convey the form of his art. As is the case in craft production, the movements in generation are the instruments or means by which the form is transferred to the matter. Second, movements present in the first mixture of male and female residues are used as tools in the production of the embryo's body. The movements, each for a different part and stage of development, are used by nutritive soul to build the body of the new organism. In both cases, the relation of the soul or form to the movements it uses as tools is one of a first, unaffected agent to last agents. Like a *techné*, nutritive soul – or the male, in virtue of possessing nutritive soul – is a first, unaffected agent. Like the tools that the craftsman uses (or, the motions of those tools), the movements in the first mixture of semen and *katamênia* are the last agents. In the next section, I explain why this construal of the relation between soul and the movements is important.

### 4. The Significance of Tool-Talk

There are at least three interpretive rewards to treating movements as tools or last agents. Rather than assuming that there must be a movement in the generative process that can be identified with the form, this reading sharply distinguishes the form from the movements. Form, the first agent, and the movements, the last agents, are assigned distinct causal roles.<sup>81</sup> Consequently, Aristotle's account can allow the female to contribute movements – thus explaining maternal resemblance – without violating causal hylomorphism. The female contributes movements, but does not contribute form.

Second, treating the movements as tools allows Aristotle's theory of reproduction to assign a *privileged* causal role to form. Because the movements are tools, form cannot drop out of the causal story. Form, like the foreman at a construction site, guides, controls, and directs the last agents that it uses. At any one time-slice of the building process, it will be difficult to see what the foreman is actually doing. But this does not make his job obsolete. The foreman directs the bricklayer, the window framer, the roofer, and the painter, deciding when each should come in and do various tasks. These subcontractors do the actual bricklaying, window framing, roofing, and painting. But they would not actually be doing anything that would constitute the building of a single house were it not for the foreman employing and directing them to do so. The foreman unites the various activities of his subcontractors such that their activities constitute a single house building process.

<sup>&</sup>lt;sup>81</sup> Witt and Balme, recall, assume that we must be able to specify some movement or a subset of movements that are for form or soul. Witt's attempt to do so is not very plausible, and does not give form a privileged or primary causal role. Not finding any such movement, Balme denies that species level form has any causal role in generation. I am rejecting the assumption that both Balme and Witt make, and interpreting form or soul as having a causal role distinct from that of the movements.

In general, last agents can only be agents insofar as they are related to a first agent that has the principle of form in actuality. This is reflected in various complaints that he wages against materialist explanations that appeal to causes that are at best subsidiary causes. For instance, in DA, Aristotle criticizes Empedocles' attempt to explain the growth of plants by appealing to the natural tendencies of the elements:

What is the force that holds together the earth and the fire which tend to travel in contrary directions? If there is no counteracting force, they will be torn asunder. If there is, this must be the soul and cause of the nutrition and growth. For [fire] alone of the bodies or elements is observed to feed and increase itself. Hence the suggestion that in both plants and animals it is [fire] which is the operative force. A concurrent cause in a sense it certainly is, but not the cause *simpliciter*, that is rather the soul. For while the growth of fire goes on without limit so long as there is a supply of fuel, in the case of all complex wholes formed in the course of nature there is a limit or ratio which determines their size and increase, and limit and ratio are marks of soul but not of fire, and belong to the side of account rather than that of matter. (DA II.4 416a6-18)

And again, in GA, Aristotle rails against the idea that heat could, in the absence of soul, build a living body:

And as in speaking of an axe or any other instrument, we should not say that it was made solely by fire, so we should not say this about a foot or a hand, nor, similarly, of flesh either, because there is function of this also. As for hardness, softness, toughness, brittleness and the rest of such qualities which belong to the parts that have soul in them, heat and cold may very well produce these, but they certainly do not produce the logos in virtue of which the one is now flesh and the other bone. Rather, the movement derived from the generator who is in actuality that which the material out of which the offspring is formed is in potential. The very same thing applies to things formed in accordance with art. For, heat and cold may soften and harden the iron, but they do not produce the sword. This is done by the movement of the tools, which has the logos of the art. For the art is the principle and form of the thing being made, but in another. But nature's movement is in [the product being formed], derived from another natural being having the form in actuality. (*GA* II.1, 734b36-735a4)

The last agents of generation – the movements contributed by both parents – only get to be productive of the parts and organs they produce in virtue of being used by a first agent who has form or soul in actuality.<sup>82</sup>

It is important that there be this privileged role for form in the explanation of substantial generation in order to prevent genesis from collapsing into just a series of qualitative changes. A central point of disagreement between Aristotle and his materialist predecessors was about how apparent cases of generation are to be analyzed. The materialist opponent that Aristotle describes claims that what appear to be cases of medium-sized objects like trees and dogs coming to be are really just alterations of more basic substances, e.g., the four elements, or atoms. Aristotle, on the other hand, thinks that concrete medium-sized substances really do come to be and pass away. Consequently, it is crucial that he be able to explain substantial generation in a way that makes it clear why it is a genuine, unified change. Just as the foreman unifies the activities of the subcontractors such that their activities constitute a single house building process, the form in generation unifies the physical changes taking place in the vascular tissue such that these changes constitute a single, generative process. By making the physical changes that comprise the generative process subordinate to a ruling principle that directs that process, Aristotle's theory thereby unifies those subordinate movements.<sup>83</sup>

 $<sup>^{82}</sup>$  Compare Aristotle's criticism at GC II.9, 336a1-12 of a form of materialism that treats heat and cold as causes of generation and destruction. Aristotle remarks that they make causes "too instrumental." Aristotle thinks these are only subsidiary causes. Since the materialist does not posit a primary agent that uses them, these subsidiary causes or tools cannot even be tools. So, Aristotle complains that they make the powers in matter "too instrumental." See Joachim 122: 251-2 for a discussion of this passage as making this point.

<sup>&</sup>lt;sup>83</sup> This is a bit speculative, but there may be a similar point to Aristotle's saying that the body is a tool of soul: Saying that the body as a whole is a tool of soul signals that soul unifies the body. (An additional point to saying that the body is a tool might plausibly be the Platonic one, namely, that the soul is superior to the body, and so care for the soul is more important that care for the body.) A living organism is a substantial unity, and not just an accidental conglomeration of parts. The body parts form a unity insofar as the collection of parts is a tool of, and so for the sake of a single *telos* – the soul. The philosophical pay-off in identifying the body as a whole is for the sake of

The third significant result that Aristotle gets by treating movements as tools is that it allows the male's contribution of movements to be distinct from the contribution of form that he makes *qua* primary agent of generation. In order to transmit form, the male also contributes movements. Noting this separation of the contribution of form from the movements, consequently, allows us to block the inference that forces Cooper to ascribe to Aristotle the view that the male's semen must contain movements for parts that resemble the female and maternal ancestors. Let me explain why that is.

According to Cooper, since the father is the active factor, any feature that is produced by the reproductive process must be due to him. Cooper asks us to imagine a sculptor trying to shape some stone that is too soft and thus too difficult for that sculptor to precisely manipulate. Consequently, some features of the finished statue will not be what the sculptor intended. Cooper thinks that those unintended features should still be attributed to the sculptor's art:

Then whatever features of shape, surface texture, etc., the resulting statue has will have been the product of *his* art: his art will have been the originating source, and the only originating source, of these outcomes (assuming nothing pushes his hand or falls on the statue while he is working on it that affects these features). The stone itself contributes only as matter, not as a source of any of the changes it undergoes while these outcomes are being achieved. (Cooper 1990: 77-8)

soul. Stephen Menn puts what I take to be a similar (if not the same) point somewhat differently: "Aristotle takes up the art-or-artisan comparison from Plato in the service of his programme for reforming natural philosophy: if the animal body is governed by something like an art, which moves the body while itself remaining in a steady state, and if the body exists and acts in order to be an instrument of this art, then we have the hope of explaining the order within the animal body teleologically, and explaining its stability-in-lawlike-motion as the constant effect of an unchanging principle" (Menn 2002: 115). Similarly, I am assuming that the unity of substantial generation is part of what is at stake in identifying the movements used in animal generation as tools. That the movements used in reproduction are tools is what makes it the case that the changes taking place in the vascular tissues and residue are all part of one, unified, substantial change, and not just a coincidentally related sequence of alterations.

Cooper is correct in thinking that there must be some sense in which the sculptor's art is the ultimate source of all the features in the statue. But the sense in which this is so does not entail that all those features are part of the sculptor's art.

The sculptor's art is a first agent (which acts without itself being affected). However, the art, when exercised, must be exercised in a particular way, and with particular tools and techniques. These tools and techniques are last agents (which make contact with what they act upon, and are therefore also affected). In general, last agents can have *per se* effects that are distinct from the effects of form, the first agent. For example, the doctor will use food or drugs as tools or instruments by which the form of health is conveyed to the patient. Those instruments might consist of a special diet (e.g., of raw foods and cold liquids) that aims at reducing the temperature of the patient's blood. The determinate reduction of temperature will be the *per se* result of the diet. But that medical expertise, the knowledge that the doctor has in virtue of which he is said to have that *technê*, can still be and aim at something general, namely, health.

But individuals can be best cared for by a doctor or gymnastic instructor or anyone else knowing universally (*katholou*) what is good for everyone or for people of a certain kind (for the sciences both are said to be, and are, concerned with what is common (*tou koinou*)), even though some particular detail may perhaps be well looked after by an unscientific person, if he has studied accurately in the light of experience what happens in each case, just as some people seem to be their own best doctors, though they could give no help to any one else. None the less, it will perhaps be agreed that if a man does wish to become master of an art or science he must go to the universal, and come to know it as well as possible; for, as we have said, it is with this that the sciences are concerned. (*Nicomachean Ethics* X.9, 1180b13-22)

No art (*technê*) considers the individual. The medical art (*iatrikê*), for instance, [does not consider] what is healthy for Socrates or Callias, but [what is healthy] for this sort or these sorts (for this is in the province of art (*entechnon*), but the individual is indefinite and not knowable). (*Rhetoric* I.2, 1356b30-33)

We can concede to Cooper that the sculptor's art is the first agent of the results of the sculpting process without inferring (as Cooper does) that the sculpting art aims, *per se*, at all the results of the process; in particular, the art need not prescribe those results of which the particular tools and technique used in bringing about the statue are the *per se* causes. Tools can have *per se* effects that are far more determinate than the proper aim or goal of the first agent that uses them.

In the case of generation, the male, or his soul, is the first agent. We can agree with Cooper that the male must in some way be the agent of all the results of the generative process without inferring that the form he is transmitting must include all of those results. The movements in the generative residues from both parents can have effects more determinate than the proper aim of the first agent, the male or his soul, that uses them. Since the principle of form or soul that the male contributes can, like a *technê*, be general, the form or soul employed in the explanation of generation can be reasonably understood as a species-level form.

To recapitulate, the male is the first agent, and the movements are last agents. The movements and form are distinct causal contributions. The female can, consequently, contribute movements without thereby contributing form. Thus the account of inherited characteristics is not in tension with a reading of GA that views the explanation of generation as satisfying the principle causal hylomorphism. Moreover, treating the movements as tools makes them subordinate to form, granting form an indispensable role in generation. Form unifies the change in the way it must be unified, if it is to count as a case of genuine substantial generation. Most importantly, tools, as last agents, can have more specific effects than the first agent that uses them. And in craft cases, it looks as though Aristotle is thinking that the first agent – the *technê* that the craftsman has in his soul – is for something general, e.g. health in the patient. If we take Aristotle's comparisons between art and nature seriously, it seems that what he has in mind in GA is that form is the general, species-level form.

# 5. Nature "uses"

I am taking Aristotle talk of soul or nature using tools to signify that soul and those movements that it uses as tools are distinct causal factors. However, it is not at all obvious how we are to understand what it means for the soul or nature to use those movements as tools. The soul is nothing like a sculptor who picks up and moves a chisel. It is hard to see what literal sense there might be to Aristotle's talk of nature or soul using movements as tools.

What Aristotle means when he calls movements "tools" in GA is, I take it, part of a more general question about what Aristotle means when he speaks of the soul using the body as a tool, as he does throughout *Parts of animals* and *De anima*. ... the body is an tool (for each of the parts is for the sake of something, and in the same way also the whole [is for the sake of something]... (PA I.1, 642a11-12)

Since every tool is for the sake of something, and each of the parts of the body are for the sake of something, and this which they are the sake of is a certain action (*praxis*), it is clear that also the while body has been put together for the sake of a certain manifold (*polumerous*) action. (*PA* I.5, 645b14-7)<sup>84</sup>

All natural bodies are tools of soul. This is true of those that enter into the constitution of plants as well as of those that enter into that of animals. (DA II.4, 415b18-20)

No clear answer to what it means to treat the soul as a user of tools to be found in GA. As he does in PA and DA, in GA Aristotle speaks of the soul using tools, but does not try to explain what that means.<sup>85</sup>

Because it is so difficult to understand what Aristotle could possibly have in mind when he speaks of the soul using the body in general, or of the soul using the movements in the generative residues in particular, some scholars opt to take Aristotle's language metaphorically. The soul is not, according to some, a distinct causal factor that controls or directs the tools it is described as "using." Rather, interpreters suggest that soul is just another way

<sup>&</sup>lt;sup>84</sup> Lennox notes that "this argument, like the so-called 'function' argument of *EN* I.6, 1097b24-1098a8, appears to commit the fallacy of composition" (Lennox 2001c: 176). Lennox suggests that the appearance of fallacy (i.e., of a fallacious inference from the claim that each of the parts of the body is for the sake of something) might be removed by taking the "manifold action" that the body is for the sake of to be just the composite of the actions that the individual parts are for. However, Lennox notes that Aristotle is thinking of the manifold action as the soul, and not the composite of individual actions. Lennox concludes that Aristotle's claim at 642a11-13: "What is surprising, and problematic, is the undefended assertion that 'each of the parts is for the sake of something, and likewise also the whole"(Lennox 2001c: 149-50).

<sup>&</sup>lt;sup>85</sup> Lennox 2001b: 182-204 discusses Aristotle's ascriptions of agency to soul, an organism's formal nature and notes, correctly, that this should not be taken as merely metaphorical. The relation between such ascriptions of agency to nature and Aristotle's teleology are discussed in Preus 1975: 221-44.

of talking about the physical phenomena that Aristotle describes as doing the work of soul. The general problem with this suggestion is that, as the passages I have already cited demonstrate, it certainly does not sound as though Aristotle is thinking of soul and the movements as equivalent or identical. Rather, he describes soul as that which does things by way (*dia*) of the movements. This is not decisive, of course. But there further problems with these suggestions.

Gad Freudenthal argues that the heat present in *pneuma* (which is present in the blood and generative residues) is soul. This heat is "vital" and has "informative power" in virtue of the movements it carries. Although Aristotle will sometimes use instrumental language, Freudenthal thinks that descriptions of the soul doing certain things with that heat or *pneuma*, and descriptions of the heat doing things, are descriptions of the same state of affairs. Soul and vital heat are identical in that "Aristotle's physiological theory assigns to the vital heat the role of producing the forms of homoeomerous parts, a role which the psychological theory attributes to the working of the nutritive soul" (Freudenthal 1995: 30).<sup>86</sup> The proper way to interpret Aristotle's claims that the soul uses heat is the following:

With regard to the operations of heat in the living body, Aristotle's view was that one may use either or both of the two equivalent descriptions. (Freudenthal 1995: 31)

Freudenthal denies that soul and vital heat are related in the way Aristotle explicitly says that they are related, namely, as a user to its tools. Rather, soul and vital heat describe the same thing, considered from different perspectives.

Freudenthal's claim that soul is really another way of describing heat seems to be flatly contradicted by various passages, such as the one at DA 416a6-18 quoted earlier, where Aristotle says that it is absurd to think that fire could be anything more than a subsidiary cause of growth.<sup>87</sup> Elsewhere, he

<sup>&</sup>lt;sup>86</sup> Both in this quote and elsewhere, it seems that Freudenthal's argument for identifying soul and vital heat is that Aristotle describes both as the agents of the same results, so they must be the same thing. But, as we saw in Chapter Two, Aristotle says in GC I.7 that the doctor heals, and that the wine heals, but he is clearly not treating the medical art or the doctor (the first agent) as identical the wine (the last agent).

<sup>&</sup>lt;sup>87</sup> To be fair, Freudenthal wants to distinguish vital heat from the elemental heat that he thinks Aristotle is criticizing in these passages. But I do not really find his reasons for doing so convincing. A central problem with Freudenthal's interpretation is the way he understands the locution "heat has motions in it."

criticizes the inference from the fact that soul functions are performed by means of heat to the claim that soul is heat. Aristotle rejects the view Freudenthal attributes to him, for it conflates an instrument and the user of that instrument.

While some crudely posit fire or some such potential to be the animal's soul, it is perhaps better to say that soul is constituted in some such body. This is because among bodies the hot is the one most able to assist with the functions of the soul, for nourishing and producing change are functions of the soul, and these things come about most of all through this potential. Saying fire is the soul, then, is like saying the saw or auger is the carpenter or carpentry because the function is accomplished when they are near each other. (PA II.7, 652b6-15)

Using cybernetic processes as a model, D. M. Balme treats Aristotle's conception of the soul as simply identical to the movements. Aristotle's conception of soul, according to Balme, is that of a "self-limiting complex of motions" in the blood and generative residues. The complex of motions in the spermatic fluids is, on Balme's view, "potentially [the offspring's] adult soul" (Balme 1987a: 292).

Now what the sire transmits is in fact soul, which is therefore to be identified with the movements. (Balme 1987b: 282)<sup>88</sup>

I think that there is something misplaced about the idea that those movements can *become* the offspring's soul or form. The soul or form of a

Freudenthal takes this as meaning the heat literally carries or contains movements. What Aristotle says is that the movements are *en* the heat and cold. The sense in which the movements are *en* heat and cold, as I understand it, is not that they literally subsist or are located in the heat. Rather, Aristotle means that the movements are causally dependent on heat. See note [36] in Chapter Two.

<sup>&</sup>lt;sup>88</sup> If this is intended as an argument for Balme's interpretation, it needs to be supplemented by an additional premise stating that the male *only* supplies form, and nothing else whatsoever. Only then should we infer from the claims that the male provides form and the male provides movements that the movements are the soul or form. Aristotle does not say that the male provides only form, however.

living organism is its *nature*, and nature is a *dunamis* that a natural organism has to act on itself, *qua* itself.

For nature also is in the same genus as potentiality; for it is a principle of movement–not, however, in something else but in the thing itself *qua* itself. (*Metaphysics* IX.8, 1049b8)

The soul is a *dunamis*. But a *dunamis* is not a movement. So, it seems that Balme simply places soul in the wrong ontological category.<sup>89</sup> It is not at all clear, consequently, that Balme's construal of the relation between soul and the movements is the one Aristotle had in mind.

#### 6. Movements: The energeia of Soul

Rather than equating movements with soul *dunamis*, Aristotle says that the movements are the exercise – the *energeia* – of soul *dunamis*. In this section, I want to sketch out a way to understand what this means, which may give us some insight into why Aristotle finds the analogy with the artisan's use of tools so apt. This way of understanding why Aristotle thinks of movements involved in the exercise of soul capacities as tools of soul gives us further reason to reject the proposal that movements are identifiable with soul.

We can think of the movements as metabolic processes taking place in the organism's blood as it is concocted. Concoction gives rise to metabolic changes in the blood, residues, and vascular tissues that result in the formation and maintenance of the organism's limbs and organs. These metabolic changes constitute the exercise of nutritive soul *dunamis* to digest food and maintain the organism. In reproduction, the metabolic processes bring about the initial "diversification" of the body parts in the embryo. These processes constitute the exercise of nutritive soul *dunamis* to reproduce.

Similarly, the processes taking place in artistic production, such as the movement of the chisel or up and down motion of the hammer, constitute the exercise of the *dunamis* that the artisan has – the *technê*.

The products of art come to be by means of tools – or to put it more truly by means of their movements – and this movement is the *energeia* of the art. (GA II.4, 740b26-27)

<sup>&</sup>lt;sup>89</sup> Cf. the definition of *kinêsis* at *Physics* III.1, 201a10. Although there is a lot of scholarly controversy about how to understand this definition, it is pretty clear that a *kinêsis* is the actualization (*entelecheia*) of something (a *dunamei on*). A *kinêsis* is not a *dunamis*.

Like a hammer, the movements in the blood, generative fluids, and vascular tissues are the instruments or tools by which nutritive soul *dunamis* is exercised. The *technê* in the craftsman's soul is a *dunamis* that the craftsman has, in virtue of which the craftsman has the capacity to do certain things, *viz*, to build houses. When he exercises that capacity, he moves his hands and his hands move his tools, different movements for different effects (cf.730b15-19). Similarly, the male's nutritive soul is a *dunamis* that he has, in virtue of which he has the capacity to do certain things, including reproduce. When he exercises that capacity, the male (in virtue of having nutritive soul capacities) sets up movements in his semen, which movements are conveyed to the *katamênia*, where they are used to build the new organism.

Unlike a hammer, the movements can continue to move all by themselves once the user – the male parent – sets them in motion. We might, as the passage just quoted suggests, think of the movements as analogous not to the tools – the hammer or chisels – but to the motions of those tools. The movements that are the exercise of soul *dunamis* are species, self-moving tools. Aristotle's point is not to say that the movements and the craftsman's tools are analogous in every way. Rather, his point is that they are analogous insofar as movements are the means by which nutritive soul *dunamis* is exercised, just as the motions of the artisan's tools are the means by which the artistic *dunamis* is exercised.

Moreover, in many passages it is not the artisan but rather the art – the *dunamis* that the artisan has in virtue of which the artisan can do certain things – that is identified as the user of the tools. In DA, it is not the carpenter or flute player that uses instruments, but rather "the art must use instruments" (407b20). Sometimes Aristotle explicitly says that the art, rather than the artisan, is analogous to the soul in a living body. It is the medical art in the mind of the doctor, not the doctor, which is (on what in Chapter Two I called the "standard reading" of GC I.7, 324a24-b6) said to be the first agent of the healing. And in *Physics* II.3, 195b21-5, Aristotle explicitly states that "the art of building" is, in the strictest sense, the primary moving cause. Thus it appears as though the same concerns about how to understand the descriptions of soul using tools should apply in artifact cases, too.<sup>90</sup> That is, the difficulty we find in

<sup>&</sup>lt;sup>90</sup> It is possible that in both artistic and natural contexts, references to the art or soul are elliptical for that which has the art or soul. If this is right, then Aristotle is just using "soul" as shorthand for "the organism – this living substance – *qua* possessing soul." Similarly, references to a *technê* using tools might be short for the sculptor, e.g. Polyclitus *qua* possessing the sculpting art. Evidence in favor of this reading might be garnered from the agential synonymy principle (discussed in Chapter Two). For in general, only something synonymous with the effect can be the agent: "After these things

making any literal sense of soul using tools in GA is a much more global one. It applies in the case of craft production, as well.

I have not provided a positive proposal for construing Aristotle's claims that the soul or nature uses the body literally. However, I have been suggesting that the important point of analogy between the use of tools in artistic production and the movements in generation is that in both cases, they are the means by which a *dunamis* is exercised. If this is so, providing an account of the interface, so to speak, between soul and the movements seems less pressing.

One might think that if the movements are the *energeia* of soul *dunamis*, then everything that the movements accomplish must be precisely what that *dunamis* of which they are the *energeia* is a *dunamis* for. Since the movements result in the offspring's particular body parts and organs, then it must be that the soul *dunamis* they are the exercise of includes all those particular parts and organs. That is, contrary to what I have been saying, distinguishing form or soul from the movements that are its exercise do not, in fact, show that the *dunamis* can be general. But for the following reasons, this is not the case.

Consider Praxiteles' sculpting art. This art is a general capacity that Praxiteles has, in virtue of which he can make statues. Whenever that art is exercised, it is exercised in a particular way, through the very determinate motions of his chisel. But this does not mean that his art prescribes those very determinate motions. Rather, the sculpting art that Praxiteles is exercising prescribes the acceptable range within which those movements must fall, if it is to count as an exercise of that art (rather than, say the art of demolition, which might prescribe a different range of acceptable movements).<sup>91</sup> When Praxiteles is going to sculpt a statue of Hermes, he also must make *choices*. He must choose which marble to use, where to begin carving, which chisel should

<sup>[</sup>we note that] each substance comes to be from something synonymous" (*Metaphysics* XII.3, 1070a4-5). The most general synonymy is synonymy in being. Since the product, at least in animal generation, is a substance, the agent should also be a substance. (Aristotle says in DA that soul is a substance; it is the "substance of the ensouled body" (415b11-12). But surely the *technê* in the craftsman's soul is not a substance.) So, perhaps "soul" and *technê* are just short for the substances that have the soul or *technê*.

<sup>&</sup>lt;sup>91</sup> I am here drawing on the description of a "non-typological" model of essentialism in Lennox 2001a. As discussed in Chapter Three, Lennox argues that an essential property can be thought of as a property that falls within an appropriate range; an essential property need not be thought of as a "basic" or "stock" one, with accidental properties are "add-ons" to the basic model. I am treating the art or soul as something that, similarly, only prescribes that its exercise should fall within an appropriate range.

be used for different parts, etc. So, the precise movements of the chisel (and, consequently, the effects of those movements in the marble) result from those choices. Moreover, some of the determinate movements are going to be affected by the interaction with the marble; the movements may be affected in one way if the marble is soft, and in another if it is hard. When Praxiteles is successfully exercising his sculpting capacity, the particular movements of his chisel – some resulting from choices, and some from interactions with the matter –fall within an acceptable range. Those particular movements are thus an exercise of his general sculpting capacity.

In the case of animal generation, the male has a capacity – nutritive soul *dunamis* – to make another living organism the same in kind as himself. When he exercises that capacity, he does so in a particular way – with the particular movements occurring in the spermatic residues. Some of the determinate movements that are used to build the embryo are due to the particular movements that were present in the male's blood (analogous to the choices Praxiteles makes). And some of the determinate movements that are involved in the formation of the embryo will be results of interaction with the matter. Like the sculpting art, the capacity that the male has – his nutritive soul *dunamis* – is still a general capacity, and prescribes movements within an acceptable range. Where on that range the movements that are used to build the new organism actually fall, depends on the movements present in the parents' blood and spermatic residues, and the way in which they interact.

The movements that are productive of body parts are the *energeia* of nutritive soul capacity to reproduce. Soul, considered as a capacity, is exercised by means of these movements. All the effects of the movements, however, need not be effects that the capacity prescribes.

### 7. Conclusion

The interpretation of Aristotle's account of familial resemblance offered in this chapter identifies the movements in the parents' generative residues as the last agents of the offspring's body. Because of the way the generative residues are produced, they carry movements that are the same as those that were in the parents' blood, where they were used to nourish and maintain the parents' bodies. The movements are for parts and organs at varying levels of generality. The very specific movements result in the specific parts and features that the offspring inherits from its parents and ancestors.

The role for the soul or form is, on my view, that of a first agent that uses last agents as tools in carrying out its activity. This gives rise to a worry about the sense to be made of soul "using" the movements as tools. But the fact that the craftsman literally picks up and manipulates his tools is not, I argued, the important point of similarity between tools in craft production and movements in generation. Rather, they are analogous in being the means by which a *dunamis*, whether a *techné* or soul, is exercised. This does not tell us what Aristotle means when he says the soul "uses" the movements, but it is not clear that any alternative construal of the relation between soul and the movements – i.e., those that do not take the characterization of movements as tools used by the soul in the literal sense that I do – fare any better. Freudenthal's identification of soul with a special vital heat that has movements in it seems to be flatly contradicted by a number of passages; Aristotle explicitly denies that heat is soul. And Balme's reduction of soul to the movements appears to put soul in the wrong ontological category; soul is a *dunamis*, not a movement. By comparison, leaving the precise *modus operandi* (as Freudenthal puts it) by the soul on the body unanalyzed is attractive, even if not fully satisfying.

Despite its lacuna, the interpretation I offer has the following advantages. First, it resolves the apparent tension between causal hylomorphism and maternal resemblance. The mother can contribute movements without thereby contributing form. Further, my interpretation assigns to form or soul an indispensable role in guiding and controlling those movements, unifying the movements such that they constitute a genuine substantial change. Last, and most important for my purposes, the interpretation offered allows us to read GA as employing a concept of form at the level of the species. For, as with first agents generally, the per se aim of the first agent need not include all the determinate effects of the tools or last agents that it uses. Species form is exactly what one would hope to find being used in Aristotle's scientific practices, given the plausible justification for forms that I described in Chapter One. According to my interpretation, the biological explanation of animal generation employs a form common to members of a species, and so can explain the regular reproduction of animals the same in species as the parents. Consequently, Aristotle's scientific explanation reinforces, rather than conflicts with, his metaphysics.

# CHAPTER FIVE SUMMARY

According to the interpretation of Aristotle's *Generation of Animals* that I have argued for, the claim that Aristotle "makes no use of and has no need at all for those species-forms – the form of a human being in general, for example, shared by all the human beings – that are the staple of much contemporary discussion of Aristotle's metaphysics" (Cooper 1990: 84) is not true. According to my interpretation, the embryological theory does make use of and has a need for species-forms. As I have argued, the form that plays a privileged role in the reproductive theory is precisely what we would expect it to be, given our traditional understanding of the *Metaphysics*.

I began, in Chapter One, by outlining the general metaphysical picture that emerges from Aristotle's theoretical treatises. That picture has at its center the idea that there are substances, individuated into kinds by their forms. Forms, common to members of a species, make each member what it is essentially. I suggested that there is good reason to think that an advantage Aristotle sees in this ontology over those of his materialist predecessors (as well as over Plato's) is that forms are explanatory of the regularity with which natural phenomena occur. That is, a plausible justification for positing forms is the work that they do in explaining regularities of well-ordered natural phenomena.

In Chapter Two, I discussed the scientific theory of animal reproduction in *Generation of Animals* as it relates to Aristotle's more general views about natural science. In particular, I identified three principles of adequate explanation: causal hylomorphism, agential synonymy, and contact. Causal hylomorphism is the principle that explanations of change must identify both the form for the change – i.e., what the change is a change *into* – as well as the matter that undergoes the change of taking on that form. The principle of agential synonymy requires that the explanation specify an agent having the form for the change in actuality that conveys the form to the matter. Last, Aristotle thinks that explanations must specify the conditions under which the change will take place, should nothing interfere. In general, such conditions are referred to as "contact." For an agent to act upon a patient, they must come in contact with one another.

In that chapter I showed that in GA, Aristotle is self-consciously and explicitly crafting his explanation of animal generation to satisfy these principles. According to that explanation, the male, who has the form in actuality, is the agent who contributes form, while the female provides the matter. The matter she provides, being a residue form the excess nutritive blood that was used to produce and maintain her body parts, has the form of the change in potential. The point of this discussion was to highlight the fact that particular aspects of the theory of generation need to be properly understood as an extension of Aristotle's philosophical views about the nature of change and explanation. For instance, the fact that the male and female are assigned distinct roles in generation reflects deeply held commitments, and is not an idiosyncrasy of the account in GA.

I then, in Chapter Three, discussed the way in which Aristotle's account of inherited characteristics in GA IV.3 creates trouble for viewing his explanation of reproduction as a straightforward instance of the general pattern of scientific explanation, as described in Chapter Two. The source of the trouble is that on the assumption that the form passed on from parents to offspring is species form, it has appeared difficult to see how inherited subspecific variations are non-accidental, as Aristotle thinks that they are.

The fact that inherited traits are non-accidental has led many scholars to conclude that the form in embryology is a sub-specific form. This, however, makes the theory internally inconsistent. Aristotle is committed to causal hylomorphism, and does not think that the female contributes form, and Aristotle thinks that his theory accounts for maternal resemblance. If form is responsible for inherited characteristics, and only the male provides form, it appears that maternal inheritance cannot be consistently explained.

I concluded that chapter by urging that we reject the assumption that gives rise to trouble in the first place. That assumption is that any effect that is non-accidental is therefore due to form. This conclusion, I argued, is unwarranted, since being accidental and being due to form do not constitute and exhaustive dichotomy. Whether or not something is accidental is always relative to the subject or cause.

In the last chapter, I offered an interpretation of the account of inherited characteristics that does not assume that these are included in the form that is passed on by the male parent. Rather, the inherited characteristics are non-accidental results of the movements in the spermatic fluids from both parents that are used as tools by the first agent, the form or soul in the male.

On my view, all of the body parts that come to be formed are direct results of the movements; some of the movements are for parts and features that are general in some sense, and others are for the very specific parts and features by which offspring can take after their parents and ancestors more than other members of the species. Species form, passed on by the father, is not directly responsible for those body parts.

Like form of health in the doctor's soul, the form of an organism aims at something quite general, namely, reproduction of an organism the same in species. Like the particular cure that the doctor prescribes, the tools or intermediate last agents in generation directly aim at the very determinate parts and features. These last agents can only be agents in virtue of being used by the first agent who has the form in actuality. This interpretation is attractive in that it avoids the tension between maternal resemblance and causal hylomorphism while at the same time providing to species form a privileged causal role.

Consequently, according to my interpretation, Aristotle's scientific account of animal reproduction does precisely what we would expect it to do, given the justification of forms suggested in Chapter One. That justification for forms is that they allow Aristotle to explain regularities of well-ordered natural phenomena that his predecessors could not explain. As I have argued, in *Generation of Animals* Aristotle appeals to the transmission of forms, common to members of a species, from one generation to the next to explain one salient regularity – the regularity with which "human begets human."

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