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**Aristotle's Explanations of Monstrous Births and Deformities
in *Generation of Animals* 4.4**

Sophia Connell

1. Introduction

In *GA* 4.4, Aristotle begins an account of various different kinds of monstrosities and deformities. One might think it pretty straightforward, from previous experience with his writings, that he would very little to offer here in terms of scientific explanation. Monsters do not occur always or for the most part, but infrequently. Surely by being contrary to nature, they are the result of luck or chance (*Phys.* 2.5, 196b10-17, *Meta.* 5.30, 1025a14-16), which are accidental rather than *per se* causes and so not properly explanatory (*Phys.* 2.5, 197a33). Furthermore, rare events are associated with incidental ones and it is not possible to know about incidental matters (*Phys.* 2.5, 197a19-20, *Meta.* 6.2, 1027a19-23, and *APo* 1.30, 87b19-27). The detailed account that we find in *GA* 4.4 shows Aristotle attempting to explain why monstrous and deformed animals occur, and so seems to count as explanations in the realm of his science, broadly construed. Is there any way to provide a properly scientific explanation of why sometimes monsters come to be? In this essay, I argue that scientific knowledge of monsters is not possible. As with other chance events, two separate causal stories can be used to further elucidate what happens,¹ but there cannot be any *per se* causes of monsters. Given this, it is then perhaps surprising that Aristotle spends so long on monsters and related deformities. In what follows I will set out the account in some detail and show that, although there can be no scientific demonstration or knowledge of monsters, there are many recognizable elements of scientific explanation in *GA* 4.4. What happens in cases of monsters and deformities occurs in the process of generation, and there is much that we can know scientifically about this process—working from the animal's essential attributes outward to factors that influence these processes. In particular, we find Aristotle looking for and investigating whether “for the most part” (FMP) correlations are causally relevant and linked to essence. Even though the birth of monsters is scientifically inexplicable, the features of animals that tend to produce them

¹ As in the case of a man who meets a creditor by chance in the market (*Phys.* 2.5, 197a16-24).

can be known about. I will explain how it is that producing more than one offspring per birth is a knowable feature of a kind. This feature, along with others, can then give us a much better grasp on what happens in particular instances of monstrous birth.

I will begin by setting out some of the explanatory machinery that Aristotle must have in mind as he approaches the challenge of giving an account of monsters and individual deformed animals in *GA* 4.4. I will then give an overview of what he says about three key types of problem birth—monsters which are two animals grown together, deformities that involve redundancy of parts, and deformities that involve deficiency of parts. I will finally more closely consider three aspects of this account that can help us to assess its scientific merits: Aristotle’s use of regularity, his search for relevant differentia, and the resultant findings about the feature of bringing to birth many offspring at once. I conclude by considering whether there is any way to include monstrous birth in Aristotle’s science through the idea that “the way is prepared by nature” (*GA* 4.4, 770b4) for them.

2. Scientific explanations of natural phenomena

The *APo* provides a paradigmatic account of scientific knowledge (ἐπιστήμη) in terms of necessary demonstrations where the middle term picks out the cause of the necessary relationship between a subject and its *per se* attribute (e.g. *APo* 1.13, 2.1-2).² This model is refined in order to accommodate biological knowledge.³ Aristotle also distinguishes three types of events and explanations of them. First, there is absolute necessity, which holds always—encompassing eternal cyclic processes (*GC* 2.11, 337b30-8a18). Next, there are those things that hold only for the most part, including the objects of biological science. Finally, there are incidental events, which we think of as the result of chance or luck.

There is no understanding through demonstration of what holds by chance. For what holds by chance is neither necessary nor for the most part, but what comes about apart from these; and demonstration is for one or other of these. For every deduction is either through necessary or through for the most part propositions; and if the propositions are necessary, the conclusion is necessary too; and if for the most part, the conclusion too is

² See also Lennox 2001b: 128-31.

³ Lennox 2001b: 128-31; Leunissen 2010: 43-5.

such. Hence, if what happens by chance is neither for the most part nor necessary, there will not be demonstration of it (*APo* 1.30, 87b19-26. trans. after ROT; cf. *APo* 2.13, 96a7-11).

Events occurring due to chance, such as monsters, are immune to scientific knowledge but natural events that happen “for the most part” can be demonstrated and known.⁴ One important resource for understanding the flexible and complex model of scientific explanation is a distinction between causal and modal uses of necessity (*APo* 2.12). Causal necessity in sublunary natural objects is conditional necessity.⁵ In sublunary phenomena, the relationship between the subject and its attribute is not absolute but conditional and the middle term is an expression of teleological causation (*PA* 1.1, 640a1-9, 33-b3). Modal necessity is the idea that the relationship between cause and effect is not absolute but only occurs for the most part—which is particularly useful in the investigations in biology where internal and external material factors can impede goal-directed natural processes in particular instances (*PA* 1.1, 639b29-31, *GA* 4.8, 777a18-21).

Finally, demonstrations require starting points in the form of axioms and posits (*APo* 1.2), which are further subdivided into suppositions and definitions. Definitions will state the essence of kinds (*APo* 1.10). The search for definitions is evident in many parts of the zoology,⁶ as is the search for essential characteristics of animals. Aristotle looks for features of animals that occur regularly together so that in a second stage of analysis, he can attempt to discover if there is any necessary (in modal sense) link between the features.⁷ Devin Henry (2015: 172-174) helpfully classifies three types of “for the most part” (FMP) propositions found in the biological works. Category A1: *ceteris paribus* laws; Category A2: the more and the less; and Category B: correlation without causation. A1 expresses a defeasibility condition; for example, if females FMP do not menstruate when lactating, this means they do not unless material factors intervene or impede what

⁴ See also Henry 2015: 171.

⁵ The distinction was recently brought into focus by Kupreeva 2010 and refined by Leunissen 2010a: 46-50.

⁶ In particular in the *HA* and *PA* but also in the *GA*. See his attempts to define male and female (*GA* 1.21, 729b8-19, 766a31-4).

⁷ See Henry and Nielsen 2015: 6, and Henry 2011: 211-12.

normally occurs (*GA* 4.4, 777a3-21). A2 expresses the fact that some natural features are plastic but tend to cluster in one area—so that although dogs FMP begin to lactate five days after birth, it is natural for them to do this between four and seven days after (*HA* 6.20, 574b6-7). B-type cases are ones in which sometimes FMP propositions are merely “observable regularities” with no underlying causal basis, such as the correlation of having many toes with producing many offspring (*GA* 4.4, 771b2-8). The most straightforward type is A1, which can be used in scientific demonstrations, since propositions of this type can be easily reformulated so as to hold in every case (e.g. “all normal pregnant female animals necessarily lactate if nothing impedes”).⁸ A2 cases are more difficult since just because something happens FMP in this way does not mean that cases that fall outside that but within a normal range are not also natural.⁹ It is clear, though, that B-type propositions will be useless in our search for scientific knowledge.

We can see, then, that biology contains modes of explanation originating in an *Analytics*-style structure, inevitably reformulated for use in the sublunary realm where entities are changeable and contingent. The proper knowledge of them requires that we find the links between the *per se* attributes of entities in order to come up with informative demonstrations.

3. Aristotle on monsters and deformed kinds in *GA* 4.4

In this section, Aristotle concentrates on (i) monsters which are two animals grown together, like conjoined twins; (ii) deformities that involve redundancy of parts—one animal with parts of two or more; and (iii) deformities that involve deficiency of parts. The section is well crafted to discuss these three types of monstrous birth, linking them through a common set of causes. It ends with the related issue of superfetation, which is also the result of similar causes.

Aristotle seeks a demonstration using the same cause for various phenomena surrounding the generative processes, in particular instances including sexual differentiation, hereditary resemblances, and monstrosities (*GA* 4.3, 769b3-9). It is clear from the earlier part of *GA* 4 that one of the main causes in the case of sexual

⁸ Henry (2015) 183-4

⁹ *Ibid*, 184 attempts to reformulate FMP propositions of type A2 through another essential feature.

differentiations and heredity is the state of the mixture of the male and female generative residues. In *GA* 4.4, a broad statement of the importance of συμμετρία, due proportion (767a14-35), is followed by an intricate exposition of what goes on in this mixture. An individual animal comes to be male or female and to resemble its relatives in certain parts and features due to the δυνάμεις and the κινήσεις derived from these battling it out (*GA* 4.3, 767b21-768b15). And when everyone loses (including ancestral κινήσεις reached by relapse), nothing is left to shape the animal appropriately and so it is a monster (*GA* 768b27-9). After a confusion of shaping κινήσεις all that is left is just an animal, not recognizable as a particular kind (*GA* 4.3, 769b13).

Initially, in *GA* 4.4, Aristotle rejects the idea that deformity is due to the exclusively male semen (76931-770a5), opting instead for the view that the problems occur “in the fetations (κνήμασι) as they become established” (770a8). Fetations are a combination of male and female contributions to generation; the same causes determine how this mixture will turn out (*GA* 4.3, 769b4), an idea further elaborated as the proportional relationship between the two residues with appropriate levels of complementary δυνάμεις (*GA* 4.4, 772a2-30).¹⁰ The fetation is where the problem occurs, but in *GA* 4.3 the explanations that Aristotle reaches for do not only involve the intricacies of that mixture but instead broaden out to consider the type of animal in which these problems occur and the generative processes in them, linking these to other aspects of their nature.

In seeking the cause for these three types of problem birth, Aristotle begins to focus on one particular feature of certain animals—the propensity to produce more than one offspring per birth or polyparity.¹¹ The most polyparous of all are the many-toed (πολυσχιδής) kind.

[Monstrosities occur] more frequently in goats and sheep, because they are polyparous; and still more frequently in the many-toed, because these animals are polyparous and the offspring is not perfected when born (e.g., the dog)—most of these animals’ young, of

¹⁰ This passage more specifically explains why many offspring can be produced at once.

¹¹ Aristotle appears to distinguish the production of many offspring per birth (πολυτοκία) from the production of many offspring over a lifetime (πολυγονία, which we might call “prolificacy”), although the terms are somewhat fluid in the *HA*. Birds have both features (*GA* 3.1); they are polyparous because they produce eggs with two yolks (*GA* 4.4, 770a14-16).

course, are born blind. The cause why this occurs and the cause why they are prolific must be stated later. But the way to the production of monstrosities has been already prepared by nature (προωδοποιήται τῇ φύσει) by the fact that they generate offspring which, owing to its imperfect state, is unlike its parents (*GA* 4.4, 770a36-b5, trans. after Peck).

In this most unusual phrase, “the way has been prepared by nature,” Aristotle links the animal’s nature, its characteristic way of life, to the more frequent occurrence of monstrous birth in it. If, as Aristotle insists elsewhere, monstrous birth is contrary to nature, how can it be that nature has prepared for it? Aristotle continues as follows:

A monstrosity belongs to class contrary to nature not in its entirety but only to nature in the generality of cases (τὴν ὡς ἐπὶ τὸ πολὺ). So far as concerns the nature which is always, and is by necessity, nothing occurs contrary to that; no, unnatural occurrences are found only among those things which occur as they do in the generality of cases, but which may occur otherwise (*GA* 4.4, 770b9-13, trans. after Peck).

This statement makes a familiar point, reminding us of the contrast between absolute and modal necessity in the sublunary realm, where teleological ends can be impeded and connections are defeasible. There is nothing here yet to explain why nature itself is involved in preparing for a monstrous birth. It is only through the next statement that we are further enlightened.

Even in those instances of the phenomena we are considering, what occurs is contrary to this particular order, certainly, but it never happens in a merely random fashion (μὴ τύχοντως); and therefore it seems less of a monstrosity (ἥττον εἶναι δοκεῖ τέρας) because even that which is contrary to nature is, in a way, in accordance with nature, that is, whenever the formal nature has not gained control over the material nature.¹² Hence, people do not call things of this sort monstrosities any more than they do in the other cases where something occurs habitually (εἴωθε) [...]. Thus, there is a certain sort of vine—“smoky” is the name some people give it; and if it bears black grapes they do not reckon it as a monstrosity, because it often and habitually does this (*GA* 4.4, 770b13-22, trans. after Peck).

¹² *Phys.* 2.8, 199a31: nature is twofold, matter and form.

Because it is natural for the many-toed to produce offspring that are incomplete, this means that in some cases monsters are not “by chance.” In the first line, Aristotle refers to “the phenomena we are considering,” and at the end of this passage back to the monstrous conjoined offspring (*GA* 4.4, 770b25), and so is indicating that these monsters are part of the natural order in some way. He does not simply use the idea that natural processes are defeasible and inexplicably go wrong every once in a while. This would, in fact, allow him to give a statistical account of why monsters occur more in the polyparous. Say that a monster occurs once in every 5000 births—if the monoparous elephant ends up producing only one offspring, then it is much less likely to have a monster (a one in 5000 chance) than an animal which produces 100 offspring in its lifetime (a one in 50 chance).¹³ But Aristotle does not say this. Instead, he is interested in the characteristics of this sort of animal and how it reproduces. The reasons for increased frequency of monstrous birth begin with polyparity; when compared with prolificacy on its own, it presents an extra risk factor as the many internal offspring can hamper each other’s completion, confusing the usual κινήσεις in development (*GA* 4.4, 770b28).¹⁴ The many-toed also add another challenge, that is, their relative lack of vital heat. This means that the female parent is unable to complete the offspring at the point of birth (*GA* 4.4, 770b4-5), making their growth onto each other even more likely (*GA* 4.4, 774b10-17).¹⁵

Aristotle next expands the discussion to include two other closely related birth defects—the production of redundant parts and a deficiency in parts, both of which are also in some sense caused by polyparity (*GA* 4.4, 770b28, 771a14). Rather than a focus on what happens in all instances of generation, where the state of the mixture can lead to a confusion or weakening of the formative powers, the emphasis here is on the conditions of conception and gestation in particular types of animal. In order to tie all

¹³ This explanation would, in fact, be more appropriate to apply to all prolific animals, whether polyparous or not.

¹⁴ Aristotle does not explain the absence of the sorts of membranes between offspring that he says at *GA* 2.7, 746a12-19, prevents such conjoining.

¹⁵ This further clarification happens in *GA* 4.6. The heat of the female animal’s body is necessary to complete the offspring, suggesting that the male semen is not solely responsible for all differentiation of the new animal, a point I have argued elsewhere (see Connell 2016).

these happening together Aristotle further explores the reasons for polyparity, seeking a firmer grounding in the animals' natures.

Those that suffer from the most deformities are those that have many toes and this was explicitly linked to polyparity. However, foot type cannot explain polyparity (*GA* 4.4, 771b2-8) as the correlation is neither necessary nor sufficient. Types other than those with many toes are polyparous (e.g. the pig; *GA* 4.6, 774b24-26) and some animal with many toes are monoparous (e.g. the elephant; *GA* 4.4, 771b8-9). Furthermore, the frequent occurrence of the two together is a mere "observed regularity" without any causal basis.¹⁶ Instead, the number of offspring per birth is determined by two features that are fixed in the nature of animals—their size and their relative degree of vital heat.¹⁷

Larger size is the reason why (διὰ) an animal is not polyparous—since nourishment is used up on bodily growth and so there is less residue to become the seminal (*GA* 4.4, 771a24-5). Smaller animals, then, produce more semen and therefore can make up more offspring at a go. But since Aristotle rejects the idea that regions of the uterus draw in semen (*GA* 4.4, 771b27-33),¹⁸ he must explain why more generative residue doesn't just produce one large embryo (as more milk and fig-juice produces a larger block of cheese, *GA* 4.4, 771b25).

When animals are being perfected, there is a certain size for each, a limit of bigger and smaller; none will be formed bigger or smaller than these sizes [...]. In precisely the same way, the seminal matter [i.e. the female contribution] out of it [the embryo] is formed is not unlimited in either direction—the amount of it can be neither bigger nor smaller than certain limits; the embryo cannot be formed out of any casual amount of it. Thus, in the case of those animals which (on account of the causes stated) discharge more residue than is requisite for the principle of a single animal, it is not possible that the entirety of this should be used to form one embryo; on the contrary, as many are formed as is

¹⁶ See also Henry 2015: 174.

¹⁷ Aristotle proclaims at several points that we ought not to be amazed (θαυμάζειν, 771a19-27) by the correlation of parity and body size. On this correlation, see also *GA* 1.18, 725a28-34. On body size as an essential feature of a kind, see *PA* 4.6, 683a18-9; *PA* 4.9, 685b12; *GA* 2.6, 745a5-9; *DA* 2.4, 416a15-18, *IA* 8, 708a9-20; and *Pol.* 5.9, 1309b18-35.

¹⁸ The Pseudo-Aristotle *Problemata* 10.41 considers this theory, which appears in the Hippocratic treatise *On Nature of the Child* [*Nat. Puer.*] 31 (Potter 2012: 540) to be viable.

determined by the sizes proper to those animals (*GA* 4.4, 771b33-772a8, trans. after Peck).

Aristotle further explains, on the basis of the essential size limits of a given kind, why when larger animals have a good amount of generative residue, this is not divided up to make many offspring at once:

[In] those animals which are large and produce one offspring only, a large amount of residue does not give rise to a large number of offspring, for the same holds good: here too, the amount of the material and of that which works upon it are definite (*GA* 4.4, 772a30-33, trans. after Peck).

We now believe that each embryo is roughly the same size—i.e. one cell/ovum. Aristotle, in contrast, must hold that even brand new embryos differ in size. Although counterintuitive to us, there is nothing theoretically implausible about such a stance, which explains why a large amount of generative residue only results in many offspring if those the parents are small-bodied.

The same reasons lie behind deformities that involve redundant parts and those that involve deficient ones, i.e., the animal's size and the amount of potent generative residue it produces (both male and female). In the case of redundant parts, the male and female have produced enough generative residue to constitute more than one offspring, but not enough to make it two: the materials then ooze out to form more parts than are required (*GA* 4.4, 772b13-26). About deficiency of parts, Aristotle has very little to say, only that they are like spontaneous abortions—presumably, in these cases there is not quite enough generative residue to complete the instrumental parts. The difference between the main cases Aristotle focuses on in *GA* 4.4 are then summarised: monstrosities are the growing together of two animals, whereas deformities involving redundancy are one animal with too many parts (*GA* 4.4, 773a8-13).

4. Explanation and knowledge in *GA* 4.4

This section will more closely consider three related issues in Aristotle's explanations of monsters and deformities. I will begin by clarifying the role of frequent as opposed to rare occurrences in Aristotle's scientific explanations. Next, I will look at Aristotle's

search for relevant features of kinds based on initial clues that relative frequency provides. Finally, I will focus on the feature of the number of offspring produced per birth to see how it might fit into Aristotelian science.

Within *GA* 4, Aristotle is repeatedly looking for and finding causes.¹⁹ The framework of these causes is complex. As mentioned, it seems that one set of explanations focuses on the state of the mixture where Aristotle provides numerous posits (ὑποθήσεις) such as the presence of current (ἐνέργεια) and possible (δύναμις) potential κινήσεις,²⁰ the idea that being mastered results in changing into the opposites, and the working of relapse (*GA* 4.3, 768b5-10).²¹ In *GA* 4.4, there is explicit drive to discover a demonstration of the causes of monstrosity (769b11). Although the state of the mixture is certainly still part of his explanation of monstrous birth, Aristotle focuses now more on animal kinds and their characteristics.

In order to advance his knowledge of nature, Aristotle believes that he must find the *per se* attributes that attach to a natural subject through teleological reasoning. For example, in order for a person to be healthy, certain states of affairs must hold; these states of affairs are conditionally necessary for her health (*PA* 1.1, 639b30-40a1). This holds “for the most part” as it is a sublunary phenomenon and so defeasible. Finding items that hold together “for the most part” (FMP) is an important first step in attempting to discover more fundamental connections and explanatory *per se* attributes of a kind. But something’s happening frequently or rarely is no guarantee of such discoveries. There is no necessary connection between frequent occurrences and natural teleological ones in Aristotle’s science.²² Some events that happen infrequently are still be natural, such as the birth of a human child. Such occurrences fit with a “conditional frequency” model—under given conditions, things will happen for the most part in a certain manner.²³ Although it is rare, a woman who has a child will FMP have a

¹⁹ E.g. *GA* 4.1, 766a18; 4.1, 766b26; 4.2, 767a14-5; 4.3, 768b16; 4.3, 769a1; 4.3, 769b3; and 4.3, 769b11.

²⁰ For an explanation of my preferred translation, see Connell 2016: 311-12, 316, 319, and 322.

²¹ The section on sexual differentiation also lists a series of premises (ὑποκειμένων, *GA* 4.1, 766a16), which must be accepted before the reader can understand the causes of male and female coming to be.

²² See Judson 1995: 86, 97.

²³ *Ibid.* 89.

human child. Even when we have narrowed down such FMP propositions, there are still cases where the relevant causal connections are missing. I propose that Aristotle is well aware that correlations between events or features of a kind are not necessary or sufficient to count as properly explanatory but could be an indication or sign of these and so are worth investigated further. He can then get to work testing each until he can fix on the best and most scientific explanation and one that could ultimately feature in demonstrations. Those FMP correlations that turn out to be more promising will require careful specification, in terms of both the plasticity of the feature and those factors which can impede or prevent it. Returning, then, to Henry's 3 Categories of FMP propositions, we can apply these to Aristotle's investigations in *GA* 4.3 to see how far he gets.

FMP correlations will initially guide Aristotle in his attempts to bring to light which features of a kind are essential to it and so appropriate for defining kinds and providing scientific explanations. In *GA* 4.4, type of feet might at first have looked promising. Those that are prone to produce deformed offspring tend to be polyparous and almost all of the many-toed are polyparous. Having many toes²⁴ is correlated with other differences in the biological corpus, such as the shape of the spleen (*PA* 3.12, 674a1) and the absence of horns and hucklebones (*PA* 3.12, 674a1, *HA* 2.1, 499b23, and *PA* 4.10, 690a24). However, a focus on feet is a false start: although many toes and polyparity tend to occur with great frequency together, they are not causally related. Furthermore, no proper explanation can be attained by leaving the matter at the fact of polyparity. Having more offspring at a go only occurs because more generative residues are produced and this abundance of residues is not there for the sake of polyparity. It is, rather, a material consequence of the size and body heat of the kind which results in the production of plentiful and potent residues. The residues themselves are telic but the amount is contingent on many other factors, such as external weather conditions.

²⁴ This is a division within the blooded and viviparous kind. Cf. *HA* 2.1, 499b6-11: Of blooded and viviparous quadrupeds some have the foot cloven into many parts, as is the case with humans [...] (for some animals are many-toed, as the lion, the dog, and the leopard); others have feet cloven in two, and instead of nails have hooves, as the sheep, the goat, the deer, and the hippopotamus; other are uncloven, such as the solid-hoofed animals, the horse and the mule (trans. after Peck). See also *HA* 2.10, 502b34; *PA* 4.10, 690a5-7.

So neither foot type nor polyparity are of much use on their own in this search for knowledge. In a later work in Aristotle's school, the *Problems*, the author starts immediately with body size as the essential factor to consider with respect to the issue, asking "why is it that quadrupeds of a small size most often give birth to monstrosities, whereas man and the larger quadrupeds, such as horses and asses, do so less often?"²⁵ The tentative reply features both sets of causes considered in *GA* 4.4, polyparity and the confusion of seminal fluids.²⁶ Although there is an overlap here in the content of *GA* 4.4 and the *Problems*, there are also significant differences. In the *GA*, Aristotle is not merely speculating about whether there is a connection between certain deformities and polyparity—we find instead a more systematic attempt to explain this connection. Aristotle's focus on body size and relative degree of vital heat fixes the explanations to the animal's essence. The combination of these two factors gives the reasons why the animal has the number of offspring it does per birth. Smaller size and a high level of vital heat makes it that a great deal of potent generative residue goes to make up many smallish embryos and the heat ensures that they grow and develop properly.

The fact of polyparity is not an essential feature and so it does not appear to be explanatory. It is not conditionally necessary; it does not happen for the sake of anything coming about because body size and vital heart interact in a particular manner in the process of generation. As this, it is the result of two such crucial features; however, it occurs with enough regularity to indicate naturalness and a loose connection to the kind in question.

We might at this point profitably consider how the correlations Aristotle has so far discovered fare in terms of the requirements for adequate demonstration proposed by Devin Henry.²⁷ Size and degree of vital heat are most promising features of kinds. An elephant is FMP large (unless something impedes). Meanwhile, a human being FMP has a high degree of vital heat (unless something impedes). Bodily size and degree of vital heat are clearly excellent features for Aristotle to concentrate on in his biological explanations. As for number of offspring per birth, the answer is more complicated. Although it is not essential to a kind, it may still be feasible to use it in scientific explanations, since it is fixed within certain limits. This is because it can be tied causally

²⁵ *Problems* 10.61, 898a9.

²⁶ *Problems* 10.61, 898a10-15.

²⁷ Henry 2015.

to size and degree of vital heat. Thus, size is FMP correlated to the number of offspring per birth. The connection is defeasible due to fluctuations in the amount of generative residue produced but this in turn can be fixed with reference to the degree of vital heat FMP possessed by the animal kind. This means that the number of offspring per birth will often be fixed for a kind. So, for example, an elephant will FMP produce enough generative residue to generate one elephantine embryo. For some kinds, however, this is not the case. For human beings in particular, it is more difficult to fix how many offspring they will produce per birth, as the FMP propositions associated with twinning are more like Henry's A2. This may help to explain why Aristotle seems not to have made up his mind about whether human twinning is natural or not.

Sometimes Aristotle says that for humans having twins counts as a monstrous birth and that having one offspring is most natural to them (*GA* 4.4, 772a36-772b1). He also says that human dualize (ἐπαμφοτερίζει), sometimes producing one and sometimes more than one offspring per birth (*GA* 4.4, 772b1-3);²⁸ it would seem that both are natural to humans. It might even be the case that "humans are by nature polyparous" (*GA* 4.5, 773b23-24). Certainly human twinning is rare but this need not make it unnatural. Henry's A2 FMP phenomena do not necessarily pick out the only natural happenings within a more or less continuum. It is natural for a dog to lactate seven days after birth, even if FMP dogs lactate after five. So also it may well be natural for a human to have twins even if FMP humans do not do so. After all, they have a good level of vital heat and so are full of residues (*GA* 4.4, 772a36) and have a roomy enough uterus (*GA* 4.5, 773b24), all features which are perfectly natural to them.²⁹ On the other hand, Aristotle might choose to limit the range of what counts as natural in this case, unlike the dog case, specifying that one offspring is what is natural (*GA* 4.4, 772b3). His decision will no doubt be based on other factors he takes to be relevant. He might, for example, consider the places and sorts of human beings that more regularly produce twins and decide that they are unnatural and freakish.³⁰

²⁸ See also mules and deer (*HA* 6.22, 576a1; *HA* 6.29, 578b15).

²⁹ Another feature of human beings also aids multiple pregnancy, that is, their variable gestational period (*GA* 4.4, 772b8-10). An animal's gestational period is said to be proper to it (οἰκείος) indicating that it is likely to be a part of its essence (*GA* 4.3, 769b25).

³⁰ Aristotle believes that people living in places other than Greece are somehow defective (*Pol.* 7.7, 1327b29-28a14). Twins occur most in Egypt (*GA* 4.4, 770a35, *HA* 9(7).4, 584b31-32).

Returning, then, to the number of offspring per birth as a feature of a given animal type—it can be fixed by nature, at least for some animals. The fact that it is natural can then make better sense of two anatomical facts. Polyparous animals will need larger uteri and more numerous nipples, and nature does appear to supply them with these.³¹ The size of the uterus would seem to be fixed by nature to suit the size of the offspring. Although one could argue that this is not the case, given that it initially comes to be in order to contain the female generative residue (*GA* 4.1, 766b23-25), with no mention of gestation. Indeed, some uteri would seem to always be a bit too big, such as those in animals that superfetate. These animals have left over space in their uteri even after there is an embryo in it (*GA* 4.5, 773b24). Even if the size of the uterus is variable, it does appear that the number of nipples an animal has is not (*PA* 4.10, 688a31-b25).

Polyparous animals have their mammae upon the abdomen. This is because they have numerous young to feed, and so they need numerous mammae (*PA* 4.10, 688b15-17).

We can now establish the relevant sense in which polyparity is natural to a kind and subject to scientific understanding. It is not directly teleological but connected through essential features of the kind. It is more variable and plastic than other features, fluctuating depending on a number of factors such as time of life and locality. It comes along with essential features, in particular body size and amount of vital heat, which then results in abundant and potent generative residues. This, again combined with small body size, means that many embryos can make a start in the uterus all at once. One might think of it as a feature that follows the pattern of secondary teleology, where nature uses material conditions to further its aims.³² This seems to be plausible, since one of the goals of nature will be for each individual to reproduce itself as many times as is possible.³³ However, one might be reluctant to characterise this feature as so closely tied to teleology since it leads to detrimental results, i.e. an increased risk of severe deformities.

³¹ Even though a small uterus will be able to contain many undeveloped embryos there would seem to have to be some natural mechanism to prevent more than the viable number forming there, some “foresight” about how large the embryos will eventually get.

³² On “secondary teleology,” see Leunissen 2010: chapter 4.

³³ Connell 2016: 240-43.

Can any monstrous birth, if regular and explicable in terms of animal kind and process of generation, fit into Aristotle's natural science? The best chance for this is those conjoined offspring that most frequently occur in the many-toed kind. In these cases "the way is prepared by nature" which means those monsters are "not by chance" (*GA* 4.4, 770b15). Aristotle suggests, then, that the conjoining of twins in the many-toed kind is "not monstrous", just as black grapes on the co-called smoky vine aren't (*GA* 4.4, 770b20).³⁴ If they are not really monstrous, then it may be that we can find a proper scientific explanation for them. The way he seems to try to do this is through the idea that the monstrosity of the offspring is somehow a part of the nature of the kind – because they produce monstrous offspring almost all the time. In the many-toed their offspring are *never* complete and so are deformed already before the growing together even happens. "The way is prepared by nature" for monstrous births in this kind because due to middling vital heating capacities, they never complete offspring, which are born "deformed," i.e. unarticulated (*GA* 4.6, 774b10-17).³⁵

If this is how Aristotle wants to include deformity within natural explanations, then he is going to find this a difficult position to maintain. Indeed, it does not fit well with his overall teleology, which makes it very difficult to see how enforcing systematic deformity could be a part of nature. Rather, nature always attempts to achieve what is best and in kinds like the many-toed, its systematic failure is not natural or part of the natural order. This is the way that we can make best sense of Aristotle's deformed kinds, as has been argued recently by Charlotte Witt.³⁶ Looking particularly at aquatic quadrupeds, lobsters, moles, and females³⁷, Witt concludes that to be deformed for Aristotle is the impeded development of a part in embryogenesis. This results in an animal with a part that is (i) incomplete and therefore not functional or (ii) not used for

³⁴ Nielsen 2008: 394 provides an interesting interpretation of this passage. For her, Aristotle is arguing against the common view that black grapes are not monstrous; instead he thinks they are, just like female births.

³⁵ See also *HA* 6.33, 580a4-5; *GA* 2.6, 742a1.

³⁶ Witt 2012.

³⁷ Allan Gotthelf (1985: 39-41) gives a different account of deformity of kinds, where the kind is deformed relative to the wider kind to which it belongs.

its proper function.³⁸ So the mole has eyes that are incomplete and non-functional, while the seal and lobster use parts for roles they are not designed for (the seal swimming with a walking instrument and the lobster walking with a grasping instrument).³⁹ This account avoids the difficulty of having a teleologically focused form that is systematically producing defective animals, instead positing that the errors occur in the process of embryological development in each instance. This makes better sense of the term “ὄσπερ” used of the deformity of such animals—they are like animals that are deformed in the process of generation in other kinds—like the blind infant, whose eyes never developed properly. A potential difficulty for this theory is that quite a few non-deformed animal kinds are said to use their instrumental parts for dual functions. So the elephant uses its “nostril” as a hand (*PA* 2.16, 659a1), and this is because, unlike other quadrupeds, who use their front feet as hands, the elephant cannot do so due to its weight. As Aristotle says, nature in this case is following her wanted plan of using one and the same part for several purposes, for in the many-toed quadrupeds the fore feet are intended not merely to support the weight of the body, but to serve as hands (*PA* 2.16, 659a21-25; cf. *PA* 4.10, 687b1 and 688a2-5).⁴⁰ Although there may be challenges with applying case (ii), case (i)⁴¹ seems very apt and applies well in the case of the many-toed kind. Rather than the production of unarticulated animals being a part of

³⁸ The Greek terms used for deformity are often used of people without limbs, who then might have to use other limbs in order to complete daily tasks. See Witt 2012: 90-91.

³⁹ I disagree with Witt that the female is characterized by Aristotle in the same way, as lacking a functional part. The parts that are unfinished, defective, or used for other purposes in the seal, lobster, and mole are instrumental parts. For Aristotle, male and female do not fundamentally differ with respect to their instrumental generative parts but due to the heating action of their heart (*GA* 4.1, 766a35-b5). This is the part that forms before the rest and directs the development of the other parts (*GA* 2.6, 742a16-b18; cf. *GA* 4.4, 773a5-6). Any serious infirmity in this part would mean that the animal could not develop at all. For further discussion, see Connell 2016: chapter 8.

⁴⁰ See also the dual function of female mammarys (*PA* 4.10, 688a16ff; and b24-25) and the octopuses use of an arm as a penis (*HA* 4.1, 524a8-10).

⁴¹ This type of deformity, a deficiency of the parts (770b30; 772b37-773a2), is the one that Aristotle has the least to say about in particular instances in *GA* 4.4. This is probably because these embryos are much less likely to survive, particularly if the part that is deficient is a controlling part. They are often spontaneously aborted (*GA* 4.4, 773a1-2).

their form or nature, it is rather the case that their form systematically fails to establish itself in order to complete the offspring at the point of birth. And there is nothing natural about this. Thus, there isn't any way in which the deformities are natural or subject to any natural teleological explanation based on *per se* causes. Instead, the explanation will be in terms of material factors, divorced from essence; it will concern the state of the mixture of generative residues. We can conclude, therefore, that though conjoined offspring occur more often in the many-toed, this does not make them less monstrous but only makes it seem that they less so. Why he says that they are "not by chance" remains a mystery.

5. Conclusion

In investigating the causes of monstrous births, Aristotle seeks some kind of demonstration (*GA* 4.3, 769b4). Moving away from only focusing on the mechanisms at play in the mixture of generative residues, he broadens his analysis to consider the types of animals involved and the features that are essential to them and explanatory of their essence. In doing so, he might indeed be getting closer to demonstrative scientific knowledge. By seeking to further investigate observed regularities, we can see Aristotle trying to find out which will move us toward scientific knowledge and which will not. The explanatory framework he settles on provides a backdrop upon which the scientist can situate the occurrence of monstrous birth. So, although she cannot provide any demonstrations of why it happens, since it is anomalous, incidental and unnatural, she can see when it is more likely to happen based on her knowledge of the various kinds of animals and their essential features. By tying it to essential feature, Aristotle can then give an account a feature that has strong connections to the relevant natural processes. This feature is polyparity, a feature that most often creates the possibility for the sorts of monsters and deformities he is most interested in. Polyparity is the cause of these happenings but since it is not essential, it cannot be linked in the proper manner to the animal kinds in which it occurs, and probably cannot feature as a premise in a scientific demonstration. However, since Aristotle regards it as a pretty stable feature of a kind, piggy-backing on essential features and the regularity of the workings of internal and external material necessity, it can count as "natural." It is tied closely enough to the animal's nature for other anatomical features to be in place such as a given number of nipples and a spacious uterus.

One could see polyparity as in some ways similar to other features Aristotle discusses in *GA* 4 and 5, specifically inherited features and accidental ones. Inherited features follow particular patterns determined by the κινήσεις in the parents' generative residues. When you end up looking like your mother, the κινήσεις won't change into any chance thing (οὐκ εἰς τὸ τυχόν, *GA* 768a3) but only into the opposite of the father. Although they are not present for the sake of anything, we can think of them as "*per se* results of certain κινήσεις, which are said to be drawn from potentials that the generator has non-accidentally, *qua* generator."⁴² We might also here bring to mind the accidental features from *GA* 5 (e.g. eye color). Owls have to have eyes constructed in a particular manner from particular material (conditional necessity) in order to see acutely. The color that results from those materials conditions is not part of the essence (*GA* 5.1, 778a33, and 779a30-31) but will invariably appear. The pattern of consistent eye color following from an animal's essence is similar to the consistency with which polyparity follows from essential features.⁴³

In the case of number of offspring per birth, it would seem that natural causes underlie and make it so that although these are not *per se* causes (not intended directly), nature (like deliberation) can somehow predict that these concurrences will happen and in a way intend them.⁴⁴ What nature, however, can never intend is any increased likelihood of monsters and deformity. So although they can be predicted, monsters are the result of pure chance. There is a natural grounding for them but we cannot have any proper knowledge of monstrosity itself other than that it involves the absence of teleology (*GA* 4.10, 778a5-9).⁴⁵ And so we are forced to return to the messy

⁴² Gelber 2010: 191. See also Connell 2016: 320-1.

⁴³ In the case of eye colour, however, the colour itself is non-teleological. Many offspring per birth, on the other hand, can find a connection to the goal of generation.

⁴⁴ Allen 2015: "It seems conceivable that there could be cases in which by doing one thing *per se* one could hardly fail to do something else *per accidens*, as a concomitant. Elsewhere, of course, Aristotle is happy to allow that a substance is always and necessarily attended by some of its accidents (*Meta.* 1024a3-4; *APo* 75b1) [...] to the well informed agent, they come as no surprise, and they are part of what he does intentionally even if not with the intention of bringing them about" (79).

⁴⁵ Johnson 2005: 198.

details of what occurs in the mixture of male and female generative residues in each particular instance of generation (*GA* 4.3, 768b28-35) in order to seek reasons for them.