

## Form, Essence, and Explanation in Aristotle's Biology

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### Introduction

Aristotle's concept of form (*eidos*) is closely associated with two other key concepts in his metaphysics and natural philosophy, essence (*to ti ên einai*) and cause (*aition*). Yet in Aristotle's most sustained and detailed account of scientific explanation, the *Posterior Analytics*, a view of scientific definition and demonstration is developed which makes no reference to form or the distinction between form and matter. Moreover, the examples from the science of nature that Aristotle typically appeals to, such as thunder, eclipses, or leaf-shedding, leave the reader wondering how that theory would apply to natural substances. When we turn to Aristotle's most sustained scientific investigation of nature, his many integrated investigations of animals, we can see how his views about definition and demonstration are applied to his paradigm case of the natural unity of matter and form. In the domain of living things form is a functional concept, referring to the soul (*psuchê*), the integrated set of living activities of a body constituted to perform them. As such, form plays a key role in two very different explanatory contexts: that of explaining why each kind of organism is structured as it is; and that of explaining the amazingly complex and organized process of development. Development is the process by which biological forms, souls, are endlessly replicated. It permits a living thing to "participate in the eternal and divine." This "most natural" of an organism's formal capacities ensures "coming to be is for the sake of being."

### Essence and Explanation in Theory and Practice

Aristotle's essentialism, as it is articulated in the *Posterior Analytics* (*An. Post*), is at once sophisticated and remarkably unlike what passes for "Aristotelian essentialism" in modern philosophy (Charles 2000). The goal of scientific inquiry, according to *An. Post* II, is knowledge of certain features of the objects of inquiry, features that both make the objects what they are and are the causes of most or all the other non-accidental features of those objects. The summary statement of the position in *An. Post* II. 10 refers to a privileged kind of *definition*, one which is a rearrangement of the terms of a parallel *demonstration*. For example, in a scientific demonstration of why a certain noise

(thunder) occurs in certain clouds, the middle term identifies the cause of the noise (extinction of fire). This demonstration provides the materials for a definition of thunder as a noise that occurs in certain clouds due to the extinction of fire (*An. Post* II.10 93b38–94a9).

There are, however, two puzzling features of this discussion of scientific definition and demonstration. One puzzle is that the focus seems to be on determining the natures of the attributes in a domain of inquiry rather than on determining the nature of the substances in that domain. In other words, the *definitional* inquiry that is closely tied to the search for causal demonstration results in definitions of attributes. This discussion provides us with little insight regarding how one might pursue an inquiry into the essences of different kinds of animals.<sup>1</sup> A second puzzle is that on this view the content of a definition cannot be determined independently of causal inquiry. There is no access to essences that is independent of successful causal investigation.

These puzzles are exemplified by an example in *An. Post* that comes closest to the definitional and explanatory practices of Aristotle's biological works. The example is presented during Aristotle's discussion of converting problems (*problemata*) at the level of ordinary experience into true scientific problems, where the predications to be explained are commensurately universal. Consider one of Aristotle's conversions, wherein a question about why this or that sort of tree suffers loss of leaves leads into a question about why all and only broad-leafed trees lose their leaves. Initially one might think that Aristotle has converted his initial question into an answer: All fig trees lose their leaves *because* they are broad leafed. But Aristotle argues that, though we may consider this a provisional explanation, the "because" here is not *immediate*; for one may now inquire into the (convertible) connection between being broad-leafed and losing leaves. For the sake of illustration, Aristotle suggests that leaf loss in all such trees is due to the solidification of the moisture where the leaves connect, and he claims that this cause will also enter into *the definition of leaf loss* for these sorts of trees (*An. Post* II.16 98a35–98b38; 17 99a21–9; for detailed discussion of these passages, see Charles 2000: 204–9; Lennox 2001b: 51–3, 88–9).

As in the meteorological and astronomical examples of earlier chapters (inquiries into "thunder" and "eclipse"), there is a definition corresponding to the demonstration, but it is a definition of the *attribute* (loss of leaves), not of the kind to which the attribute belongs *per se* (trees with broad leaves).

If you take the primitive middle term, it is an account of the loss of leaves; for there will first be a middle in the one direction (that all are such); and then a middle term for this (that sap solidifies or something of that sort). What is it to lose leaves? It is for the sap to solidify in the connection of the seed. (99a25–9)

Also as in the earlier examples, it looks as if that subject – trees with broad leaves – is identified a posteriori, in the process of discovering an attribute that is commensurate with loss of leaves. In these cases, the subject kind is not identified prior to the demonstrative inquiry.<sup>2</sup>

Since the 1970s, a great deal of work has been done to narrow the distance between the understanding of Aristotle's essentialism derived from the *Analytics* and the explanatory and definitional practices of the biological works (Kullmann 1974; Bolton 1987;

Charles 2000: ch. 12; Gotthelf 1985, 1987b; Lennox 1987b, 1990).<sup>3</sup> This scholarship has shown us, for example, that when Aristotle finishes his account of the heart with the following words, he has in mind the idea of the relation of essence and explanation that is expressed in *An. Post* II.8–10:

Regarding the heart, then, what sort of thing it is, what it is for the sake of, and the cause owing to which it is present in those animals that have it, let so much be said. (*PA* III.4 667b13–14)

And indeed, *PA* I.1, the philosophical groundwork of Aristotle's biology, defends the view that in the study of the products of natural generation, the cause identified as that-for-the-sake-of-which takes precedence over motive and material causes. This precedence ordering is given because in the case of things that come to be, the account of the essence (i.e. the definition) identifies the final cause (639b12–21). For example, Aristotle's general account of the heart concludes (i) that the heart is present for the sake of originating blood, (ii) that it is also the primary perceptive part, and (iii) that it is thus the primary organ of the perceptive capacity of soul, the capacity essential to being an animal (*PA* III.4 666a34–6).<sup>4</sup> The definition of a heart and the explanation of why animals with hearts have hearts are intertwined in precisely the way the *Posterior Analytics* would lead us to expect.<sup>5</sup>

Not surprisingly, then, the aforementioned puzzles about the account of essence in the *An. Post* also manifest themselves in the biological practice. It should be noted, for example, that the only "kind" that is mentioned in Aristotle's conclusion about the heart is "animal," and the only "subject" to which the part "heart" belongs is "those animals that have it." This is far more the rule than the exception in *PA*, and the reason again seems to follow from the principles of the *An. Post* II: in many cases the groupings of animals to which a part belongs commensurately are not easily identified and are typically picked out by reference to other differentiae. In considering, for example, animals with multiple stomachs (a group we now call "ruminants"), Aristotle explains why all of them have this feature. In so doing, he notes that they also share hoofs, horns, and a dearth of upper teeth, and this level of similarity is sufficient for Aristotle to give a single explanation that applies to all of them. Aristotle typically identifies them by a Greek nominal phrase that literally translates as "the ones that do not have both rows of teeth (*ta mê amphôdonta*)" (cf. *PA* III.2 663b29–664a3, III.14 674a32–b18; *An. Post* II.14 98a13–19). That group will be the subject of a demonstration that explains the possession of four stomachs, but it will be identified as subject only during the search for that demonstration.

Another grouping that Aristotle investigates that does not constitute an identified kind is the group of animals that possess lungs and also share a number of correlated features, all of which can be explained by reference to breathing. Aristotle concludes his discussion of the lung by claiming that, even though animals with a lung do not constitute an identified kind, the lung is nevertheless part of their being (*ousia*) – as much, he insists, as having feathered wings is part of the being of birds (*PA* III.6 669b8–12).

Until now I have been stressing the similarities (including the shared puzzles) between Aristotle's account of essence and explanation in the *Analytics* and the defini-

tions and explanations one finds in the biological works. There are, however, important differences that derive from the abstractness of the account in the *Posterior Analytics*. Aristotle will often, and I suspect intentionally, exemplify the same philosophical point in *An. Post* II with an example drawn from mathematics and an example drawn from the investigation of nature. The account of definition and explanation provided must apply to both, since he is providing an account of knowledge as such. It has often been noted that neither in *An. Post* nor in the *Organon* in general is there any place for an analysis that divides being into material and formal aspects. Even when it is finally acknowledged that there are four distinct kinds of causes, there is no mention of matter and form, but rather of “necessitating ground” and “essence” (*to ti en einai*) (*An. Post* II.11 94a20–4).

Aristotle considers the objects investigated by biology, on the other hand, to be *paradigmatic* of the unity of matter and form, and the closely related teleological unity of structure and function, characteristic of natural substances. How does this affect the understanding of essence, as presented in the *Posterior Analytics*? The example of the heart described above (and it is typical of the practice in *On the Parts of Animals*) suggests at least a significant amount of continuity. But that example also suggests that Aristotle’s views about explanation and definition will involve essential reference to the functions of the soul and to the way matter is organized for the sake of performing the soul’s functions.

### Form, Function, and Biological Essentialism

After having outlined, in the opening pages of *De Partibus Animalium* I, the approach to the scientific investigation of living things that will give us true understanding of them, Aristotle tells us why it was left to him to identify this approach:

One reason our predecessors did not arrive at this way is that there was no “what it is to be” and “defining substantial being” (*to ti ên einai kai to horisasthai tèn ousian ouk ên*). Democritus touched on it first, not however as necessary for the study of nature, but because he was carried away by the subject itself; while in Socrates’ time interest in this [sort of inquiry] grew, but research into the natural world ceased, and philosophers turned instead to practical virtue and politics. (642a24–31)

Coming as it does near the end of the *PA* I.1, the argument leading up to this claim of historical precedence provides us with several interpretive clues. The way of inquiry that was *not* employed prior to Aristotle will be the new path characterized in this chapter. When it comes to causal investigation, that sort of inquiry gives *priority* to natural ends over antecedent motive causes (639b11–21), and it introduces a special sort of necessity, the *conditional* necessity for antecedent materials and processes to be present *if* natural ends are to be achieved (639b21–640a8; 642a1–17). This causally prior end of natural development for which we are to search is not, however, an organism’s body, at least not insofar as it is conceived as a mere anatomical structure. Instead, the end of organic development is *form*, conceived of in functional terms, the *soul* of the living thing (640b28–641a32, cf. 645b15–20).

There are, however, two quite distinct ways in which the form of a living thing enjoys causal/explanatory precedence in Aristotle's philosophy of biology. First, explanatory priority is given to *the function for the sake of which* the organisms being investigated have those parts. This is the central task of *De Partibus Animalium* II–IV, as exemplified in the example of the heart discussed earlier. In this domain, we find Aristotle moving in the direction of a kind of unified account of the essences of animal kinds. Second, explanatory priority is given to *the actual being* in accounting for the various stages of potentiality represented in animal development. This is the primary task of *De Generatione Animalium*. In this section we will look at the definitional and explanatory role of form in the discussion of animal being in *De Partibus*; in the next we will turn to its role in Aristotle's account of animal generation.

If Aristotle the biologist continues to hold that there is a tight connection between demonstration and definition, he must integrate that view with his views about the priority of “the cause for the sake of which” over motive causes and the priority of living form over living matter. Just such an integration is outlined in *PA* I.5. The causal priorities are especially clear in the following passage.

Since every instrument is for the sake of something, and each of the parts of the body is for the sake of a certain action, it is apparent that the entire body too has been constituted for the sake of a certain complete action.<sup>6</sup> For sawing is not for the sake of the saw, but the saw for the sake of sawing; for sawing is a certain use. So the body too is in a way for the sake of the soul, and the parts are for the sake of the functions in relation to which each of them has naturally developed. (645b15–20)

The connection between essence and explanation here is as intimate as it was in the *Posterior Analytics*. The unity of matter and form in animals is to be understood as the unity of an instrumental structure and its functional capacity. The various features of a part are to be explained by reference to the function or action for-the-sake-of-which that part came to be and exists; the physical features of the animal as a whole are to be understood by reference to the animal's complex, yet integrated, way of life. The definition of a part that corresponds to such an explanation will necessarily make reference to the part's structure, but only in so far as that structure exists for the sake of performing its function or functions (645a33–6). To be the heart of a certain kind of animal is to be an instrument structured (and located) appropriately for the nutritive and perceptive functions of that (kind of) animal.

The resulting teleological unity of matter and form can be understood at any level of generality. In the previous chapter, Aristotle resolved an *aporia* raised at the very beginning of the book (639a15–19). As he restates it in *PA* I.4:

On the one hand, in so far as what is indivisible in form is a substantial being, it would be best, if one could, to study separately the things that are particular and undivided in form – just as one studies mankind, so too bird; for this kind has forms. But the study would be of any one of the indivisible birds, e.g. sparrow or crane or something of this sort. On the other hand, in so far as this will result in speaking many times about the same affection because it belongs in common to many things, in this respect speaking separately about each one is somewhat silly and tedious. (644a29–34)

This tack is not merely silly and tedious – according to the *Posterior Analytics* it is wholly mistaken, as it will fail to produce scientific knowledge. For, if the same feature belongs to a sparrow and a crane because they are birds, the first step toward understanding this feature must be to grasp that it belongs *per se* to bird, not to crane or sparrow (cf. *An. Post* I.4 73b25–74a3, 5 74a4–b4; cf. Lennox 2001b: 7–10).

Aristotle resolves the puzzle of animal groupings by identifying animals that share many differentiae at the same level of universality. The features of these animals vary in degree rather than in kind. As a consequence of these similarities, their forms will be more like one another than anything else. If a particular type of animal does not belong to such a grouping, we must speak of it separately (644b1–8).

Aristotle is implementing a view about “sameness in kind”; animals are to be brought together into kinds in virtue of differing only “by degree” or “by the more and less” (644a15–23). In chapter 4 he focuses on more and less variations in *parts* – variations in an animal’s size, density, texture, color, and so on. These appear to be the features Aristotle thinks we will use in our *initial* identification of kinds – they are “better known to us.” Prior to this discussion about the identification of kinds in chapter 4, however, chapter 1 had already insisted on the *definitional* and *explanatory* priority of the functional capacities of organisms and their parts. It is not surprising, then, that just prior to the passage we began this section with, arguing for the explanatory priority of actions to parts, Aristotle extends his resolution of the *aporia* regarding the particular and the general from parts to *actions*:

Therefore one should first discuss the actions of animals – those common to all, those according to kind, and those according to form. I call “common” those [actions] that belong to all the animals, and “according to kind” those [actions] whose differences from each other we see in degree; for example, I speak of bird “according to kind,” but I speak of mankind, and everything without any difference according to its general account, “according to form.” (645b20–6)

Soul-based activities (*praxeis*) are both *common* and *formal* features. That is, at whatever level of generality or specificity one considers a function performed by a part, it is that for the sake of which that part exists – it is a soul function. Material features and formal features, structures and their functions, can be identified at various levels of universality. To refer to an action “according to form” is to refer to it at a certain level of universality; but actions and their capacities are *formal* features of the animal, aspects of its soul, regardless of the level of generality at which they are described.<sup>7</sup>

Earlier, I noted that Aristotle concludes his philosophical introduction to biology by arguing that the entire body has been constituted for the sake of a certain complete action” and that “the body is in a way for the sake of the soul, and the parts are for the sake of their functions.” We can see this grand vision manifested in his actual explanatory practice in a chapter near the end of *PA* IV, where he discusses the external organs of birds. A study of the method employed in that chapter has an additional payoff. It will provide us with insight into the intimate connections between Aristotle’s views about more-and-less variation of forms within kinds and his views about the explanation and definition of structure, both of which reference the essence of animal being, functional activity.

To comprehend fully that chapter, some background from the *Historia Animalium* is helpful. There, Aristotle commences his study with a discussion of the fundamental modes of similarity and difference among animals. This discussion meshes very tightly with those we have investigated in *PA* I.4–5. After focusing on the differences between parts within kinds – differences in degree or by more and less – he extends the analysis to three other fundamental features in terms of which animals are differentiated: actions (*praxeis*), character traits (*ethê*) and ways of life (*bioi*). Indeed *HA* in its entirety is organized around these categories of differentiae. And in the investigations of these latter three modes of difference in *HA* V–IX, a certain relationship among them emerges. Animals have the character traits and perform the actions they do in virtue of their way of life. In *HA*, way of life is absolutely fundamental (cf. *HA* I.1 487a11–488b10, VII.1–2 588a17, 588b4–590a18, VIII.1–7 609a19, 610a34, 612b18–22).

Our focus is, of course, on essence and explanation. Thus, as we examine the pattern of explanation in *PA* IV.12, in which *bios* is central, the dominant question will be: what is the relationship between *bios* and soul, understood as that “complete action” for the sake of which the body has the parts organized as it does?

In *PA* IV.12 Aristotle is moving on to discuss the external parts of birds, having already discussed the two-legged and four-legged land dwellers in chapters 10 and 11.<sup>8</sup> He first discusses the observable similarities and differences of their parts and notes correlations among them. He treats these as sufficient grounds for the groupings mentioned.

Among birds, differentiation of one from another is *by means of excess and deficiency of their parts, i.e. according to the more and less*. That is, some of them are long-legged, some short-legged, some have a broad tongue, others a narrow one, and likewise too with the other parts. (*PA* IV.12 692b3–6)

He next notes that all birds have feathers and beaks, and that these parts differ *by more and less*, but are *analogous* to parts such as scales or trunks in other kinds of animals (692b15–18). When he moves on to discuss the neck, he begins to note correlations among the measurable variations in all of these parts, and then he offers a single, functional explanation for the correlated variations of parts. For example,

*those that are long-legged have a long neck, while those that are short-legged have a short one . . . for if the neck were short in those with long legs, the neck would not be of service to them for eating food off the ground; nor if it were long in those with short legs. Again for those that eat flesh a long neck would be contrary to their way of life (bios).* (692b19–693a6; italics added).

The crook-taloned birds *also* have a type of beak that is correlated with talons, and both are explained by reference to their predatory way of life (693a10–13). By contrast, “all birds whose way of life (*bios*) includes swamp-dwelling and plant-eating have a flat beak; for such a beak is useful both for digging up and cropping off their nourishment” (693a14–17). 4

The modes of life (*bioi*) of the different birds account both for their differences and for the correlations among those differences. The focus of inquiry is the provision of functional explanations of the more and less variations within the kind “bird.” The *explananda*

of such explanations will be more and less differences between birds of one form and another.

This chapter shows us another side of essence, however. A number of features are identified as *idia* of birds – feathers (692b10), beaks (b15–16) and feathered wings (693a26). These are features properly identified as commensurate universals of the kind “bird.” It is also claimed that it is of the being (*ousia*) of birds to be *blooded*, yet *winged* (693b5–7) and *able to fly* (693b12–13) – all features of wider extension than the kind “bird,” though the combination is commensurate (cf. *An. Post* II.13 96a24–b14). Indeed, it is this *combination* of features in the being of bird *qua* bird that necessitates their peculiar form of bipedalism (693b5–14). Moreover, there appear to be fundamental presuppositions about the ratio of different elements in different kinds (694a22–27; Lennox 2001b: 194–5). These features are *not* explained in functional terms; nor are those that are direct consequences of them. Functional explanations enter only once one is attempting to account for the *differences* within a kind.<sup>9</sup> 5

The dominant theme of *PA* IV. 10–13 is the way in which each of Aristotle’s “great kinds” (*megista genē*) has each of its parts differentiated in just the way needed so that all of the parts are able to function harmoniously together. Certain features and modes of activity are identified with the *ousia* or essence of birds generally; other universal features, such as bipedalism, are explained as a consequence of this combination of essential features. Each form of bird has each of these parts differentiated for its own way of life, or *bios*. This central explanatory concept requires the biologist to take a certain perspective on the animal’s functional activities. Those activities must be looked at from an ecological perspective; and the parts, then, must be organized not only for a particular function, but also in terms of the functions they perform within the wider context of the animal’s way of life. A hawk is essentially a carnivore that hunts by soaring at great heights; this means it must fly in a certain way, capture and kill prey of a certain kind, and eat in a certain way. All of these activities will differ in degree from those of other birds, and this dictates differences in the way its parts are constructed. Finally, it is not merely the *structure* of each part that will be explained by reference to a function; the *coordination* of various structures will be explained by reference to the various functions that are required for a particular way of life. The talons, hooked beak, strong, short neck, thick, streamlined wings, short tail feathers, and so on, must be organized in an integrated manner.

This discussion of the external parts of birds is the hard currency behind the promissory note of *PA* I.5. What was there referred to abstractly as a “certain complete action” for the sake of which the entire body of an animal is organized is, we now see, the full complement of an animal’s activities organized around the single goal of its specific way of life. *PA* I.5 makes it clear that this explanatory relationship takes precedence over the relationship between a single part and its activity, and we can now see why this is. A beak is hooked in order to perform a specific kind of nutritive function, that of overpowering and eating prey; but that attribute of the beak is a consequence of the hawk’s way of life, as are a large number of other, coordinate, attributes.

Only in this chapter is the explanatory centrality of *bios* made explicit. To be precise: of 20 uses of the term *bios* in all of *PA*, 9 occur in the 3 Bekker pages of *PA* devoted to the external parts of birds. I have nothing but unsubstantiated speculation as to how this is to be explained. But the fundamental idea so beautifully illustrated here – that

entire systems of organs are organized in a coordinated way and that this organization is related to some basic feature of the animal's way of life – can be found much more widely.

Does Aristotle consider the possibility that the way of life of a kind might change and lead to a significant change in the activities and structures that are organized for a particular way of life? As far as I can see, he does not consider the possibility. It is likely idle to speculate on the reasons for this. But if we now turn to the other way in which form has explanatory and definitional priority over matter in Aristotle's biology, we can at least see that there are reasons, rooted in his metaphysics, that would make any sort of "evolutionary" understanding of such changes difficult to accept.

### The Priority of Being to Generation

Near the start of the chapter, we saw that a certain view of essence that is defended in the *Posterior Analytics* apparently undergirds the results of biological inquiry found in the *De Partibus Animalium*. One problematic aspect of this view is that the identification of biological kinds appears to be guided by the search for those groupings of animals whose features are commensurate with the feature to be explained. Among commensurately universal features there will be explanatory priority relations, and scientific explanation (demonstration) will display the feature or features that are explanatorily basic – the features that are in one sense or another the cause(s) of the others. Next, we tracked the way in which this explanation-driven view of essence is articulated and implemented in a biological context. The theory defended in *PA I* is that organisms, and in particular animals, are natural unities of matter and form. Form, however, is to be understood as the soul, the integrated functional capacities, of an organism; matter is to be understood as the body, organized so that it can perform the animal's living functions. The animal's body is the seat of its functional capacities; in the absence of those capacities its parts are what they are in name only. The many "more and less" anatomical differences that distinguish the parts of one form of a kind from another are defined and explained by identifying the functional contribution of those variations to the animal's way of life.

Of equal importance is that this natural, teleological unity that is the animal is prior in every respect to the process of coming to be that gives rise to it. Armed now with a concrete sense of how his explanation-based essentialism functions in a biological context, we are prepared to explore Aristotle's views about the explanatory priority of being to becoming in a biological context. The key is to be found in his understanding of the ability of organisms to replicate themselves.

Aristotle insists that the failure of earlier natural philosophers to inquire into definition and essence was in part due to their tendency to seek the efficient cause of organic development in the interactions of antecedent materials. In his view this is the opposite of the truth. The true efficient cause is an already actual organism that (in virtue of its nutritive/generative soul) produces a seed with a potency (*dunamis*) for becoming an organism of the same kind (641b25–32).<sup>10</sup> Against Empedocles, Aristotle holds, in what is surely an intentional echo of *Philebus* 54A7–9, that just as in the crafts, so in nature, "generation is for the sake of being; being is not for the sake of coming to be."

It is a principle he reminds us of in *De Generatione Animalium*, in order to highlight the methodological relationship between investigating animal being and animal development:

For as was stated initially in the first accounts (*kat'archas en tois protois logois*), it is not because each thing's coming to be is of a certain sort that it *is* of a certain sort; rather it came to be such a thing on account of its *being* of this sort; for generation follows on and is for the sake of being; being is not for the sake of generation. (778b2–7)

Failure to appreciate the priority of being to becoming leads Empedocles to attempt to explain the beautifully adapted structures of mature organisms as mechanical consequences of antecedent events with no intrinsic connection to those organisms. Since Empedocles failed to recognize that each seed has a potency for the appropriate form, he didn't consider the source of that potency:

its producer was prior – not only in account but also in time.<sup>11</sup> For one human being generates another; consequently, it is on account of *that* one being such as it is that *this* one's generation turns out a certain way. (640a22–6)

Empedocles, and others of his sort, consistently attempted to understand the features of mature organisms as coincidental outcomes of materially necessitated developmental processes. Actually, it is not clear that they would consider these interactions as having sufficient unity to be considered a single process. At least, this is how Aristotle understood their project (cf. Code 1997).

But what is the connection between these failures and the failure to search for an account of the essence? In one sense, once we attend to the Greek rather than our translations, the answer is obvious. It is *ousia* that Aristotle claims is causally prior to *genesis*, and it is the search for the definition of *ousia*, for *to ti ên einai* – the-being-what-it-is – that Aristotle is claiming his predecessors failed to appreciate. To put it plainly: they failed to give investigative priority to what is naturally prior!

In a deeper sense, however, the answer is not at all obvious. One could defend the causal/explanatory priority of the end state (i.e. the actual organism) relative to the process of development, and yet see this as unconnected to questions about the definition and essence of the natural substances that are those end states – as most modern defenders of teleology explanation do. We now need to ask how Aristotle understands the connection between essence and causal explanation when the *explanandum* is the animal's *generation* rather than its parts.

In words reminiscent of *Metaphysics* Z.7–9 and Θ.8, Aristotle begins his extended explanation of animal generation by stating a first principle:

To understand how each thing comes to be it is necessary to grasp the following, making it our first principle: as many things as come to be by nature or by art come to be by means of a being in actuality from that which is potentially such as that being. (734b22–3)

He often reminds us of this first principle, as we saw in *PA* I.1, with the expression “For a human being generates a human being.” This expression serves as a leitmotif for concretizing two different, though related, consequences of his teleology.<sup>12</sup>

- 1 *Natural, substantial generation is formal replication.* Formal replication is my shorthand for Aristotle's claim that in biological generation, organisms make another *like*, or *such as*, or *one-in-form* with, themselves. This is a point that can be made either with or without contrasting formal replication with chance production. (Passages without the contrast with chance include: *Phys* II.1 193b12, II.2 194b13, II.7 198a26; *PA* II.1 646a33; *GA* II.1 735a19–21 (with which compare *An* II.4 415a23–b8); *Met* Z.7 1032a25, Z.8 1033b32, A.3 1070a28, A.4 1070b31–4. Passages with the contrast include *GC* II.6 333b7; *Met* Z.8 1033b32, A.3 1070a8.)
- 2 *Act is prior to potency* (cf. *Phys* II.1 193b8, III.2 202all; *Met* Θ.8 1049b25, N.5 1092a16).<sup>13</sup> Earlier, we discussed Aristotle's criticism of Empedocles' attempt to explain the being of an animal by reference to its mode of coming to be. Aristotle ends that section of *PA* I.1 with the somewhat Delphic remark: "Again the seed is in potency (*dunamei*); and how potency (*dunamis*) is related to complete act (*entelecheia*) we know." (642a1) The two items prior to the seed (one prior in *both* time and being, the other just in being) are the two beings non-accidentally related to the seed's potency: [i] the adult organism or organisms<sup>14</sup> responsible for producing a seed, and [ii] the fully formed organism toward which the seed is developing.

The priority of being to coming to be is one of those bedrock starting points that Aristotle shares with those working in the Parmenidean tradition, including Plato. Aristotle also shares with Plato the identification of *form* as the source and cause of being. The idea that the coming to be of natural substances is to be understood as the replication of form, on the other hand, allows Aristotle to do something his predecessors in that tradition could *not* do – it allows him to take unqualified, substantial generation seriously. Thus Aristotle's refrain, *anthropos anthropon genna*, is twice given in the *Metaphysics* as a sufficient reason for treating Plato's theory of Forms as unnecessary for an account of natural substances (*Met* Z.8 1033b–1034a1; A.3 1070a4–30; cf. Lennox 2001b: 147–54). But Aristotle also believes that only a proper understanding of the relationship of act to potency will permit one simultaneously to take substantial generation seriously while accepting the priority of being to coming to be.

Aristotle considers replication to be among a living thing's most natural activities (*phusikôtaton tôn ergôn*, *An* II.4 415a27, *phusei ergon*; *GA* II.1 735a19; cf. *Pol* I.1 1252a26–30) at least in the case of those living things that are not maimed or spontaneously generated. He tells us this in the *De anima*, in the process of arguing that the potency for nutrition and the capacity for generation are in fact one and the same. Living things perform this function, he claims, "in order that they may participate in the everlasting and divine as far as possible; for all desire this and do whatever they do in accordance with nature for the sake of this" (*An* II.4 415a27–b2; cf. *GA* II.1 735a16–23). This is a single potency because in both its nutritive and generative manifestations it has the same, single goal – self-maintenance.

Since, however, living things inevitably pass away, generation allows the maintenance, not of the animal itself but "what is like it, not one numerically, yet one in form" (*An* II. 4 415b7–8). The exercise of our nutritive potency, in its reproductive manifestation, is via a process of *formal replication*. It is not merely making another animal (or plant); it is making an animal *one-in-form* with the animal that is generating.<sup>15</sup> This is

not a point about ontological level; it is a point about *the explanatory priority of soul*. “One-in-form” here is not in contrast to one-in-kind; it is in contrast to *numerical unity*. To exist eternally as a natural unity of matter and form would be to go on forever, as do planets and stars. In contrast, many living things have the ability to replicate themselves, so that something *numerically distinct from* but *formally like* them continues on. This fact, as we will see, allows the study of generation to be the object of a science.

The opening of the second book of the *Generation of Animals* supplements this account with deeper metaphysical grounding for the idea that generation is formal replication. The goal of this discussion is to explain why it is *good* that there be male and female, and what such a distinction is *for* (731b22–4). Since, however, the male and the female capacities exist for the sake of generation, either generation must be taken as a given, or there must be a more basic cause for it. But as we have seen, coming to be is for the sake of being; Aristotle does not take it as a given.

While there are a number of interpretive problems associated with that passage<sup>16</sup>, we can take from it at least two important messages for our purposes. Aristotle begins with the assumption that there are two fundamentally different kinds of natural beings – those that are eternal and those that come to be and perish. Those in the latter category can either be or not be, and being is the better state.<sup>17</sup> In the case of living things, this alternative is in fact the alternative between living and not living, and living just is being in possession of those functional capacities that constitute the soul. The soul, therefore, is the source of a living thing’s continued living – the source and cause of its being in the better state.

However, by their very nature generated things cannot exist eternally in a numerical sense – unlike planets, for example. But being eternal *in a way* is better than simply going out of existence. Generation is a way that individual living things can share in the eternal. “On account of these causes there is a generation of animals.” Generation is one more manifestation of the drive for self-preservation, our “most natural” function. Indeed, the discussion in *De Anima* concludes that “since it is just to designate everything according to its end, but the generation of a likeness of itself is its end, the primary soul would be a capacity to generate a likeness of itself” (416b23–6).

The understanding of generation as the replication of form, then, allows natural particulars a way of “participating” (*metechein*) or “partaking” (*koinônein*) in eternal being simply by activating one of their soul functions. Though by their very nature generated things cannot *be* eternal, the ability of certain living things to replicate their forms permits them *a share in* the eternal.<sup>18</sup> Formal replication is, concretely, what it means to say that coming to be is for the sake of being. At the most abstract level, this is the explanation for why every “complete” organism has a natural capacity to reproduce.

Of course, the product of generation is an animal, a unity of matter and form, not just a form. A human being generates in order to produce another human being; therefore the process of generation should be explained by reference to its end. In the study of natural coming to be, teleological explanation depends on a prior understanding of the essence of what is coming to be.

What is transmitted in sexual generation is a capacity of the soul to transform already prepared blood into tissues, by means of a heat that is specifically for carrying out nutritive/generative processes. Aristotle tells us that this heat acts according to a

*logos*, a formula, that determines what it makes, where it makes it, and when it makes it. (For the details, see Henry, ch. 23, in this volume) The heat, which is an instrument, must not be confused with the generative capacity (*GA* II.1 734b28–36).

That “motion from the generator” is, a few lines later, referred to as “the motion of *the nature*”; and, by contrast with the crafts, it is in the developing thing itself though “derived from another nature *having the form in actuality*” (735a3–5; and see “the productive potency” (740b36), and “the potency of nutritive soul” (740b30)).<sup>19</sup>

The male seed, and later the embryo, is a unity of matter and form; it possesses a productive and generative potency that, once present in the material prepared by the female, begins its work, starting with the construction of the heart. The activation of that potency is, like the potency itself, always referred to in the singular. There is one, single generation identified by reference to its end. Like the single process of building a house, biological development involves innumerable component movements; but these display a *logos*, an organized pattern, and it is this *logos* that constitutes the process of generation. From an Aristotelian perspective, that single potency and the coming to be that is its actuality<sup>20</sup> are primary, while the various instrumental movements subserve that single, goal-directed generation.<sup>21</sup> Yet prior even to it, to return to our starting point, is the end for the sake of generation, which is one-in-form with its efficient cause.

As in all such cases, the transmitted potency of the seed is that of a particular male parent. Thus, it is not just the capacity to make, for example, hawk in general; it must be the capacity to make a particular hawk. But if it makes a particular hawk, it makes a hawk; and if a hawk, a bird; and if a bird, a blooded animal. This, I take it, is the point of Aristotle’s comment in *GA* IV. 3, that when sufficient relapsing of the generative capacity of the male occurs, “only that which is common is left, i.e. to be a human being” (768b12–13). If none of the particular features of parents or their immediate ancestors (*mêtheni eoikenai tôn oikeiôn kai suggenôn*) emerge, what is left is a human being that lacks any of *that family’s* particular features – Aristotle cannot mean that the result is human being in general. As he puts the point in *Metaphysics* A. 5:

These primary sources are not universal; for the particular is the source of particulars; for human being is the source of human being in general; but there is no such thing. Peleus is the source of Achilles, and your father of you. . . . and the causes of things in the same form are different, not in form, but because the causes of the particulars are other – your matter, form and mover are other than mine – though the same in the general formula. (1071a20–2, 27–9; cf. *Phys* II.3 195b6–10, b25–7)

Recall that in *PA* I. 5, in discussing the application of his grades of likeness to actions, Aristotle noted that to speak of actions *kat’ eidos* – he uses human being as his example – is to discuss them at a level where “they have no difference according to the universal account” (*kata ton katholou logon mêdemian echei diaphoran*) (645b26–27). In the previous chapter, he refers to “last forms (*ta eschata eidê*)” as *ousiai* and exemplifies them by Socrates and Coriscus – but he immediately says that they are “undifferentiated with respect to form” (*kata to eidos adiaphora*) (644a24–6). In the context of explaining biological generation, we now see the same point being stressed. To say that every organism that is complete generates another one-in-form with it is not to make a point about essential membership in a kind. It is to make a point about *the manner in which form and end control coming-to-be*, at whatever level of generality one wishes to describe that

process. It is in the way the account of the actual form takes precedence in the causal explanation of coming-to-be that we see how it is that, once again, there is an intimate relationship between essence and causal explanation in Aristotle's biological practice.

Biological replication is also the centerpiece of the argument for the priority in time and being of *energeia* to *dunamis* in *Metaphysics* Θ.8:

But actuality is [not only prior in time but] also prior in being (*ousia*), e.g. father to child, human being to seed; because the former already has form, the latter not; and because everything which comes to be progresses to a principle (*archê*) and end (*telos*); for that for the sake of which is a principle, and generation is for the sake of the end. And the actuality is an end, and potency is attained for the sake of this. (1050a4–10)

The argument for the priority of being of the actual over the potential in account and even, in a certain sense, in time, rests on the possession of form. This argument serves as the metaphysical backdrop for Aristotle's opening move in his biological account of the teleological priority of an animal's non-uniform parts to its uniform parts. This priority is justified on grounds that "in generation, things are opposed to the way they are in being (*ousia*)" and that "the last stage in generation is primary in nature" (646a24–26). In his general summary of the point, he also reminds us that, even in time, another organism with the being that is primary in nature must already be present, as the generation's efficient cause:

every generated thing develops from something to something, i.e. from a principle to a principle, from the primary mover that already has a certain nature to a certain shape or other such end. For a human being generates a human being, and a plant a plant, from the underlying matter of each. (646a30–5)

Once again it turns out the priority of the actual organism over the process of generation that temporally precedes it has two sides: it provides the basis for the proper identification of the developmental process *and* for its proper explanation. The actual parent is the productive source of that process; and the form of the actual organism provides our only means of determining why each stage of that process is occurring when, where and how it is occurring. The kind of understanding of organic systems arranged for distinctive ways of life in the *De Partibus Animalium* forms the basis for accurate teleological explanations in the *De Generatione Animalium*. This is the import of the extremely difficult and extended discussion of why Aristotle's predecessors have failed in their attempts to explain the order in which the parts come to be in *GA* II.6 (742a17–743a1). As he puts it there:

For, with parts, as with other things, one is by nature prior to another. But the prior exists in many ways. For that for the sake of which and what is for the sake of it are different, and while one of them is prior in generation, the other is prior in being. (742a18–22)

His point is at once highly abstract and of immense practical importance for the embryologist. Just watching things unfold will not tell you why they are unfolding as they are. You must know what the parts are for and which ones subserve which. Otherwise,

the developmental process will make no sense. Again, a proper account of generation depends on knowing what the parts are. But, as Aristotle says in the opening paragraph of his study of animal generation, “the *logos* and that for the sake of which as end are the same” (715a8–9).

## Conclusion

*De Partibus Animalium* elaborates the explanation-based essentialism of *Posterior Analytics* II, but in a context given scant attention in the *Analytics* – that of natural bodies that come to be and are for the sake of living. Given certain assumptions about Aristotle’s essentialism, two aspects of the essentialism defended in *An. Post* are problematic: its focus on finding the essences of attributes rather than substantial kinds, and its method of identifying kinds that appeared to be dependent on explanatory context. Aristotle’s theory of biological method in *PA* I, and his practice in *PA* II–IV, provide us with a deeper understanding of his commitments. There is a method for identifying large kinds (*megista genê*) such as bird, fish or insect that is pre-explanatory; but this method has causal explanation as its goal, and the kinds are identified based on the possession of commensurate differentiae. (In the case of bird, for example, these include the possession of a beak, feathered wings, a form of bipedalism.) Moreover, the causal explanations are primarily *teleological*, specifically *functional* explanations of *differences along more/less continua* in the organs and tissues of organisms within these kinds. At the center of these explanations are certain basic activities (*praxeis*) that all play a role in the animal’s way of life (*bios*). The organic activities that constitute the way of life of an animal are the explanation-based essences of the forms of a kind such as bird or fish. These kinds, however, also have essences – for example, birds are blooded, winged, feathered, beaked, flyers. Why birds have any of these features is not subject to teleological explanation. At this level, we reach explanatory bed-rock. That is what it is to be a bird. Period.

Aristotle’s biology, however, includes a treatise that is self-consciously distinct from the *De Partibus Animalium*, namely *De Generatione Animalium*. “A human being generates a human being” echoes through Aristotle’s metaphysics and natural philosophy. What does Aristotle find so significant in this apparent truism? It stresses, depending on which aspect of the phrase one emphasizes, three crucial points: being is prior to coming to be in two respects, as the motive source of generation and as its goal; coming to be is not a chance process but a goal-directed one; and generation is more precisely a formal replication, a sort of *formal* self-maintenance. Since every coming to be of an animal (save those that are spontaneously generated) is causally dependent in this way on a prior, actual organism of the same kind, and since the natural goal of that parent’s capacity to reproduce is another organism, one-in-form with the parent, there does not appear to be a natural way for this theory to accommodate regular evolutionary change. In *Physics* II.8 Aristotle attributes to Empedocles a view whereby a “fitting arrangement” of teeth arises by chance and is perpetuated because it happens to be useful (198b24–31). But it is precisely the idea that the “fitting arrangement” arises by chance that Aristotle rejects. “Again whatever chanced along would need to come about in seeds [for this view to be true]; but those saying this do away both with nature

and what happens by nature; those things are by nature which arrive at a certain end, having moved toward it continuously from a certain origin within them” (199b13–17). And that origin is provided by the form of the prior, actual parent.

In his ability to explain substantial coming to be without either appealing to separate forms or reducing coming to be to an incidental byproduct of chance, Aristotle makes one of his most fundamental advances over his predecessors. There are reasons rooted deep in his metaphysics for separating the account of animal being from the account of animal coming to be. But in the end it is the essence stated in the account of the substantial being that provides us with our only means of understanding and explaining the complex process of biological development.

## Notes

<sup>1</sup> Aristotle is fully aware of this gap in the *An. Post* model, as two passages in the *Metaphysics* clearly demonstrate. In Z.17 he dismisses inquiries of the form “Why is an X an X?”: “This much, then, is clear: one does not inquire why that which is a human being is a human being; therefore one inquires why one thing belongs to another (*that* it belongs must be clear; if it is not, one inquires about nothing); for example “Why does it thunder?” [is an inquiry about] “Why does a certain noise come about in the clouds?” For in this way the object of inquiry is one thing predicated of another” (1041a22–6). See Charles (2000: 283–309) and Wedin (2000: 405–52) for contrasting accounts of the relationship between the *An. Post* model and Z. 17.

The same point is made about the *An. Post* paradigm cases in H.4. In discussing the role of matter in a causal analysis of substance, he explicitly refers to eclipses as exemplary of cases where the *explanandum* exists by nature (*physei*) but is *not* a substance – rather, the subject is a substance. In this case, he notes, the moon is the subject (1044b8–11).

<sup>2</sup> This of course does not mean the general kind being investigated by the science in question – plant, animal, heavenly body, natural objects – cannot be familiar to us in advance. But, as the opening page of *PA* I.1 shows, the typical domain of investigation begins with only some such very general characterization and then a grab bag of categories that may or may not have value for a demonstrative science (see Lennox 1987a/2001b: ch. 1).

<sup>3</sup> The goal of eventually finding explanations of attributes at the level of commensurate universality is central to the methodology of the *Historia Animalium* as well, as a great deal of detailed research has made clear (Balme 1987b; Gotthelf 1988; Lennox 1987a, 2001b: ch. 1, 1991, 2001b: ch. 2). But the way in which this goal is pursued has serious implications for the kind of essentialism that can be reasonably defended on the basis of Aristotle’s biological works.

<sup>4</sup> It needs to be noted that it is part of Aristotle’s explicit theory that many animals that perceive lack hearts. *PA* III.4, however, is part of the discussion of the internal organic parts of blooded animals. Aristotle turns to the bloodless animals in Book IV, and when he does so he notes that they must have an analogue of the heart and blood (cf. *PA* IV.5 678b1–7)

<sup>5</sup> This claim of affinity between the *An. Post* Model and Aristotle’s biological project has its critics of course. The most sustained and knowledgeable critic is Sir Geoffrey Lloyd; see for example Lloyd 1990 and Lloyd 1996: chs. 1–7.

<sup>6</sup> The majority of the manuscripts read *plêrous* (full, complete, whole) *praxis*, though Peck (1961: 102) and Düring (1943: 122–3) both follow ms. P, which reads *polumerous*. The vulgate makes good sense, given the substitution at b18 of “soul” for the disputed phrase. Nevertheless, since Aristotle will occasionally speak of “parts” of the soul when referring to its integrated functional

capacities, either reading could yield a picture of the body as a whole organized for a unified soul.

<sup>7</sup>Space limitations do not allow further development of this point, but it has important implications for the question of the ontological status of form.

<sup>8</sup>For a discussion of the overall plan of *PA* II–IV cf. Gotthelf (1987a: 172–8); and Lennox (2001a: 220–1, 254, 292–3, 315).

<sup>9</sup>Though due to space limitations the subject must be set aside, this leads to an intimate connection between division and explanation in Aristotle’s biology (cf. *PA* I.5 645b1–3; Gotthelf 1997: 215–30; Lennox 2001a: 175, 2001b: 7–38).

<sup>10</sup>This *dunamis* of the male parent conveyed by seed, analogous to the capacity of a shipbuilder, is nicely captured in Allan Gotthelf’s phrase “irreducible potential for form” (Gotthelf 1987b).

<sup>11</sup>This passage is making, in a more specific context, exactly the same point as *Met* Θ.8 1049b18–27, where Aristotle is defending the claim that in one respect act is prior to potency *even in time*.

<sup>12</sup>This expression virtually always takes the form of an *explication*, introduced by the Greek particle *gar* (for, that is).

<sup>13</sup>See the papers of Kosman and Witt, in Scaltsas et al. (1994), for very different views of this priority. I have chosen the somewhat archaic renderings of “potency” and “act” for *dunamis* and *energeia* because, while I am in broad agreement with those concerned about the misleading character of “actuality” and “potentiality,” I am less convinced that someone reading the English translations “activity” or “capacity” gains much insight into the Aristotelian concepts, especially in their extended, metaphysical applications.

<sup>14</sup>*Generation of Animals* occasionally restricts the term, in the case of sexual generation in animals, to the male semen. But more commonly it is a generic term by which he refers to both the male and female contributions when he is not differentiating them. Again, at least once he denies that the female contributes seed, but his typical and more common position is to stress that female animals contribute a different kind of seed.

<sup>15</sup>When the very potency (a power to heat informed with a *logos*) that transforms nutrients into blood and blood into the appropriate tissues in the appropriate places at the appropriate times is conveyed, via male seed, to a properly prepared portion of the female menstrual fluid, it has the same effect – that is, it transforms this prepared menstrual blood into the appropriate tissues at the appropriate places and times in order to constitute the appropriate organs.

<sup>16</sup>For two quite different interpretations see Balme (1992: 155–6); Lennox (2001 133–7).

<sup>17</sup>It may be that the belief that being is better than non-being is simply bedrock for Aristotle. But I can think of at least one way in which he could argue for it from principles he accepts. In setting up the teleological groundwork for his ethical theory, Aristotle makes the general claim that the good is properly said to be that at which all things aim (e.g. *NE* I.1 1094a2–3); and that if there is some end of everything pursued in action, this is the good of action (*NE* I.7 1097a18–23). Now, the existence of an eternal being is guaranteed; its existence is not dependent on any action on its part. But, for a thing that comes to be and passes away, and in particular for a living thing, continued existence is ever dependent on its performing the appropriate actions. And all living things, by nature as we might say (and as Aristotle certainly would say), are continually acting to maintain themselves, for the sake of continuing to live, i.e., to be. On the principles articulated in *NE* I, then, continued living or being qualifies as the good for such contingent beings. It is that toward which their activities are directed.

<sup>18</sup>Thus while I am in accord with Witt (1994) on seeing the dependence of coming to be on being in teleological terms, I think these passages argue decisively *against* the end being the “species” or “type” (cf. 224–8).

- <sup>19</sup> And compare: “Just as the potency of the nutritive soul later, in the animals and plants, produces growth from nourishment using heat and cold as instruments (for the movement of the nutritive soul is in them, and each part comes to be according to a certain *logos*), so too that which comes to be by nature is constituted from the beginning” (740b30–4).
- <sup>20</sup> This understanding of coming to be is thus very congenial to the account of Aristotle’s understanding of motion given in Gill (1989: 183–206).
- <sup>21</sup> The analogy with house building continues to be powerful. Even though many people work on building a house; even though they stop each day and go home and resume the next day; even though each of them acts independently and is involved in innumerable different activities on any given day – it is, nevertheless, natural to describe the on-going process of building a house as a *single* process. By comparison with this, biological development has far greater unity. And it is natural to describe the source of the unity in each case as a “blueprint,” or as Aristotle would say, a *logos*, specifying the form the result is to take.

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