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# The Birds and the Bees: Aristotle on the Biological Concept of Analogy

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# **The Birds and the Bees: Aristotle on the Biological Concept of Analogy**

“*Analogue*. A part or organ in one animal which has the same function as another part or organ in a different animal. *Homologue*. The same organ in different animals under every variety of form and function.” — Richard Owen, 1843.

## **Introduction.**

Elsewhere I have argued that Aristotle was a realist about natural kinds, at least when it comes to natural biological kinds.<sup>1</sup> Thus he agrees with Socrates in the *Phaedrus*, who famously employs the metaphor of a butcher to describe his method of collection and division (265d-e). Collection consists in “seeing together the many scattered things and drawing them into a single form”, while division involves cutting up each thing “along its natural joints” (κατ' ἄρθρα ἢ πέφυκεν). In doing so, Socrates tells us, one must be careful not to break any part into pieces “like a bad butcher might do”. Aristotle echoes Socrates’ point by insisting that, when dividing up animals into kinds, “nothing alike in kind should be torn apart” (*Parts of Animals* [PA] I 2, 642b16-17). For this reason, he says, the method of dichotomy is worthless: “For people who divide in this manner necessarily separate and tear apart <kinds>” (b18). It is hard not to read all of this as expressing a commitment to the reality of natural kinds.<sup>2</sup> For (Plato’s) Socrates, the natural world contains “parts” (cf., *Statesman* 262ab) that are individuated on the basis of real, mind-independent boundaries (the “joints”). Being a bad butcher consists in dividing across those boundaries. What I want to argue in this paper is that Aristotle uses the concept of analogy as an important tool for establishing the boundaries between animal kinds (e.g., birds and fish).<sup>3</sup> To put it in terms of the *Phaedrus* metaphor, the analogical relation helps the biologist establish where the

“natural joints” are.

We can get at this idea by thinking about a common problem in philosophy. In the *Parts of Animals* Aristotle treats a kind (γέννη) as a group of animals that all share a single common nature and is divisible into forms or species (εἶδη)<sup>4</sup> whose attributes differ from one another by degree along a continuum (*PA* I 4). The birds are a paradigm example of a biological kind:

Among the birds, differentiation of one form (εἶδος) from another is by means of excess or deficiency of their parts, and according to the more and less. That is, some birds are long-legged others short-legged, some have a broad tongue others a narrow one, and likely too with the other parts. Considered distinctly, they differ slightly from each other in their parts, but in relation to other animals they differ even in the shape of their parts. (*PA* IV 12, 692b3-9 Lennox translation with modifications)

According to this theory the various species within a kind all possess the same generic features. But those generic features are all realized in ways that vary from species to species by degree along a ‘more-and-less’ continuum.<sup>5</sup> For example, while all birds have beaks, some beaks will be shorter, some longer, some flatter, some more curved, some harder, some more pliable, and so forth. Along any dimension we choose, then, each attribute will differ from one species to the next only by shades and degrees (Lennox 2001a, 162).

At the same time, Aristotle thinks that the animal world comes divided up into distinct kinds (γέννη) — such as birds and fish — separated from one another by discrete boundaries. Thus, while the differences between species are *continuous*, the differences between kinds are *discontinuous*. The features of birds do not gradually blend into those of fish; fish and birds are separated from one another by an unbridgeable gap.

This way of thinking about specific- versus generic-difference raises an old-chestnut of a sorites problem. If the species within a single kind exhibit continuous variations in their attributes (they differ by ‘the more and the less’), at what point does the degree of difference between two individuals become too great such that it no longer represents a difference in species but becomes a difference in kind?<sup>6</sup> Aristotle’s answer, as we shall see, invokes the concept of analogy. While animals of the same kind have features that differ from one another by degree according to the ‘more-and-less’, those belonging to separate kinds have parts that are the same only ‘by analogy’. But how do we understand this? Several things Aristotle says invite us to think of the differences between kinds as a function of their “distance” in morphospace. For example, in *PA* I 4 he tells us that a kind (γένος) contains species (εἶδη) that are “not too distant” (μὴ πολὺ διεστῶτα) from one another (or, as Lennox [2001b, 171] puts it, are “not widely separated”). The same idea is suggested by *Metaphysics* X. In talking about things that are ‘other’ in kind, Aristotle says:

Since it is possible for things that differ to differ from one another by the more and the less, there is some greatest difference and this I call ‘contrariety’. That contrariety sets the maximum difference [between things that differ by the more and the less] is made clear by induction. For things that differ in kind do not have a path to one another but are too distant and not commensurable (οὐκ ἔχει ὁδὸν εἰς ἄλληλα, ἀλλ’ ἀπέχει πλεον καὶ ἀσύμβλητα). Whereas for things that differ in species the contraries are the extremes from which generation takes place. And the greatest interval (διάστημα μέγιστον) is between the extremes, so that it also holds of the contraries. (*Metaphysics* X 4, 1055a3-9)

Given these remarks, it is tempting to think of animal kinds as being separated in morphospace from other kinds by a greater distance than that which separates species of the same kind. This is

how Lennox (2001a, 161) characterizes things: “In the *PA* and *HA*... forms [or species] are said to be one in kind provided their parts for the most part only differ in degree, that is, by ‘the more and the less’. If their differences are predominantly greater than this, they may be described as one only by analogy.”<sup>7</sup>

However, analogy cannot be understood simply as a more extensive degree of difference than the more-and-less without running up against the same sorites problem. At what point do the more-and-less variations between species (which are only a matter of degree) become *too extensive* such that we are now dealing with analogical similarities? In this paper I will offer a different understanding of Aristotle’s biological concept of analogy that allows him to treat analogues as evidence of discontinuous kinds. I need to argue for this account in stages. But first a disclaimer. This paper is not intended to revolutionize our understanding of Aristotle’s biological concept of analogy. Instead it has the more modest aim of offering a new and more thorough defense of certain controversial positions that have been articulated by others (in many cases only implicitly). In doing so I hope to make a small contribution to our understanding of the system of relations that underwrite Aristotle’s approach to classification (viz., the tripartite system of generic, specific, and analogical identity). In this sense the paper aims to consolidate existing scholarship into a more unified picture of analogy.

### **1. The Basic Concept of Analogy.**

The basic concept of *analogon* refers to a kind of equivalency relation, which can be expressed by the general formula: ‘as *B* is in *A* or to *A*, so *D* is in *C* or to *C*’. For example, “as knowledge stands to the object of knowledge, so is perception related to the object of perception” or “as sight is in the eye, so is intellect in the soul, and as calm is in the sea, so is stillness in the air” (*Topics* I 17, 108a7-12; cf., *Metaphysics* IX 6, 1048a35-b9). Thus, at its core is the idea of

geometrical proportion (e.g., *DC* 273a31-274a3, 275a5-10, 289b13-17; *Mechanics* 849b1-849b19).

It is this sense of *analogon* that Aristotle applies to the concept of distributive justice in Book V of the *Nicomachean Ethics* [EN]:

Justice is a species of the proportionate (ἀνάλογόν)... Justice, too, involves at minimum four terms.<sup>8</sup> And the ratio (λόγος) between one pair of terms is the same as that between the other pair; for there is a similar distinction between the persons and between the things. Thus, as *B* is to *A* so *D* is to *C* and vice versa. ...This, then, is what justice is, namely, the proportional. Injustice is what violates this proportion.

(*ENV* 3, 1131a29-b17)

In the *Poetics* the term *analogon* is used for a type of metaphor where it means “analogy” in the more familiar sense. Aristotle defines a metaphor as “the substitution of a name for something else” (1457b6-7), which is said to occur in a number of ways. A term designating a genus may be substituted for one of its species, or a species for its genus, or one species term for another species term (b7-16), or else the two terms may be related analogically. The last of these is described as follows:

[Metaphor formed] from analogy is possible whenever there are four terms so related that the second (B) is to the first (A) as the fourth (D) to the third (C); for one may then substitute (D) for (B) in the metaphor and vice versa. Now and then, too, they qualify the metaphor by adding on to it that to which the word it supplants is relative. Thus a cup stands to Dionysus as a shield to Ares: the cup accordingly will be described as the ‘shield of Dionysus’ and the shield as the ‘cup of Ares’. Or, to take another example, as old age is to life so evening stands to day. One will accordingly

describe evening as ‘the old age of the day’ or... old age as ‘the evening or sunset of life’. (*Poetics* I 21, 1457b8-24)

While “analogy” here retains the idea of geometrical proportion, unlike the purely mathematical sense, the literary use of *analogon* also expresses something about the taxonomic relation between the terms involved.<sup>9</sup> In the first three cases of metaphor the terms that are substituted for one another are either related as genus to species or else they are both species of the same genus. By contrast, analogies are made by substituting terms drawn from distinct genera (e.g., cup:shield, evening:old age).<sup>10</sup> In the biological works Aristotle describes the analogical relation by way of example:

By differing ‘analogically’ I mean that, while some have a lung, others have not a lung but instead something different that is to them what a lung is to those that have one; and some have blood, while others have its analogue possessing the same power that blood has in the blooded. (*PA* I 5, 645b1-10 Lennox transl. with modifications)

Other examples of biological analogues include: the heart and its analogue (e.g., the *mytilis*) (*PA* 678b2, *History of Animals* [*HA*] 469b6-20, *De Motu Animalium* 703a15); bone, cartilage, fish-spine, cuttlebone (*PA* 651b36-652a7; 655a28-655b2; *HA* 516b33-517a5); sinew and its analogue (*Generation of Animals* [*GA*] 737b1-4); hair, feathers, scales, and horned plates (*GA* 782a17, *HA* 486b21, *PA* 691a14-17, 692b10-13); nail and hoof (*HA* 486b20); hand and claw (*HA* 486b20); and the brain and its analogue (*PA* 652b25). As we shall see, the biological concept of analogy closely parallels its use in the *Poetics*. It describes a four-term correspondence relation between traits, e.g., what scales are to fish feathers are to birds. And calling the traits “analogues” implies that the animals that possess them belong to separate γένη.

Now all analogies require something similar between the terms that forms the basis of the analogical relationship: in order to be considered proper analogues, the second term (*B*) must stand to the first term (*A*) in the same way that the fourth (*D*) term stands to the third (*C*). This makes the terms “one by analogy” (*Metaphysics* V 6, 1016b31-1017a2). Biological analogies are based on a number of different types of similarity. In some cases Aristotle calls two different parts analogues because they occupy the same functional role in their respective animals. For example bone, cartilage, and fish-spine are all present for the sake of supporting the flesh. The analogy between sinew and its counterpart is also based on similarity of function (*GA* 737b1-4). All animals require some kind of connective tissue to hold their parts together. In some this function is performed by sinew, in others by some unnamed tissue that is its biological equivalent. Other functional analogues include: blood and its counterpart in bloodless animals (both serve as matter for the parts); the heart and its counterpart (both parts are the source of blood and the seat of sensation); and the blood vessels and their counterpart (both function as a container for the nutritive material, blood or its counterpart). In other cases biological analogies are based on a shared location within the animal. For example, what makes feathers, scales, hair, and horned plates analogues is the fact that they all cover the outside of the animal (*PA* 691a14-17, 692b10-13; *GA* 782a16-20; *HA* 505a22-505a27, 517b14-15; cf., Hess 1965, 330).<sup>11</sup> Finally, *GA* 742b37 and 766b3 suggest that Aristotle might have also taken the similarity in the timing of the development of two parts as grounds for judging them to be analogues of one another (cf., 735a23-6, 765b35).

In contrast to this reading, Leunissen (this volume) claims that Aristotle reduces all analogies to similarity in capacity. However, her primary text (*PA* I 5, 645b1-10 translated above) only asserts sameness in capacity for one particular example, namely blood and its analogue.



That passage does not commit Aristotle to the stronger view that all analogical similarity is ultimately reducible to that basis. More importantly, some analogies resist any such reduction. For example, it is hard to see what soul capacity might be common to the feathers, scales, hair, and horned plates. Leunissen suggests that the analogy in this case is ultimately grounded in the fact that all these parts exist for the sake of protecting the flesh. However, Aristotle nowhere suggests that either feathers or fish scales are for protection. Indeed, he must at least have thought that flight feathers (both those that cover the wings and those that cover the rump, i.e., the tail feathers) are present for the sake of flying not for protection. Similarly, the crest feathers are surely not for protection. And yet all these feathers are presumably included in the scale-feather analogy.

The next question to consider is what role the concept of analogy plays in Aristotle's biology. What is gained by identifying two parts as analogues rather than homologues? On the reading I shall defend, analogy serves two principal functions. First, Aristotle uses the concept of analogy as a tool for identifying separate kinds (*γέννη*). On this reading the fact that feathers and scales are the same only by analogy constitutes evidence for classifying birds and fish as different kinds (Part 3). Second, analogy plays an explanatory role in which the same causal explanation is transferred to "φ and its analogue" (Part 4). Here the function of analogy is to group different parts into a single explanatory class unified on the basis of shared causes. The bulk of my discussion will be focused on the classificatory function of analogy. In order to clear the way for that, however, I first need to show that classification was among the aims of Aristotle's biology (Part 2). For this has not been universally accepted by commentators.

## **2. The Debate Over Classification.**

First a brief history of the debate. Early in the 20th Century there was a tendency among some historians of science to see Aristotle's *History of Animals* as an attempt to construct a taxonomy of animals along the lines of Linnaeus' great system. When they could not uncover any consistent classification scheme the *HA* was declared to be a disorganized failure. In the 1960s David Balme took up the challenge of showing that this way of understanding the *HA* was deeply mistaken. The failure to see any coherent organization of data in the *HA*, he argued, was a direct consequence of the assumption that what Aristotle is trying to do there is produce a robust taxonomy of animals. This conclusion was reinforced by the work of Pierre Pellegrin, Allan Gotthelf, and Jim Lennox in the '80s and '90s. The work of these scholars was pioneering in that it helped us to gain a better understanding of what the ultimate aims of the *HA* really were. This understanding could not be achieved (they argued) until we stopped thinking about the *HA* as a work of taxonomy. Instead the ultimate aim of the *HA* is the collection and organization of data in a way that facilitates demonstration. Gotthelf and Lennox extended Balme's thesis and did much to show that the *HA*, when looked at from this perspective, is not only highly successful but fits nicely within the broader picture of scientific inquiry introduced in the *Analytiks* and developed in the biological works themselves (esp., *PA* I 1). The new consensus was that Aristotle's biological works did not have among its goals the project of setting up a systematic classification of animals.<sup>12</sup> In the 1990s David Charles revived the taxonomic reading. According to Charles, at least one of the aims of the *History of Animals* is to establish the existence of the natural kinds studied by zoology, which *Posterior Analytics* [*APo.*] II tells us is a necessary preliminary step towards the ultimate goal of generating scientific definitions of those kinds. To this extent, Charles argued, Aristotle must have been engaged in "the taxonomic task of laying out which kinds exist" (2000, 315n9). According to Charles, it is in *HA* I 1-5 that Aristotle

establishes the existence of his so-called Great Kinds (μέγιστα γένη), which are collected at the start of *HA* I 6. Finally, Byron Stoyles (2012) has recently defended the view that classification remains among the goals of Aristotle's biology, even if he did not attempt to set up a full-blown *taxonomy* of animals in Charles' sense.

My own sympathies lie somewhere in the Charles-Stoyles camp.<sup>13</sup> David Balme's insistence that Aristotle was not engaged in classification was a healthy reaction against the view that treated the *HA* as a failed attempt to set up something akin to the Linnaean hierarchy. But in many ways it was an overreaction. Since my thesis about the role of analogy in Aristotle's biology depends on the claim that Aristotle did engage in classification, I need to say something to motivate this position. I shall do so by addressing some of Balme's classic arguments against classification.

In *Teleology, First Principles, and Scientific Method in Aristotle's Biology* Allan Gotthelf presents and defends Balme's arguments against the traditional view that the *HA* contains a systematic classification of animals. Gotthelf defines classification this way:

By a 'systematic classification (or taxonomy) of animals' I mean: a grouping of animal forms (ἄτομα εἶδη) under a hierarchical series of larger kinds (γένη) which aims to be... (i) mutually *exhaustive* at any upper level, and especially at the highest level, of the lower kinds and forms; (ii) mutually *exclusive* at any upper level of the lower kinds and forms; and (iii) a grouping of animals by *essential nature*, so that: (a) each is an authentic *kind*, in the sense that the kind name is always in the first category of being, identifying *what something is*; from which it follows that (b) there is only one such grouping of the animals there are, which entails that the systematic classification is (iv) unique. (Gotthelf 2012, 264)

Much of Balme's work was devoted to showing that Aristotle's biology neither contained nor attempted to set up a classification of animals in this sense. In defense of this Balme presented five main lines of argument (from Gotthelf 2012):

- (1) While Aristotle engages in division, the aim of division is definition *not* classification (contra Lloyd 1961).
- (2) The *HA* is primarily a study of animal *differentiae* not a study of animals themselves; so “what looked to other scholars like a classification of *animals* was really a classification of animal *features*” (Gotthelf 2012, 268 [emphasis added]; cf., 281)
- (3) The terms “γένος” and “εἶδος” do not correspond to any fixed ranks in a classification (e.g., they do not pick out “genus” and “species” in the Linnaean taxonomic system).
- (4) Aristotle often uses γένος for groupings that are not natural kinds but “mere differentiae classes”.
- (5) The list of “greatest kinds” (μέγιστα γένη), which *might* be taken as a basis for a natural classification of animals, is not exhaustive and lacks intermediate kinds “that a taxonomical concern would entail” (Gotthelf 2012, 268-9).

The first thing to say here is that Gotthelf's definition of “classification” is too strict. For not all classification schemes exhibit the features he describes. For example, in Henry (2011) I defend an interpretation according to which Aristotle employs a *rank-free* approach to classification that recognizes many equally legitimate ways of classifying things into natural kinds, where no *single* way of classifying them is privileged over the other.<sup>14</sup> On this interpretation Aristotle's system of classification does not involve a commitment to (i), (ii), or (iii.b). Thus in what follows it will be useful to distinguish between “classification” and “taxonomy”. I shall use the term “classification”

in the broad sense to refer to the systematic arrangement of things into a hierarchy of kinds based on shared similarities and differences in a way that reflects the relationships between them. By contrast, I shall use the term “taxonomy” for a particular kind of classification system that is designed (at minimum) to locate things in a nested hierarchy of *fixed* and *exhaustive* ranks (e.g., family, genus, species). A more robust conception of taxonomy might also insist on the other conditions that Gotthelf sets out in the above passage, though it need not.

(This way of understanding “classification” makes the thesis of this section much less controversial. For Gotthelf and Lennox, at least, appear to accept that Aristotle was engaged in classification in this sense. For example, Lennox speaks of *HA* I 1 as providing an “account of how to group animals into kinds in advance of understanding the causal essences that explain these groupings” (2005, 97; cf., Lennox 1990). He simply denies that Aristotle is attempting to set up “classifications which are absolute (rather than context relative), hierarchical and exhaustive”, that is, a *taxonomy* of animals (1990, 175).<sup>15</sup> But the distinction is well-worth making explicit since those who were party to the original debates often conflated the two terms. As a result it was not always clear what view they were rejecting.<sup>16</sup>)

Now as I see it Balme’s arguments are decisive against the view that Aristotle attempted to set up a taxonomy of animals. But they do not rule out the view that *classification* remains an important part of Aristotle’s biology. It is this latter view that I wish to defend here. In what follows I shall confine myself to some brief remarks in response to Balme’s arguments (1) and (2), which target the idea of classification in general.<sup>17</sup>

Let me start with (1). Aristotle can surely be said to have classified animals in the sense of organizing them into a hierarchy of kinds based on shared characteristics. And his primary means for doing this is the method of collection and division. Now Balme is certainly right that

Aristotle (like Plato) sees division as a mechanism for generating definitions. But definition and classification do not constitute mutually exclusive aims of division. For definitions might themselves be broadly classificatory in nature, where defining a thing involves locating its place within a nested hierarchy of interrelated kinds.<sup>18</sup> Let me offer one example from the *History of Animals* to illustrate what I mean. At *HA* I 1, 487b35-488a13 Aristotle divides animals into gregarious animals (e.g., bees, humans, ants, schooling fish) and solitary animals (e.g., spiders, lizards). Next gregarious animals are divided into eusocial animals (e.g., bees, humans, ants) and non-eusocial animals (e.g., schooling fish, geese, deer).<sup>19</sup> Finally, the eusocial animals are divided into those that are hierarchically organized under a ruler (e.g., bees, humans) and those whose social organization is ‘anarchical’, i.e., lacks a ruler (e.g., ants).<sup>20</sup> Notice that this division tree at once classifies animals in a nested hierarchy of kinds and provides the raw materials for generating definitions of them. For example, ants are classified as a eusocial form of gregarious animal that does not submit to a ruler. This provides the materials for answering the question, “What is an ant?” By consulting the division we can see that ants are (at least in part) gregarious animals that live together in communities organized around a common task but lack a hegemonic structure (they are ἀναρχος).<sup>21</sup>

Balme’s second argument is based on his claim that the *HA* is primarily a study of animal *differentiae* (or attributes) as such and not a study of animals themselves:

The *HA* is a collection and preliminary analysis of the *differences* between animals. The animals are called in as witnesses to differentiae, not in order to be described as animals. What is interesting about the blind mole [for example] is precisely that, though viviparous, it is blind - the only case of this combination of characteristics known to Aristotle, who quotes it often. (Balme 1987, 88)

Once you come to see that Aristotle's focus in *HA* and elsewhere is on animal *features*, the temptation to see animal groupings based on those features as necessarily a *classification scheme* disappears. And that was David Balme's great advance. (Gotthelf 2012, 267-8)

Although Gotthelf concedes that it may be possible to view Aristotle as engaging in classification, he insists that it would still only be a systematic classification of animal *features* and not animals as such:

Now, I *do* think *HA* is indeed concerned to establish that kinds exist [in accordance with *APo.* II 1-2], in preparation for the later enterprise of establishing the essential definitions of those kinds, but the kinds in question are *kinds of differentiae*, not the kinds of animals. Note that *HA* might indeed be viewed as providing (among other things) a systematic classification of *differentiae*, presented via a significant use of division... (Gotthelf 2012, 281)

Consider the above example. One might insist that what Aristotle is dividing there are activities or ways of making a living. For example, when Aristotle divides τὰ ἀγελαία into τὰ πολιτικὰ and τὰ σποραδικά, one might take him to be dividing gregarious lifestyles into eusocial forms of gregarious living and the other way of living in groups where animals are scattered and disorganized (e.g., schooling). On this reading the division tree presents a systematic classification of animal features not a classification of the animals themselves. Particular animals are (as Balme puts it) brought in only as "witnesses" to those different ways of making a living.

But this is not the only nor, indeed, most natural way of reading our passage. A more natural reading takes Aristotle to be dividing gregarious *animals* into those that live in social

groups organized around a common function (e.g., bees, humans, ants) and those that live in groups without any social structure (e.g., schooling fish, flocking birds). He then divides the eusocial kind of *animal* into those that have a ruler (e.g., bees, humans) and those that do not (e.g., ants). There are no obvious textual reasons for thinking this is the wrong way to take the passage. At the very least the text is compatible with both readings.<sup>22</sup>

The interpretation I am suggesting departs from the Balme-Gotthelf reading in non-trivial ways. On my interpretation differentiae are not the things being divided but the means by which division takes place.<sup>23</sup> More importantly, division often results in animal kinds defined intensionally by the possession of certain features. In these cases particular species are mentioned, not as ‘witnesses to differentiae’, but as examples of things found in the extensions of those kinds. Consider *HA* 489a35-b4. This division results in three classes of animal each defined intensionally by its mode of reproducing, giving us live-bearing animals (τὰ μὲν ζωοτόκα), egg-laying animals (τὰ δ' ὠοτόκα), and larva-producing animals (τὰ δὲ σκωληγοτόκα). Particular species are then mentioned as examples of the sorts of things included in the extension of each kind (e.g., “The live-bearing animals include humans, horses, seals, and all other animals that are covered in hair, and, among marine animals, cetaceans, e.g., the dolphin, and what are called cartilaginous fish [sc. sharks and rays].”).<sup>24</sup> Of course, this is not to deny that Aristotle is ever focused on differentiae as such. In *GA* V 3, for example, he identifies hair as the wider kind, which he then proceeds to divide into different forms of hair (781b34: εἶδη) based on more-and-less variations in their attributes (782a1-7).<sup>25</sup> My point is simply that Aristotle is interested in classification and that in many cases what he is attempting to classify are animals themselves. Thus what I want to deny is Balme’s “great advance”, that Aristotle’s focus is exclusively on differentiae as such and that to find in his works a classification of animals results from a failure



to appreciate this fact.

### **3. The Role of Analogy in Aristotle's Biology.**

In *History of Animals* I 1 Aristotle outlines a theory of classification that is centered around three comparative relations. Animals that have the majority of their parts the same in form are said to belong to the same species. In *PA* I 5 Aristotle cashes this out in terms of having features that “do not exhibit a difference relative to the general account (κατὰ τὸν καθόλου λόγον μηδεμίαν ἔχει διαφορὰν)” (645b25-6). In other words, members of the same species have features defined by the same universal account. Animals whose parts are the same in kind but differ by degree according to the more and less belong to different species of the same kind (see *PA* 692b3-9, translated above). Finally, animals whose parts are the same only by analogy belong to separate kinds.<sup>26</sup> Aristotle's comparative approach to classifying animals raises the following question. Are we meant to take the classification of animals or the classification of parts as prior? Do we classify animals based on the comparative relations among their parts or do our judgements about the status of their parts depend on how we have classified them?

David Charles adopts the latter view. According to Charles the parts of animals are considered homologous or analogous depending on the prior taxonomic relation of the animals to which they belong, which is established on independent grounds. For example, insect wings and bird wings are identified as analogues *because* insects and birds belong to separate top-level kinds:

The central role of differentiae of this type [sc. soul-functions] is illustrated by other aspects of *Historia Animalium* A.1-5. The discussion of parts follows the pattern of *De Partibus Animalium*: if the genus is the same, animals will differ by the more and the

less (*HA*, A.1, 486a22 ff.). By contrast, if features belong to different genera, they will only be analogically similar (486b20-2). But, as before, the genera (such as bird and fish) appear to be taken as already determined. As in *De Partibus Animalium*, sameness and difference [sc. of features] rest on sameness and difference in genus (and presumably, therefore, on difference in basic soul function).” (Charles 2000, 318)

Pellegrin takes a similar reading:

[F]rom the Aristotelian point of view, it is impossible to say that the analogy feather-scale fixes the *γένος* at the level of ‘bird’ or ‘fish’, but we must understand that feather and scale can be called analogous as soon as one has decided to take ‘bird’ and ‘fish’ as *γένη*. (Pellegrin 1987, 228-9)

According to this first reading, then, the analogical relation between parts is entirely dependent on, and determined by, our prior classification of the animals that possess them.<sup>27</sup>

I want to argue that this gets things the wrong way round: Aristotle uses the analogical relation as evidence that two groups constitute distinct top-level kinds. On this reading we first compare two groups of animals and determine whether their parts are homologues or analogues. This then provides the basis for classifying those animals as either different species of the same kind or as constituting entirely separate kinds. Thus birds and insects are classified as distinct kinds *because* the majority of their parts are the same only by analogy, which is itself determined on independent grounds.<sup>28</sup> The evidence for this reading is drawn primarily from those theoretical passages where Aristotle discusses the concept of analogy itself.<sup>29</sup> There are three main texts that support this reading: *HA* I 1, 486a14-468b21; *HA* I 6, 491a14-491a18; *PA* I 4, 644a13-23. The first two passages, taken by themselves, are compatible with both interpretations.

In the first passage, for example, Aristotle could be saying that species of the same kind have parts that differ by the more-and-less while those that belong to separate kinds have parts that are the same only by analogy without committing himself to a view about the relative priority of those relations. The second passage is slightly more explicit about that. There Aristotle tells us that the relations between the parts ultimately determine the differences between the animals that possess them. The relations in question are clearly those enumerated in the opening section of *HA I 1*, including analogical sameness. And it is reasonable to assume that the differences Aristotle has in mind are the very same ‘taxonomic’ differences that he spells out in that section. However, the third passage is categorical that the analogical relation provides the grounds for classifying animals into distinct top-level kinds. Aristotle says that common sense is correct to treat the water dwellers and the fliers as two separate kinds *on the grounds that* their parts are the same only by analogy: “For all those animals that differ by degree and the more and the less have been brought together under one kind, while all those that are analogous have been kept apart.” Here the concepts of homology and analogy are clearly used as tools for classifying animals rather than vice versa.<sup>30</sup>

If the classification of animals presupposes the analogical relation, then there must be a story to tell for what makes parts of animals analogous that is independent of considerations about their place in a division tree. Unfortunately Aristotle never explicitly addresses this question. However, I think we can gain some insight by contrasting the analogue relation with the relation of sameness in kind. For we have seen that Aristotle opposes sameness by analogy to sameness in kind. A good place to turn here is the *Metaphysics*. There Aristotle argues that different species of the same kind all share a common property, which is specifically differentiated in each. And the “common item” that unites the various species of a kind is said to be a shared

underlying matter. According to this view, even if things that differ in kind have similar forms, those forms will be predicated of different (proximate) material subjects. There are four texts where this doctrine is spelled out:

‘Kind’ is used in all three ways: (i) to refer to a continuous generation of things of the same form; (ii) to refer to the first mover of things of the same form<sup>31</sup>; and (iii) in the sense of matter. For that to which the differentia and quality belongs is the subject (τὸ ὑποκείμενον), which we call matter. Things, then, are said to differ in kind whose proximate subject (τὸ πρῶτον ὑποκείμενον) is different and cannot be resolved into one another or both into the same thing. (*Metaphysics* V 28, 1024b6-11)

That which is different from anything is different in some respect, so that there must be something the same with respect to which they differ. And this is either the same kind or the same species. For all things that differ do so either in kind or in species: (i) *A* and *B* differ in kind if they do not have their matter in common and are not generated from one another (i.e., if they belong to different figures of predication); (ii) they differ in species if they are both members of the same kind [i.e., they do have their matter in common], the kind being that same thing which both *A* and *B* are said to be with respect to their substance. (*Metaphysics* X 3, 1054b23-31; cf., 1055b11-17, 1055a28-9)

For by ‘kind’ I mean that one identical thing which is predicated of both <species> and is differentiated in a non-accidental way, whether conceived of as matter or otherwise. For not only must the common item (τὸ κοινὸν) belong to the different things, for example not only must both be animals but this very ‘animal’ must also be

different in each (e.g., in the one case horse and in the other human), and therefore this common item is specifically different in them. One, then, will be one sort of animal in virtue of its own nature and the other another sort of animal (e.g., one will be a horse, the other a human). (*Metaphysics* X 8, 1057b37-1058a6)

Evidently, therefore, with reference to that which is called the kind none of the species that belong to the kind is either the same as, or other than, it in species. And rightly so, for the matter is signified by the negation and the kind is the matter of that which is called a kind, not in the sense in which we speak of the clan of Heraclidae but in the sense in which we speak of a kind in nature (ὡς τὸ ἐν τῇ φύσει). (*Metaphysics* X 8, 1058a21-4)

Aristotle is explicit, especially in the first two passages, that things that differ in kind lack a common material substratum.<sup>32</sup> Extending this to the biological works, when Aristotle tells us in *PA* I 4 that things that are the same in kind share a “single common nature” (μίαν φύσιν κοινήν: 644b1-3), one way to read this is to take it as a reference to a common *material* nature. If this is right, then biological analogues turn out to be parts that realize the same capacity of soul or occupy a similar location in the animals whose parts they are but are not specific (more-and-less) modifications of the same underlying material substratum.<sup>33</sup>

To see what I have in mind, consider bird wings and insect wings again. All bird wings are covered in feathers. And different species of bird have feathers that differ by the more-and-less: some feathers are longer, some shorter; some are blue, some red; some have few splits, some many splits; and so forth. What makes all bird feathers the same part is the fact that these are all more-and-less modifications of the same underlying feather-matter. The feathers of different

species are what you get when this same proximate matter is modified in different ways to suit that species' particular way of life. By contrast, although insect wings perform the same function as bird wings, they are not more-and-less modifications of the same generic matter. You don't get an insect wing by taking a bird feather and fusing all the splits into a continuous membrane. The split feathers of a bird wing and the solid membrane of an insect wing, though functionally equivalent, are modifications of two completely different (proximate) material subjects.<sup>34</sup> The philosophical upshot of this interpretation is that it shows how Aristotle is able to use the concept of analogy to determine where the "natural joints" of the world are. Even in cases where two animals appear to have similar attributes or where their parts execute similar functions, we can be sure that they constitute distinct natural kinds if it is discovered that their attributes are not modifications of a common underlying material substratum. For species of the same kind all share a common material nature.<sup>35</sup>

#### **4. The Explanatory Function of Analogy.**

To close let me say a few words about the explanatory role of analogy in Aristotle's biology. I do not have much to say here since the role of analogy in explanation has been adequately addressed by Gotthelf. I do not have much to add to his illuminating account.<sup>36</sup> Gotthelf summarizes the proper method of explanation outlined in *Parts of Animals* I (see 639a15-b6, 644b1-8, 645b1-15) as follows:

[T]he pattern goes like this: for each feature, identify first the widest class of animals that possess it. Then identify the variations (or differences, *diaphora*) in which it comes. Then identify the widest class of animals that possess each of these differences. Then explain why all animals that have that feature at all do have it. Finally, explain the variations in the feature by reference, wherever possible, to variations in the cause of

the feature. In the simplest cases we deal with kinds and their subkinds. In those cases we explain the *differences* in some generic attribute (e.g., feathers) across subkinds of the large kind (e.g., Bird) by reference to the *differences*, across those subkinds, in the features which explain the presence of the generic attribute in the large kind. (Gotthelf 2012, 193 *n.* 18)

While Aristotle's description of this method in *PA I 1* and 4 restricts the procedure to features that are common to kinds (*κοινή κατὰ γένος*, 639b4), in practice he extends the method to features that are common by analogy (*τὸ κοινὸν κατ' ἀναλογίαν*, 645b27). We find this pattern wherever Aristotle gives an explanation that applies to “ $\phi$  and its analogue”. These are cases where there is some wider group  $G$  to which some feature  $F$  belongs, but  $F$  is common to the members of  $G$  only by analogy. For example, feathers are common *κατὰ γένος* since they are found in all and only birds (which is a genuine kind). By contrast, connective tissue is common to those animal that have it only *κατ' ἀναλογίαν*. But we still look for the cause of this part at the level of the widest group to which the feature belongs. On Aristotle's account, all animals have connective tissue for the sake of holding the bones together (a common final cause). However, in some this part takes the form of sinew, while in others some unnamed tissue that is its biological equivalent. Likewise, all animals have a part that serves as both the source of its nutritive material and the primary seat of its sensory capacities, but this part is neither generically nor specifically the same in every animal. In blooded animals it takes the form of a heart while in bloodless animals it some part analogous to it (e.g., the *mystis*).

But if the interpretation in Part 3 is correct, then while analogical unity (whether based on shared function, shared location, or shared developmental systems) may allow us to posit a common *explanation* for  $\phi$  and its analogue, this is not grounds for treating the class of animals

that possess those parts as a *natural kind*. Indeed, Aristotle says that things that are one by analogy do *not* constitute a single kind (*Metaphysics* V 6, 1017a2). This requires modifying the view of natural kinds defended in Henry (2011). There I argued that for Aristotle natural kinds are limited to those groups whose shared similarities are underwritten by common causes. But we can now see that this is necessary but not sufficient for being a natural kind. Rather, those shared similarities must also be the result of common causes operating on a common material substratum. For example, birds, bats, and flying insects will have certain features in common (at some level of generality) that are due to the teleological requirements stemming from a similar way of life. For example, in each case being a flier conditionally necessitates wings with certain aerodynamic properties. In birds this requirement is satisfied by feathered wings, in bats skin-covered wings, and in flying insects membranous wings. But this does not make “fliers” a unified natural kind, since the parts that each animal uses for flying are not more-and-less modifications of the same (proximate) material substratum. That, I think, is the take-away message from *PA* I 4, 644a13-23.

### **Appendix: The Nail-Hoof Analogy**

Towards the end of her commentary Leunissen raises an objection to the view defended in Part 3 (that biological analogues are differentiated in terms of their matter) by pointing to examples where Aristotle seems to treat analogous parts as identical at the material level. The example she highlights is the nail-hoof analogy mentioned (e.g.) at *HA* I 1, 486b20.<sup>37</sup> Aristotle thinks that these parts are both generated out of the final residue of blood that is left over from the production of skin and that both are therefore thoroughly earthy in their (material) nature. This presents a challenge to my view because it would mean that two parts *A* and *B* can be analogues even if they share some matter in common. And yet, as we have seen, Aristotle is



explicit in the *Metaphysics* that things that differ in kind (as biological analogues do) lack a common material substratum.<sup>38</sup> Thus, if nails and hoofs really are proper biological analogues, then they should be modifications of different material subjects. So there is an apparent tension in Aristotle's text generated by my reading.

I think the best way to reconcile the *Metaphysics* account with nail-hoof example (and similar ones pulled from Aristotle's actual research on animals) is to emphasize the different levels at which material similarities exist. Now I don't deny that biological analogues share material similarities at *some* level. So it is not a problem that nails and hooves are both formed out of a residue of blood. Likewise, it is not a problem for my reading that Aristotle thinks all animal parts are *ultimately* composed of the same material elements, viz., the hot, cold, moist, and dry.<sup>39</sup> What I am suggesting is rather that biological analogues are modifications of different *proximate* matter. Thus, when I say that all bird feathers are different modifications of the same underlying feather matter, "feather matter" is short hand for whatever constitutes the proximate matter of a feather that stands as the underlying subject (τὸ ὑποκείμενον) of its form.<sup>40</sup> The interpretation of proximate matter is controversial (e.g., Heinaman 1979, 256-7), and I don't propose to give any definitive account of that here. Instead by the "proximate matter" of a thing I mean whatever it is that constitutes the primary subject that immediately underlies its form (the subject of which the form is directly predicated) in the way that surface immediately underlies colour (colour being directly predicated of surface). Thus, although Aristotle refers to blood as the matter *out of which* the parts of animals are generated and maintained, this material lies at too 'deep' a level to constitute their proximate matter. A hand, for example, is not hand-shaped blood. Nor should we say that the animal soul is directly predicated of blood.

Leunissen's objection rests on the assumption that the raw materials out of which an *X* is

generated persist unchanged in the process and become the proximate matter of the fully-formed *X*.<sup>41</sup> If Aristotle accepted this principle, then we could infer from the fact that nails and hooves are formed out of the same pre-existing matter that the proximate matter which serves as the underlying subject of their respective forms is also the same. While most commentators take *Physics* I 7 to hold that *some* matter persists as a constituent of the substance that comes into being, Aristotle does not identify this with the *proximate* matter of that substance.<sup>42</sup> In fact, there are several places where Aristotle appears to reject this. For example in several places in *GC* I Aristotle argues that when a new substance comes into being the subject from which the change proceeds does not endure but is “wholly transformed” (ὅλον μεταβάλλῃ) in the process (319b8-21), which he glosses as changing in both form *and* matter together (317a20-6). Applying this to Leunissen’s example, while nails and hooves might be formed out of the same raw materials, those materials will be completely transformed into different proximate matters in the process of generation: nail-matter in the one case; hoof-matter in the other. If this is right, then the two analogues are not modifications of the same material subjects, even if they are generated from the same raw materials.

The interpretations offered in this paper and its commentary have different virtues that are worth highlighting. Leunissen’s reading has the virtue of being restricted to the biology and not importing theory from the *Metaphysics* (to which some scholars are quite hostile). One who adopts Leunissen’s reading will say that the principle that governs the biology is the one stated at *PA* I 4, 644b7-15 where Aristotle suggests that kind differences are to be defined in terms of gross morphology differences. My reading has the advantage of starting from Aristotle’s more general theory about kinds in the *Metaphysics* and then showing how this can help illuminate what he says in the biology. So what of the *PA* I 4 passage on this reading? What Aristotle says there is that

“roughly speaking, kinds have been demarcated by the shape of the parts and of the whole body”. As I read this, Aristotle is telling us how animal kinds, like birds and fish, have traditionally been demarcated (ὄρισται) by common sense. Now Aristotle clearly agrees that gross morphological differences can be used as a *diagnostic* feature when demarcating top-level kinds (morphology is a fairly reliable guide here). But that does not commit him to the view that being separated in morphospace is what *constitutes* kind differences. In other words, I see no reason to think that the *PA* has abandoned the *Metaphysics* view that things differ in kind whose differentiae are predicated of different proximate material subjects.

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<sup>1</sup> See Henry (2011).

<sup>2</sup> Plato uses the term “natural kind” (πεφυκὸς εἶδος) at *Phaedrus* 266a3.

<sup>3</sup> As others have pointed out, Aristotle uses the concept of a γένος for groups at varying levels in a division tree. In this paper I am concerned with what I will call “top-level” kinds: those groups that constitute the most general kinds within a given domain in the sense that there is no wider kind under which they fall (e.g., birds and fish are top-level kinds in the domain of animals). These correspond to what Aristotle calls μέγιστα γένη (see Stoyles 2012).

<sup>4</sup> The problems with translating εἶδος as “species” in the context of Aristotle's biology have been well-established (Balme 1962, Pellegrin 1986). While I agree that (in Aristotle's biology at least) γένος and εἶδος do not correspond to “genus” and “species” in the modern taxonomic sense, I shall retain these familiar translations for convenience.

<sup>5</sup> For the canonical account of this theory see Lennox (2001a, 160-181). For symmetry I will refer to parts that represent different (more-and-less) modifications of the same generic structure as “homologues”, though nothing depends on adopting this terminology.

<sup>6</sup> This question is posed, but not answered, by Lennox (2001b, 168-9). See also Wilson (1997, 36).

<sup>7</sup> Lennox tends to characterize analogical difference simply as a more “extensive” degree of difference than differing by the more-and-less (2001, 161, 170). However he also describes biological analogues as “structurally different” (2001, p. 179 *n.* 8; 2001b, 168). While he does not say in what this structural difference consists, his interpretation of a kind as the material substratum for specific difference (Lennox 2001, 167-71) suggests a reading of analogy that is close to the one offered in this paper.

<sup>8</sup> *EN* V 3 distinguishes between “discrete” (διηρημένῃ) analogies, which involve four terms, and “continuous” analogies, which only involve three “for it uses one term as two and mentions it twice” (*EN* V 3, 1131a31-3; compare *Timaeus* 31b8-32a8). As we shall see, biological analogues fall into the former category.

<sup>9</sup> Kirby (1997, 533).

<sup>10</sup> Not all uses of *analogon* imply a taxonomic relation between the terms, though. For example, at *Meteorologica* 347b13-15 Aristotle says: “From that region there fall three bodies condensed by cold, namely, water, snow, and hail. Two of these correspond to (ἀνάλογόν) the phenomena on the lower level and are due to the same causes, differing from one by the more and less.” In the biological works being the same by analogy *is opposed to* differing by the more-and-less, where the latter characterizes the relation between species of the same genus. Likewise *GA I*, 727a2-4 refers to menstrual fluid and semen as “analogues”, even though in Aristotle’s theory they are specific forms of the same generic matter (they are both concocted residues of blood). In this context all Aristotle means to say is that menstrual fluid is the spermatic counter-part of semen. See also *Meteor.* 362b30-3.

<sup>11</sup> See also *PA* 681b29-30: “The location of this part [sc. the *mystis*] makes it clear that it is the analogue of the heart; for the location is the same.”

<sup>12</sup> See Balme (e.g., 1992, 105), Gotthelf (e.g., 2012, Ch. 12-14), and Lennox (1987, 100). Things are complicated here by the fact that Balme, Gotthelf, and Lennox all tended to conflate “classification” with “taxonomy” (Pellegrin was more careful). See below.

<sup>13</sup> Charles (1990, 2000), Henry (2011), and Stoyles (2012) all agree that Aristotle was engaged in classification in some sense. Charles argues that Aristotle attempted to construct a single taxonomy of animals. By contrast, both Henry and Stoyles hold that Aristotle employs a non-taxonomic (rank-free) approach to classification that recognizes many equally legitimate and cross-cutting ways of classifying animals into natural kinds where no *single way* of classifying them is privileged over the other.

<sup>14</sup> This reading is similar to that of Pellegrin (1986), except that I take Aristotle also to be a realist about biological kinds rather than being merely pragmatic about them (Henry 2011, 200-1).

<sup>15</sup> Lennox: “...there isn’t even a blueprint of a taxonomy here, though there are lots of classifications” (*opt. cite*). Charles, by contrast, endorses the stronger claim that Aristotle attempted to set up a single taxonomy of animals with the μέγιστα γένη at the top.

<sup>16</sup> The notable exception here is Pellegrin (1986).

<sup>17</sup> To be more specific, I think arguments (3) and (5) are decisive against the taxonomic reading. But they do not rule out the idea that Aristotle employed a rank-free approach to classification (see note 13 above). I also have serious doubts about Balme’s claim that Aristotle sometimes uses γένος for “natural kinds” and sometimes for “mere differentiae classes”. This strikes me as question begging, and I cannot find any basis for it in the text itself.

<sup>18</sup> See Bayer (1998).

<sup>19</sup> As Aristotle goes on to say, by “eusocial” (τὰ πολιτικὰ) animals he means those that live in social groups organized around a common function (τὸ ἔργον). The σποραδικά are animals that form groups that lack any kind of social structure, where the members are scattered within the group as it were. Aristotle’s example of the latter are tuna and bonitos, which are both types of schooling fish. Unlike, say, an ant colony or a bee hive, schools are groups that lack any social organization but are just collections of fish. Herds, flocks, and other such groups also fit this description.

<sup>20</sup> Aristotle clearly did not appreciate that ants have queens that control the colony through chemical signals.

<sup>21</sup> Compare Plato’s classificatory definition of the angler at *Sophist* 221b1-3, which “weaves together” all the terms collected from one side of the division tree. I should say that this classification provides the raw materials for a *potential* definition of the ant kind. For the *HA* is generally thought to be a pre-causal treatise, and deciding which features are part of the essence of a kind can only be done on the basis of identifying causes.

<sup>22</sup> This might be giving too much away to the Balme-Gotthelf reading. For taking τὰ ἀγελαία, τὰ πολιτικὰ, and τὰ σποραδικά to refer to ways of living as such seems to stretch the Greek beyond what is possible. Nevertheless cases in which Aristotle explicitly divides animals into classes abound in the biological works. For example, *GA* II 1, 732a25-b14 begins: “Of animals (τῶν δὲ ζώων), some give birth to complete offspring and bring forth externally something like itself (e.g., all those that bring forth live young), while others produce something that is undifferentiated and has not yet acquired its proper form.” See also *HA* IX 633a29-b5 (discussed in Lennox 1990, 177).

<sup>23</sup> Compare Plato’s *Sophist* and *Statesman* where differentiae are usually picked out by the use of the dative of means.

<sup>24</sup> See also *HA* I 5, 490a6-20. There Aristotle divides flying animals into different sub-kinds based on differences in the structure of their wings. In this case division is explicitly said to result in animal kinds, for example “the feathered kind among the animals” (τὸ πτερωτὸν γένος τῶν ζώων: 490a12). Here the γένος of bird is defined intensionally as feathered fliers (490a12); eagles and hawks are noted as particular animals in the extension of that γένος (a6).

<sup>25</sup> See Leunissen this volume: *n.* 2.



<sup>26</sup> Aristotle does not say whether (3) applies only to the most extensive or top-level kinds (μέγιστα γένη, e.g., bird) or to sub-kinds within a more extensive kind as well (e.g., raptors, water-fowl, carrion birds). I assume he means that animals in different top-level kinds have the majority of their parts the same only by analogy (*HA* 486a25, 497b4-13). I shall by-pass the related issue of whether all intra-generic differences are more-and-less differences or whether species within the same top-level kinds can have some parts that are the same only by analogy.

<sup>27</sup> See also Balme (1987); cf., Wilson (1997, 337). Balme and Pellegrin both contend that the concept of analogy is context relative so that same two parts can be deemed analogues or homologues depending on how we classify our kinds. But this is not right. As evidence they point to *PA* II 8, 653b33-5 and *PA* II 9, 655a33. In the first passage cartilage and bone are described as analogues, in the second as homologues. A more careful reading of those texts shows that Aristotle is in fact talking about two different types of cartilage, one that is present in land-dwelling mammals and is homologous to bone, and another that is present in sharks and rays, which is only analogous to bone. This is clearer at *HA* II 7, 516b33-517a5.

<sup>28</sup> For a similar reading see Lennox (2001b, 169) and Lennox (2005, 96-7).

<sup>29</sup> Leunissen (this volume) is certainly right when she notes that Aristotle does not use the concept of *analogon* to classify animal kinds ‘in practice’ (e.g., in *PA* II-IV). But this is just what we should expect. For *PA*, *GA*, and arguably *HA*, do not represent the stage of inquiry where Aristotle is fixing kinds. I say ‘arguably *HA*’ because commentators are divided on the issue of whether or not *HA* is engaged in fixing kinds, and if so, where. For a summary of the debates see Gotthelf (2012, Ch. 12). My own view is that the biological works all *present* classifications (in the form of division trees) but that by the time he came to write those treatises Aristotle had already worked those classifications out (note how he often says to “consult the divisions”). If this is right, then we wouldn’t expect to find examples where *analogon* is used in its primary classificatory role. Instead, as we should expect, most of the examples use *analogon* in its explanatory role (see next section). Much of what Leunissen says about explanatory and organizational efficiency in her comments apply to that use of *analogon*.

<sup>30</sup> Leunissen (this volume) offers a deflationary reading of this passage, which I do not find compelling. The explanatory *gar* at 644a17 makes it clear that Aristotle thinks the fact that two groups of animals have parts that are the same only by analogy gives us a reason for classifying them as separate kinds (compare 644b11). As for 644a22-3, although Aristotle says that it is “not easy” to classify animals based on analogy, he does not say that we shouldn’t use analogy to do so.

<sup>31</sup> This is the sense in which we might speak of “the clan of Heraclidae”, which Aristotle opposes to the natural sense of a kind (see *Metaphysics* X 8, 1058a21-4 below).

<sup>32</sup> On the kind-as-matter doctrine see Rorty (1973) and the reply by Grene (1974). Lennox (2001a, 167-71) offers a nice account of how the *Metaphysics* doctrine applies to biological kinds.

<sup>33</sup> This reading is similar to the embryological interpretation of analogy discussed in Wilson (1997, 337-8), though without the developmental implications he assigns to that reading. (I am sympathetic to Wilson’s worries about that aspect.) My claim that biological analogues are modifications of different (proximate) material subjects does not depend on taking common nature in the *PA* I 4 passage to refer to a common material nature. My claim is based primarily on the *Metaphysics* X doctrine spelled out in the above passages. It is worth noting that most commentators take *μίαν φύσιν κοινήν* at *PA* 644b1-3 to refer instead to a common formal nature (e.g., Charles 2000, 312-18). However, given what Aristotle says in *Metaphysics* X, it is at least as plausible that the *φύσις* that Aristotle says is common to all members of a kind is the material nature (cf., *Physics* I 7, 191a7-12: *ἡ ὑποκειμένη φύσις*).

<sup>34</sup> When Aristotle says that “the nature of bone and cartilage is the same but differs by the more and less” (*PA* II 9, 655a32-3; cf., *HA* II 7, 516b33-517a5 ), I therefore take him to mean they share the same material nature (though it may also be true that they also execute the same function).

<sup>35</sup> Leunissen (this volume) objects to my reading on the grounds that reference to a common material nature would encounter the same sorites problem I claim it avoids. Whether or not she is right, this is independent of my main claims about the role of analogy in Aristotle’s systematics. At best Leunissen provides grounds for doubting that Aristotle *is* able to use the concept of analogy to determine where the natural joints of the world are. But that was only supposed to be the “philosophical upshot” of my reading.

<sup>36</sup> See Gotthelf (2012, s.v. analogy, as a type of unity).

<sup>37</sup> See also *GA* V 6, 786a34-786b4.

<sup>38</sup> I think Leunissen makes too much of Aristotle’s remark at *Metaphysics* X 8, 1058a1-2 when he says that “by ‘kind’ I mean that one identical thing which is predicated of both <species> and is differentiated in a non-accidental way, *whether conceived of as matter or otherwise*”. What he means, I take it, is that his current point does not turn on which view one takes. But it is clear from the rest of *Metaphysics* X that he takes the former view: that one thing that all species of a kind share is a common underlying material substratum (1054b23-31, 1055b11-17, 1055a28-9, 1058a21-4; cf., *GC* I 6-7).

<sup>39</sup> Aristotle identifies these as “the matter of all composite bodies” at *PA* 646a13-17 (see also *De juv.* 466a21-3).

<sup>40</sup> For the concept of matter as underlying subject see *Metaphysics* VII 13, 1038b1-9.

<sup>41</sup> This is a modification of Shields' Substrate as Proximate Matter (SPM) principle: "The proximate matter of *x* must persist (or must be able to persist) as such through the substantial generation (or destruction) of *x*." Shields (1999, 140) argues that Aristotle rejects this principle.

<sup>42</sup> *GA* II 4, 740b34-35 might also be taken as evidence for this principle. But, again, all Aristotle is saying there is that the raw materials *out of which* the parts are formed and maintained (the *terminus ad quo*) are the same. He does not say that in each case those raw materials persist unchanged and become the *proximate* matter of the substances that come into being. And there is no reason he should say that.