Binghamton University

The Open Repository @ Binghamton (The ORB)

The Society for Ancient Greek Philosophy Newsletter

3-28-1991

Division and Explanation in Aristotle's Parts of Animals

Allan Gotthelf

The College of New Jersey

Follow this and additional works at: <https://orb.binghamton.edu/sagp>

Part of the [Ancient History, Greek and Roman through Late Antiquity Commons](#), [Ancient Philosophy Commons](#), and the [History of Philosophy Commons](#)

Recommended Citation

Gotthelf, Allan, "Division and Explanation in Aristotle's Parts of Animals" (1991). *The Society for Ancient Greek Philosophy Newsletter*. 241.

<https://orb.binghamton.edu/sagp/241>

This Article is brought to you for free and open access by The Open Repository @ Binghamton (The ORB). It has been accepted for inclusion in The Society for Ancient Greek Philosophy Newsletter by an authorized administrator of The Open Repository @ Binghamton (The ORB). For more information, please contact ORB@binghamton.edu.

Division and Explanation in Aristotle's *Parts of Animals*

1. THE IMPORTANCE OF DIVISION IN ARISTOTLE

The nature and proper methods of logical division, διαίρεσις, are important concerns in at least four of Plato's later dialogues, and reflections on the process may even have led Plato to a revised conception of the very nature of a Form. The place of division in Aristotle's *Topics* - both in the organization of some of its materials and as the method for seeking definitions which many of the *topoi* are designed to regulate - suggests the importance διαίρεσις must have had in the Academy,¹ as does the Epicrates fragment and Aristotle's criticism of alternative views of the nature or purpose of division in *Prior Analytics* I.31, *Posterior Analytics* II.5 and II.13, and *Parts of Animals* I.2-3.

But, as David Balme has argued,² Aristotle criticizes these alternative views not in order to reject division but to *reform* it. When he criticizes those who think the production of a definition by division constitutes a deduction, or even demonstration, of that definition, he reminds us that division is nonetheless *useful*, in the establishment of definitions, and appears to devote most of a long chapter (*APo.* II.13) to the central role of division in "hunt[ing] out what is predicated in what a thing is" (96a22), which *may* be a reference to the definitions that feature as first principles in demonstrations.³ And when Aristotle rejects dichotomous division as a way of defining εἶδη in *PA* I.2-3, he replaces it with division by multiple differentiae simultaneously, and argues that that procedure successfully avoids the criticisms dichotomous division falls prey to. Finally, in *Metaphysics* Z.12, he indicates how one of his reforms of division - the rule that one must divide "by the differentia of a differentia",⁴ e.g. *footed* by *split-footed*⁵ and not by *feathered* - allows at least a partial resolution of the problem of the unity of definition.

Balme has even argued - controversially but not entirely implausibly - that definitions by division are involved in the solution to be found in *Metaph.* H.6 of the unity problem for the *object* of definition. And Pierre Pellegrin has insisted that the very concepts of γένος, εἶδος and διαφορά which feature so centrally in the discussions of definitions and much else throughout the corpus, derive their precise logical relationships to each other from their place in the divisional process. These interpretative claims have been challenged, and alternative readings of some of the passages I've mentioned have been given, but these controversies, currently unresolved as they are, only underscore the fact that the topic of the place of division in Aristotle's logic, metaphysics, and biology is an important one, and warrants more study.

The biological case is perhaps the most perplexing. For the critique of dichotomous division in *PA* I.2-3 ends, as I've said, with the firm endorsement of a method argued to *work* where dichotomous division does not. In seeking a definition of an ἄτομον εἶδος (such as sparrow or crane), Aristotle instructs us to divide, not the γένος *Animal* by one differentia at a time, but a commonly recognized γένος of animals (in this case Bird), marked out by multiple differentiae, by dividing these differentiae simultaneously, each as many times as necessary to reach the definition sought. In *PA* I.4 he even goes on to explain how to select the γένη from which to start the process.

Thus the method, and now to work, one might think. But, as Balme put it in 1976: "The puzzle is, what happened to diaeresis after that? Aristotle makes no further use of it in biology; and no *genos* or *eidos* is

¹Cf. Cherniss 1944 and Tarán 1981.

²Balme 1987; cf. Pellegrin 1988, ch. 1.

³Useful: *APr.* I.31 46a31-2, *APo.* II.13 96b25-26 (cf. II.5 91b28-32). In fact, it is "only" (96b35) with division that one can ensure completeness. Alternatively, II.13 may be concerned with pre-causal definitions (cf. Ross ad loc.).

⁴1038a9-10; cf. *PA* I.3 643b17, and Balme 1972: 102-103, 117 and 1987: 69, 73.

actually defined." Or, to put the question more neutrally, *does* division have any role in the biology and, if so, is that role connected in any way with the reforms of division presented in *PA* I.2-4, and more generally, with the discussions of division in the logical and metaphysical writings?

Now, I don't pretend to have the answers to the larger of these questions. I don't think anyone does, yet. But work done since 1976, especially by Balme, Pellegrin, and James Lennox, has moved us closer to solving the puzzle, and I would like, in this small paper, to add one more piece to that eventual solution.

2. SOME RECENT WORK

In a recent essay on "The Reforms of *Diaeresis*",⁶ Balme suggested that the reforms summarized in I.2-4, with their focus on sameness, difference, and sub-division of differentiae, require a precise grasp of each of the differentiae that might appear in a divisional definition of animal εἶδη prior to the production of those definitions, and that the *Historia Animalium* (chronologically the last of the biological treatises) was conceived as the vehicle for achieving that grasp. *HA* would thus not itself contain definitions by division, but would make such definitions possible. Aristotle never reached the stage of providing such definitions, Balme suggests, and "we may indeed doubt whether [he] maintained this aim when his experience as a naturalist increased", since he would have realized that "there is no end to the recognition of fresh significant differentiae". But the "unfinishable" character of the collection and analysis of differentiae would not preclude the use of "the correct identification and grouping" of differentiae collected, which would "[lead] directly to the fundamental causes of animals' attributes and differences. This might well have seemed the best way towards a methodical *apodeixis* of living nature" (80).

But if Balme is right, it would seem that the reforms of division have now become useless - *unless* division so reformed plays a role in the search for and/or organization of scientific *explanations*. In two recent papers, James Lennox has argued that division indeed plays such a role, specifically in the *pre-explanatory* stage of Aristotelian science. In a paper significantly entitled "Divide and Explain" (1987), Lennox, as he summarized:

develops Balme's suggestion that *APo.* II.14 is a key text in solving the puzzle of the relationship between division and demonstration in Aristotle's scientific method. Central to the theory of the *APo.* is the articulation of a distinction between incidental and unqualified understanding. Unqualified understanding requires locating the widest kinds to which differentiae belong universally: this allows explanations of why sub-kinds of these widest kinds have the differentiae in question, and identifies those features which are either essential to the kind, or explicable as consequences of its essence.⁷

To use an example from *APo.* I.5, isosceles triangles have an angle sum equal to that of two right angles because they are triangles; we understand the former connection fully only when we understand why triangles *as such* have that attribute. From that we explain why, say, isosceles triangles do. Thus *APo.* II.14 instructs us to seek, for any differentia to be explained, the widest class to which it belongs, and to do so by "selecting from ... the divisions" (98a1-2). This procedure, as Lennox puts it, "assumes a set of divisions of a subject domain ready at hand, and as the examples suggest, organized along Aristotelian lines" (1987: 98). Those divisions will be the source both of the predicates of the propositions to be demonstrated and of their subjects, as we look up and down the relevant divisions for the widest class to which each predicate applies universally. Division thus helps "direct, or redirect, inquiry to the appropriate level for...explanations of...primitive predications" (99). Division as such neither supplies the true propositions nor identifies the actual causes - empirical inquiry of specific sorts is required for that - but it organizes the former and facilitates the latter. Research into *HA* which Lennox and I did in collaboration, he goes on to argue, shows that this "downward division/correlation methodology" is much "like what we find in" that treatise (99).⁸

⁵"For split-footedness is a certain sort (τις) of footedness" (1038a15).

⁶Part I of Balme 1987.

In a subsequent paper⁹ Lennox connects both the prescription of *APo.* II.14 and the practice of *HA* with the account in *APr.* I.27-31 of, as Aristotle puts it, "how we may ourselves always be supplied with deductions about what is set up, and the route by which we may obtain the principles concerning any particular subject".¹⁰ Although, as Aristotle says, "division by means of kinds is only a small part of the procedure that has been described" (45a31-32), Lennox is surely right that it is an indispensable part.

Division thus plays an important role in the pre-explanatory stage of science. But what about the explanatory stage itself? In his papers, as I noted, Lennox suggests that division is involved in explanation of why sub-kinds of a kind that possess a feature primitively also possess that feature, but as he notes this is at best "partial demonstration".¹¹ What of unqualified demonstration, proper explanation? Is division involved there? That's our question.

3. DIVIDING THE CAUSES

Once we have the connections to be explained at the proper level of generality, and are ready to search for the causes of these connections, is division of any help? There is at least one passage in *PA* I which suggests that it might be:

ἀναγκαῖον δὲ πρῶτον τὰ συμβεβηκότα διελεῖν περὶ ἕκαστον γένος, ὅσα καθ' αὐτὰ πᾶσιν ὑπάρχει τοῖς ζῴοις, μετὰ δὲ ταῦτα τὰς αἰτίας αὐτῶν πειρᾶσθαι διελεῖν. (645b1-3)

It is necessary first to divide the attributes pertaining to each kind which are present in all the animals [of that kind] in virtue of themselves, and after that to try to divide their causes.

Now I have translated διελεῖν as "divide", but the word could also be translated "distinguish", in the sense of "set out separately". Peck has "describe", Louis has "analyser" and "discerner"; Balme, on the other hand, has "divide off", and Pellegrin, in his discussion of this passage,¹² insists on "divide". If "divide" is not translated, this precept (as I'll call it) would be pretty much equivalent in content to the following general methodological remark in at *HA* I.6, with which it has some striking verbal similarities:

δι' ἀκριβείας δ' ὕστερον ἐροῦμεν, ἵνα πρῶτον τὰς ὑπαρχούσας διαφορὰς καὶ τὰ συμβεβηκότα πᾶσι λάβωμεν. μετὰ δὲ τοῦτο τὰς αἰτίας τούτων πειρατέον εὐρεῖν. (491a9-11)

We will speak in detail later, in order that we may first grasp the differences and attributes which are present in all. After that we must try to find their causes.

I think, however, that the stronger reading is the more likely one, for two reasons. First, the precept appears as part of a discussion of an issue that spans three passages, one each in chs. 1, 4 and 5 of *PA* I; these passages

⁷Gotthelf and Lennox 1987, Introduction to Part II: 66-67.

⁸For discussion of the aims of *HA* see, in addition to Lennox 1987, Balme 1991, Gotthelf 1988, and Lennox 1991.

⁹Lennox 1991.

¹⁰43a20-22, tr. Smith.

¹¹Demonstration κατὰ μέρος. For references, and a discussion of my reservations about Lennox's view of this, see Lennox 1991.

together make a case for beginning explanation at a generic level and moving downward; Aristotelian division of differentiae, as we'll see, is the natural mechanism for that downward movement. Secondly, the organization of much of the explanation across PA II-IV is consistent with the precept, *and illuminated by it*, if διελεῖν is translated "divide". In what follows I'd like to develop these points, and make a case for the view that Aristotelian division does play a certain role in Aristotelian explanation.

(a) starting explanation at the generic level: PA I

The three PA I passages I have in mind are: ch. 1, 639a15-b5; ch. 4, 644a12-b15 (most of the chapter); and ch. 5 645b1-14 (which begins with our precept). These three passages hang together. The I.4 passage continues an aporia introduced in the I.1 passage; the I.5 passage resolves that aporia, referring in the process back to the two preceding passages. Let's look at them in order.

PA I.1 announces itself as concerned with the methodological principles (ῥοι, 639a13) that ought to be used in evaluating "the method of demonstration" in inquiries about nature.¹³ At first we don't actually get principles, we get questions, the proper answers to which will be the principles. I reproduce Balme's translation of the first question (with εἶδος however translated "form" rather than "species"):

Should one take each *being* singly and clarify its nature independently, making individual studies of, say, man or lion or ox and so on, or should one first posit the attributes common to all in respect of something common? For many of the same attributes belong to many different kinds of animal, for example sleep, breathing, growth, wasting, death, and any other affections and conditions of this sort (for at present we are not in a position to speak of them with clarity and precision). If we do speak of the animals severally, it is plain that we shall often be saying the same things about many of them. For each of the above attributes belongs to both horses and dogs and men, so that if one refers to each of their attributes one will have to speak repeatedly about the same ones - all that are the same in different forms of animal which having no differentia themselves. On the other hand there are no doubt others which, although they have the same designation, differ by the formal differentia. Animal locomotion, for example, is evidently not one in form, for there are differences between flying, swimming, walking, and creeping. Therefore [we have an aporia]. (639a15-b5)

It has often been pointed out that the first side of the aporia cannot merely be recommending brevity.¹⁴ The kind of repetition Aristotle complains of is just the sort discussed in *Posterior Analytics* I.5, as a case of failing to have grasped the *actual* cause, and to that extent failing to give proper demonstration: to give separate proofs, for instance, that isosceles, equilateral, and scalene triangles, respectively, have an angle sum equal to two right angles is not to see that it is in virtue of the feature that makes them *triangles*, and not of the equality or non-equality of their sides, that they have that angle sum. But Aristotle does not make the connection with the *APo.* theory explicit, and the issue is simply presented as an aporia.

At I.4 it is taken up again. Here the case for starting not with common attributes of the broad kinds (such as Bird), but straightaway with the attributes of the "indivisible forms" (such as sparrow and crane), is given a metaphysical twist: doing it that way, we get our subjects as close as scientifically possible to the actual οὐσίαι - the metaphysically *proper* subjects (644a29-33¹⁵). Again, the counter-argument is repetition, now not

¹²1986: 43, 156.

¹³The verb δείκνυμι is general enough to permit the list to include principles that pertain to the organization of information that occurs at the ὅτι stage of inquiry, as well as principles pertaining to the type of explanation, and the noun ἰστορία, used as it is by Aristotle either for the ὅτι stage alone or for the entire scientific enterprise from start to finish, positively suggests it.

¹⁴E.g. Balme 1972, Kullmann 1974, Lennox 1987. For an interesting discussion of the historical background to the question, see Kullmann 1974: 12.

only its length but its "virtual absurdity" (which may be an allusion to explanatory inadequacy). Here he proposes a solution:

Perhaps then the right course is to speak of some affections in common by kinds (γένη), whenever the kinds have been satisfactorily marked off by popular usage and possess both a single nature in common and forms not far separated in them - bird and fish and any other that is unnamed but like the kind embraces the forms that are in it; but wherever [the affections] are not like this [i.e. common,] to speak of particulars, for example about man or any other such.¹⁶

The presentation of the aporia in I.1 ended with a question. Here, the alternative of starting with attributes possessed in common across γένη is endorsed, although tentatively (ἴσως, b1), and elsewhere in the chapter an apparatus for dealing with the I.1 objection to going this route is introduced. The I.1 objection was that some attributes which are possessed in common exist in the animals in different forms. When Aristotle, at the opening of the chapter, explained the notion of common attributes that differ in the more and less, he introduced a way of dealing with at least a set of cases that meet that description without abandoning the virtues of starting at the generic level:

For all kinds that differ by degree and by *the more and the less* have been linked under one kind, while all that are analogous have been separated. I mean, for example, that bird differs from bird by *the more* or by degree (one is long-feathered, another is short-feathered) but fishes differ from bird by analogy (what is feather in one is scale in the other).¹⁷

But now let's consider why starting at the generic level *is* a virtue in these cases: what, exactly, would be repeated if we only gave separate explanations for each variation of the common attribute? The only answer can be that the common aspect of the varying attributes is explained by the same thing in each case, a thing which would be said many times if it isn't said all at once for the entire kind. We could, for instance, explain why long-feathered birds have long feathers, and short-feathered birds short feathers. In both cases what would be repeated must be the explanation of why they each have feathers. Feathers are something they have in virtue of being birds, not in virtue of being the sort of birds they are. To that extent, it's the same argument as in the case of the angle sum of the three types of triangles. But the difference is also instructive, and spells out a pattern of explanation Aristotle must have had in mind. In the triangle case, the feature in question, having an angle sum of two right angles, is possessed identically by the three types of triangles, and nothing is learned by moving down to that level. But, in the case of birds, while we must start at the generic level, something further *is* learned when one moves from understanding why all birds have feathers (say because they're needed to lift their weight in flying) to understanding why e.g. eagles have long feathers but sparrows have short ones (perhaps because of their *particular* weights and the *type* of flying their *particular* feeding needs require).

So, the pattern I am suggesting is as follows: Explain the *differences* in some generic attribute across sub-kinds of a large kind in some generic attribute by reference to the *differences*, across these sub-kinds, in the features which explain the presence of that generic attribute in the large kind. Now, this pattern is not actually spelled out here, since the focus of the chapter is not on explanation. And in principle nothing prevents there being cases where this isn't so: certain variations in wings, for example, might just be used say for defense

¹⁵For Balme's revision of his 1972 reading, translation and note for this passage, see Longrigg 1977.

¹⁶Readers of the Loeb *PA* should note that Peck rewrites the text of this passage. Balme translates the MSS and I have followed him. I take ὅσα δὲ μὴ τοιαῦτα (b6) to modify the same subject the coordinate τὰ μὲν κατὰ γένη κοινῇ (b2) modifies, namely the *attributes*, referred to as ὑπάρχοντα at a26 and as πάθη at a34, and so interpolate as I do; but it *could* be modifying γένη.

¹⁷644a16ff. Cf. *HA* I.1 486a15-487a10 for a fuller discussion of the sorts of samenesses and differences in animal features, and the sorts of "more and less" relationships; the parallel examples for "same by analogy" at 486b19-21 and "differ by analogy" at 644a21-22 make clear that they are the same relationship (described from two different standpoints).

instead of for a distinct type of flying. But it would certainly be reasonable to expect our pattern to be the predominant one, and that, as we will see, is most often the case across *PA* II-IV.¹⁸

This discussion in *PA* I.4 is followed by the famous exhortation to biological study which begins chapter 5, evidently inserted by some editor (it has no connecting particle). Our precept comes next but the sequence is not a logical one and they cannot have been written one to follow the other. The lines immediately following the precept *are* connected with it, and tie it right back to the I.4 passage, referring to it twice as it does. I quote:

It is necessary first to divide the attributes pertaining to each kind which are present in all the animals [of that kind] in virtue of themselves, and after that to try to divide their causes. Now *we have said before* that many belong in common to many animals, some simply (for example feet, feathers, scales, and affections too in the same way), but others analogously. (By 'analogously' I mean that some have lungs while others have not lungs but something else instead which is to them what lungs are to the former; and some have blood while others have the analogous part that possesses the same capability (δύναμις) as blood does for the blooded.) To speak separately about each particular will, *as we said before*, often result in repetition when we speak of every attribute: the same ones belong to many. Let this then be determined so. (645a36-b14; tr. Balme, with opening sentence modified and emphases added)

Here too we are instructed to start with common features and to move downward to more specific ones. There is one difference, which we will return to later, namely that analogy is now explicitly identified as a type of commonality - blood and its counterpart in the bloodless animals (or lungs and gills), although not common ὁπλῶς, *are* common by analogy, because they possess the same δύναμις (at least at some level of generality). This does not contradict the spirit of the early discussions, although they were restricted to the paradigm case of simply common attributes, those possessed uniquely across a single γένος; for we can either divide the common function directly, or divide the analogous group of simply common features into the individual cases, and then divide each of the common feature down in the way required. But the addition of features common only by analogy will prove very important in understanding the discussions in *PA* II-IV, where sometimes different parts which perform the same function (e.g. eyelids, nictating membranes, and an unusually hard eye-material) will be grouped and explained under one common heading: eye-protection (657a26).

This passage in I.5 may also remind one of the passage in *APo.* II.14 where Aristotle explains that in looking for the proper subject of propositions to be explained - the widest class possessing a given feature - that subject will sometimes be a γένος (e.g. bird), sometimes a group that is not a γένος but nonetheless shares common features (e.g. the horned animals), and *sometimes* a group which shares only analogous features (such as pounce [a rigid structure in some cephalopods], fish-spine, and bone); they should be treated together because the common function they all perform will either explain, or be explained by other features they all possess in common.¹⁹

We began the survey of these three passages in the attempt to better understand the I.5 precept to first διελεῖν the essential attributes then try to διελεῖν their causes. One the reading of it that arises from considering it in connection with the related passages in I.1 and I.4, it says, in effect: "One should start with larger divisible kinds and their common, divisible attributes. For each common attribute, state its (divisible)

¹⁸I referred in the previous sentence to the aims of this chapter. In fact, there seem to be two aims, and it would be useful to connect them, as I have not yet been able to do. One aim, which I noted in my introduction, is to explain how to select the kinds from which the reformed division described in the previous chapter should proceed; the second is to resolve the aporia developed in the first chapter. The two aims are obviously connected, and since one bears on division and the other, in the end, on explanation, understanding the connection should contribute importantly to the wider aims of this paper.

¹⁹Perhaps only analogously in common, if *APo.* II.17 99a15 applies: "And things which are the same by analogy will have their middle terms the same by analogy too".

cause. Then divide the common attribute, identifying for each of its sub-divisions the widest sub-class (of the large kind) that possesses it. Then, wherever possible, seek the causes of these more specific attributes by dividing the cause of the common attribute. Since many divisible attributes *are* possessed in common across large kinds (and sometimes even more widely), we mustn't in those cases, on pain of repetition and explanatory inadequacy, start with the indivisible forms. Let this then be determined so."

If this reading is right, we now have a way in which division is used in explanation - not just at the pre-explanatory stage, but in the laying out, perhaps in some cases even in the very discovery, of the explanations themselves. There are various ways to test this reading. One way is to see if the pattern described can be found in the actual explanations offered in the biological corpus.

(b) The organization of explanations in PA II-IV

I think in fact that the pattern recommended by our I.5 precept, so interpreted, pervades PA II-IV. I've suggested that the precept as worded focuses on a paradigm case but is meant to be taken more broadly. The paradigm case is one in which we have a proper kind, such as Bird, and a set of attributes possessed by animals of that kind in virtue of itself (feathers, beaks, inward-bending two-leggedness, etc.). Each such attribute is given a causal account (involving, typically, both final and material factors). Each of these attributes is divided into its various forms (typically according to more-and-less variations), and each distinct form of attribute is explained from a corresponding variation in the generic causal factors (i.e. from the *particular* nature and needs, and the *particular* materials available in the construction of, the sub-group of birds that possess it). But, as we've seen, the immediately following lines in I.5 (as well as the related passage in I.4, and the discussion in *APo.* II.14) allow that the feature being explained may only be analogously common, and the subject class need not be a proper kind, but any grouping which correlates with a common attribute.

These extensions are important in understanding PA II-IV, because that treatise is organized not primarily by animals kinds but by animal parts. The subject class for each part tends simply to be the widest class of animals which possess that part, and that class may or may not form a kind. To illustrate my claim that the pattern is pervasive, I've chosen three chapters from different parts of the study, covering a variety of cases: the discussion of marrow, a uniform part, in II.6, the discussion of eye-coverings, a non-uniform part (or set of analogous parts), in II.13, and the discussion of external parts of birds, in IV.12.

The chapter on marrow is one of a series of discussions of uniform parts in II.2-9. By the time marrow is reached, there have already been discussions of blood, lard, and suet (two fatty materials, one earthier than the other). The chapter opens with an argument for the material nature (and cause) of marrow: it is concocted blood. Differences in the degree of fattiness of marrow across different animals are noted, and correlated with the presence of lard or suet in these animals. Then differences in quantity of marrow from one animal to the next are noted, and correlated with different strengths and densities of bone. Then we get causal explanation. The function of marrow (as evidenced by its source in blood and its location in bones) is established: it is the nourishing of bones. Since smallness of quantity of marrow correlates with strength and density of bone, the explanation is simple: a variation in function - "the nourishing of strong, dense bones" - explains the difference in quantity - "small amount of marrow". Similarly, the correlation of differences of fattiness of marrow with presence of lard or presence of suet points to the cause of those differences: since lard and suet are themselves concocted blood, and their relative presence has already been established to be a function of the density of the blood being concocted, differences in density of the blood explain the different degrees of fattiness of marrow.

The pattern? Identify the part, determine its general cause (involving both material and final factors), divide the part along the different more-and-less dimensions it is found to vary in. Correlate with those variations, variations in the causal factors, and establish that variation in the causal factors is in fact responsible for variation in the part, thereby "dividing the causes".

And the eye-coverings in II.13? The pattern is much the same. I quote the entire chapter in my own

translation to have it before us.

Humans and birds and fourfooted animals, both live-bearing and egg-bearing, have protection for their eyes. The live-bearing ones have two eyelids, with which they also blink. The heavy birds and some others, and the egg-bearing fourfooted animals, close their eyes with the lower eyelid, but birds blink with a membrane from the corner of the eye.

Now the cause of their having this protection is that eyes are moist in order that they may naturally see sharply. For, if they were hard-skinned, they would be less subject to damage by outside things striking them, but then they would not be sharpsighted. So, for the sake of this, the skin around the pupil is fine, and for safety there are eyelids. And because of this they all blink, and humans most of all. They all do so in order that the eyelids may prevent things from striking the eyes (and this is not due to choice but produced naturally); humans do so most often because they are the most fine-skinned.

The eyelid is enveloped with skin; that is why neither the eyelid nor the foreskin will grow back together - because the skins are lacking in flesh.

Birds which close their eyes with the lower eyelid, and the egg-bearing fourfooted animals, close them in this way because of the hardness of the skin around the head. For in the heavy, feathered animals, because they are not fliers, growth of wings has been turned into thickness of skin. That is why they too close their eyes with their lower eyelid, while pigeons and the like do so with both. The fourfooted egg-bearing animals, on the other hand, are horny-scaled, and these scales are all harder than hair; so their skins are also harder than ordinary skin. The skin around their heads, then, is hard, and that is why they do not have an eyelid there; but the skin lower down is fleshy, so that there they have an eyelid that is fine and extensible. The heavy birds, though, blink not with this eyelid but with their membrane, because the former's movement is slow while quick is what's needed and the membrane is that. And they blink from the corner of the eye alongside the nostrils because it is better for things of their nature to be from one source, and they have a source where they attach to the nostrils, and the front is more a source than the side.

The fourfooted egg-bearing animals do not blink in the same way because it is not necessary for them, being earthbound, to have their eyes moist and their sight accurate; but for birds it is necessary, for they use their sight for seeing at great distances. That is why the crooktaloned birds are also sharpsighted (for they sight their food from above, and that is why they, most of all birds, fly to great heights). Birds that are earthbound and not able to fly, such as domestic fowl and the like are not sharpsighted, for nothing in their mode of life demands it.

Fishes and insects and hardskinned animals have different sorts of eyes, but none of them has an eyelid. For the hardskinned animals can't have it at all: the eyelid's use requires action that's quick and thus by skin. But instead of this sort of protection, they are all hard-eyed; it's as if they were seeing through an eyelid that was directly attached. Since they must see less sharply because of the hardness, nature made the eyes for insects movable, and for hardskinned animals even more so (just as some of the fourfooted animals have movable ears), in order that they might see more sharply by turning toward the light and receiving its rays. Fishes, on the other hand, are moist-eyed, for, moving around as much as they do, they must use their sight from afar. Now, in the case of terrestrial animals, the air is easy to see through. But in the case of fishes, since water is a hindrance to seeing sharply and does not, as the air does, contain many things that can hit the eyes - because of this they do not have an eyelid (for nature makes nothing without a point); but for dealing with the water's thickness they are moist-eyed.

The attribute being explained is "eye-covering". Aristotle begins by identifying the widest class of animals which possess any sort of eye-covering. He then briefly divides the types of eye-coverings. In the second paragraph he gives the cause of the possession of eye-coverings as such, identifying both final and material factors. This cause explains blinking, and he immediately notes a difference in blinking between man and other animals and explains it by reference to a difference in the causal factors. He then returns to the differences in eye-covering and goes on to "divide the causes", explaining the *differences* in eye-coverings across groups of animals by reference to the *differences*, among these groups, in the general features which explain the presence of eye-covering as such. "Divide the attribute ... then try to divide its cause."

The external parts of birds are grouped and studied together in IV.12. Birds do, of course share certain generic external parts with other animals; some of these have already been mentioned in that connection, and others are noted in the course of this chapter, but birds do have a distinctive outer appearance and shape, which is the source of their initial grouping as a kind (644b7-15; cf. Balme 1972 *ad loc.*), and a single common nature associated with aspects of that appearance which validates that initial grouping (644b3). In fact, Aristotle begins the chapter by making the case for studying the birds separately: "In the birds, the differentiation is in the excess and deficiency, and with respect to the more and less, of their parts; for some of them are long-legged, others short-legged, and some have a broad tongue, others a narrow one, and similarly for the other parts. And they have few parts among themselves which differ [significantly], but when compared with the other animals they do differ [significantly] in the form (*μορφή*) of their parts." Having said this, Aristotle lists a number of external parts distinctive (*ἰδιώ*) to birds, including their feathers (and in general their characteristic wings), their beak, their inward-bending two-leggedness, and their distinctive breast, along with features they have in common with other animals, such as "a neck which sticks up" (692b20) and other generic features of their "trunk". Some of these distinctive parts are explained in terms of the basic nature of a bird ("the οὐσία in the case of the bird includes being blooded...and being a flier is in the οὐσία of a bird" (693b6, 13; cf. Gotthelf 1985: 43ff.) Differences among the different types of bird (grouped by correlated features, not by indivisible bird forms such as sparrow and crane) are then explained by reference to differences in e.g. mode of flight, type of food, mass of body, etc., that is, by differences in the broad general factors in the nature of a bird, both material and final, which explain the distinctive features of a bird. Here's just one example. Earlier on, in the discussion of mouths of blooded animals, in III.1 Aristotle had identified the functions that the beak, which substitutes for both lips and teeth, perform: feeding and defense. Now, in IV.12, having explained how variations in neck size is explained by variations in the animal's mode of life (*βίος*, roughly its habitat and corresponding type of food), he says:

Beaks also differ according to the mode of life. For some are straight, some curved; straight wherever it is simply for eating, curved wherever it's a flesh-eater, for it is useful towards overpowering its prey, and it must get its food from animals, most often by force. Those whose mode of life is marsh-based and are herbivorous have broad beaks, for such a beak is useful for digging and pulling up their food and for cropping plants. Some of them, however, have a long beak, just as they have a long neck, because they get their food from some depth.... (693a11-19, tr. mine with borrowings from Peck)

This chapter is not as simply organized as the others we've discussed, perhaps because of the complexity of the subject-matter, perhaps also because, as some peculiar features of IV.10-end suggest, it may be very early; but the pattern is still prevalent. One can open *PA* II-IV more or less at random and light immediately upon such a pattern of argument.

Now, granted that differences in generic attributes are explained, for the most part, by differences in the causes of those attributes, why should we speak of these hierarchical relationships as *divisions*? For the I.5 precept to be recommending this pattern of explanation, as I have claimed it does, I will have to show that these sub-differentiations, both of the features that turn out to be explained, and of those that turn out to do the explaining, count as divisions. I think we have two criteria to go on. First, we must ensure that the sequence of attributes down which the explanatory progression proceeds fits the relevant Aristotelian reforms of Academic division, so that the process would count as a division for Aristotle. Secondly, we can see if any of the reasons Aristotle gives for the usefulness of division in other contexts. On the first criterion, I think we get a positive answer. Although the reforms of division are focused on definition, they apply more generally to the sorts of pre-definitional divisions we have evidence Aristotle himself had prepared²⁰. Balme 1987 isolated three reforms: (i) distinguishing the categories of *γένος*, *εἶδος*, and *διαφορά* from each other, viewing a *γένος* not as a separate entity but as a potentiality that exists only in its different *εἶδη*, an abstraction or determinable; (ii) insisting on *successive* differentiation - dividing only by "the differentia of a differentia"; and (iii) requiring that division be by multiple differentiae simultaneously. The first two reforms obviously apply to the cases of differentiation we have looked at. The subject of study is the immense diversity of animals in the natural world,

²⁰cf. Barnes 1975: 240.

not some independent realm of kinds that are to be "interwoven" in some logical manner. The ontological distinction between generic potentialities or determinables and formal actualities or determinations is fully realized in the doctrine of the more-and-the-less which permeates the biology. And the explanatory pattern I've described requires that the divisions be by differentia of a differentia, since there has to be entailment from the bottom up if the cause of the lower differentia is to be a form of the cause of the higher differentia. The multiple differentiae reform is meant to apply primarily to definitions of whole animals, but as Pellegrin has observed, it should apply as well to all those animal parts that require more than one line of division to characterize them. In fact, as I've indicated, the "cause" which needs to be divided in biological cases is itself usually a combination of material and final factors, and the divisions of the materials and of the functions are of course distinct axes of division. So the sequences of attributes Aristotle uses in his explanatory progression fit the Aristotelian reforms of division.

But are they drawn from, or do they themselves represent, actual *divisions*? Are these lists actually organized according to these divisional rules and organized into groups of "divisions"? Is there something *PA* II-IV is based on, or embodies, which could count as the "Divisions" (capital D) of which, say, *APo.* II.14 speaks? The answer here too seems to be yes, if we consider what the usefulness of these divisions is. We have already commented on the entailment relationship, from the bottom up, that is crucial to make the explanatory scheme work; the same relationship is commented on in *Metaph.* Z.12 in connection with definition, and said to be ensured by taking "the differentia of a differentia". One can do that without pre-existing division tables, but they facilitate the process. When *APo.* II.13 speaks of usefulness of division it is in the role of ensuring (in fact it is the "only" thing which ensures) "completeness". That has a certain meaning in definition, but in explanation, I take it the value of a complete division, reflecting the whole of one's survey of the attributes in one's realm of study, is to give one an exhaustive supply of attributes to be explained and attributes that do the explaining. The all-and-only correlations Aristotle draws on in the course of producing his explanations depend on completeness of a certain sort, that the organization of attributes by division best ensures.

For all these reasons I am inclined to think that *PA* II-IV embodies a use of Aristotelian division at the *explanatory* level, not previously discussed by scholars, a use which is reasonably encapsulated in the I.5 precept that "it is necessary first to divide the attributes pertaining to each kind which are present in all the animals [of that kind] in virtue of themselves, and after that to try to divide their causes."

My thesis, and the arguments I offer in its defense have various implications, and raise several interesting questions in my own mind, especially about the relationship of Aristotle's thought to Plato's, but I think it best to stop at this point, and save them, to be brought in during our discussion, in case they are relevant. At this point, I'd much rather have your comments than go on talking.²¹

Allan Gotthelf
Department of Philosophy
Trenton State College
Trenton, NJ 08650

²¹I am sorry that, due to some personal difficulties, I was unable to make this paper available in advance of the session. I would like to thank Robert Bolton, Catherine Culver, David Depew, and James Lennox for helpful discussion of some of these issues; none of them has seen the paper, however, and the responsibility for its shortcomings is entirely mine. [I would also like to thank those who participated in discussion at the San Francisco session, and Tony Preus for including the paper in the Fall mailing. I would be most interested to receive additional comments from Society members on this paper and its issues.]

BIBLIOGRAPHY

- Balme, D.M. 1972. *Aristotle's De Partibus Animalium I and De Generatione Animalium I (with passages from II.1-3)*. Oxford.
- Balme, D.M. 1987. 'Aristotle's use of division and differentiae', in Gotthelf and Lennox 1987, pp. 69-89.
- Balme, D.M. 1991. *Aristotle, Historia Animalium, Books VII-X*. Prepared for publication by A. Gotthelf. Loeb Classical Library. London and Cambridge, Mass.
- Barnes, J. 1975. *Aristotle's Posterior Analytics*. Oxford.
- Cherniss, H. 1944. *Aristotle's Criticism of Plato and the Academy*. Baltimore.
- Ferejohn, M. 1991. *The Origins of Aristotelian Science*. New Haven.
- Gotthelf, A. 1985. 'Notes toward a study of substance and essence in Aristotle's *Parts of Animals* II-IV', in *Aristotle on Nature and Living Things: Philosophical and Historical Studies presented to David M. Balme on his seventieth birthday*, ed. A. Gotthelf (Pittsburgh and Bristol, 1985), pp. 27-54.
- Gotthelf, A. 1988. 'Historiae I: Plantarum et Animalium', in *Theophrastean Studies*, eds. W.W. Fortenbaugh and R.W. Sharples. Rutgers Studies in Classical Humanities III. New Brunswick, N.J., pp. .
- Lennox, J.G. 1987. 'Divide and explain: the *Posterior Analytics* in practice', in Gotthelf and Lennox 1987, pp. 90-119.
- Lennox, J.G. 1991. 'Between data and demonstration; the *Analytics* and the *Historia Animalium*, in *Science and Philosophy in Classical Greece*, ed A.C. Bowen (New York, 1991).
- Longrigg, J. 1977. Review of D.M. Balme: *Aristotle's De Partibus Animalium I and De Generatione Animalium I (with passages from II 1-3)* (Oxford 1972), *Classical Review* n.s. 27, pp. 38-39.
- Pellegrin, P. 1986. *Aristotle's Classification of Animals: biology and the conceptual unity of the Aristotelian corpus*, tr. A. Preus. Berkeley. (Rev. edn. of *La Classification des animaux chez Aristote: statut de la biologie et unité de l'aristotélisme*. Paris 1982.)
- Pellegrin, P. 1987. 'Logical difference and biological difference: the unity of Aristotle's thought', in Gotthelf and Lennox 1987, pp. 313-338.
- Tarán, L. 1981. *Speusippus of Athens: a critical study with a collection of the related texts and commentary*. Leiden.