# Explanation and teleology in Aristotle's Philosophy of Nature

Leunissen, M.E.M.P.J.

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Καὶ γὰρ ἐν τοῖς μὴ κεχαρισμένοις αὐτῶν πρὸς τὴν αἴσθησιν κατὰ
τὴν θεωρίαν ὅμως ἡ δημιουργήσασα φύσις ἀμηχάνους ἡδονὰς
παρέχει τοῖς δυναμένοις τὰς αἰτίας γνωρίζειν καὶ φύσει φιλοσόφοις.

Aristotle, *PA*.I.5, 645a7-10

Cover:
The Youth of Aristotle, c. 1875
Charles Degeorget (1857 - 1888)
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Shown at the Salon of 1875

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**TABLE OF CONTENTS**

# INTRODUCTION

Why do organisms reproduce? Why do birds have wings? Why do neither snakes nor stars have feet? Why do most of the hoofed life-bearing animals have horns (but not all of them)? Why do human beings build houses, or walk after dinner?

For Aristotle, questions such as these go to the heart of natural philosophy, which is the study of the coming to be and presence of beings that have their own internal principle of change and rest. Throughout his lifetime, Aristotle was deeply committed to investigating and explaining natural phenomena, which is reflected in the large amount of natural treatises we possess today. Among these treatises, Aristotle's *Physics* is most fundamental. In this treatise, Aristotle lays out the general theoretical framework for his natural philosophy, defining notions such as nature, motion, causation, place, and time. In the other treatises, Aristotle explores more specific problems related to the study of natural beings, like coming to be and passing away (in *De Generatione et Corruptione*), the nature and motion of the elements (in *De Generatione et Corruptione* and the second part of *De Caelo*), the motions and features of the heavenly bodies (in the first part of *De Caelo*), atmospheric causes and changes (in *Meteorologica*), the notion of soul and its dependence on natural bodies (in *De Anima*), and finally, the causes of the coming to be and presence of living beings and of their parts and motions (in the biological works).

What unites the questions explored in these natural treatises, exemplified by the questions above, is that they are predominantly questions asking for the reason why, or, as Aristotle puts it, questions asking 'for the sake of which'. By posing this specific kind of why-question, Aristotle is inquiring after the *function* served by the presence, absence, or material differentiation of a certain natural feature, or after the *goal* for the sake of which some animal motion or natural process takes place. According to Aristotle's understanding of scientific knowledge, the answers to these questions constitute teleological explanations, because they pick out the final cause (in the form of a function or goal) for the sake of which something has come to be or is present (or absent, etc.). These teleological explanations are a central feature of Aristotle's investigation of nature, and reflect the importance he attributes to final causality in the coming to be and presence of regular natural

phenomena. According to Aristotle, everything that exists or comes to be 'by nature' comes to be or changes, unless prevented, for a purpose and towards an end, and is present for the sake of that purpose or end. Final causality thus operates among all natural beings, from the level of the inanimate elements, through that of living beings, and on to the eternal realm of the heavenly bodies.

Although the importance of teleology for Aristotle (and in the ancient world in general)[1] has been acknowledged widely,[2] its nature and scope have consistently been the focus of much debate.[3] These debates have progressively led to a better understanding of Aristotle's notion of teleology. This is especially the case with regard to teleology as a descriptive principle of nature entailing the internal goal-directed tendency of natural processes (which is to be contrasted with processes due to spontaneity or necessity).[4] What I have found to be lacking in the literature, however, is an understanding of the role Aristotle attributes to teleology in *explaining* natural phenomena. Setting aside the other issues that remain concerning the nature and scope of teleology, the question that this dissertation sets out to resolve is how – granted that Aristotle has established teleology as a cause of natural phenomena – he then *uses* (e.g. refers to, draws inferences from, builds premises upon, rejects other possible explanations on the basis of) this teleology as a principle of scientific explanation.

I believe that this gap in our current understanding of the role of teleology within Aristotle's theory of science is unfortunate for the following four reasons.

First, Aristotle argues at several instances throughout the corpus that final causes possess some kind of priority over his other three types of causes, and that

[1] Hankinson (1998), 6.
[2] E.g. Caston (2006), 341; Gotthelf & Lennox (1987), 199; Gotthelf (1997b), 82; Johnson (2005), 1-2.
[3] Cf. Quarantotto (2005), 17. For an historical overview of the trends and circumstances that shaped the earlier interpretations of Aristotle, see Johnson (2005), 15-39. On the nature of Aristotle's teleology, see in particular Bradie & Miller (1999); Cameron (2002); Charles (1988); Cooper (1982; 1985; 1987); Gotthelf (1987); Irwin (1988); Johnson (2005); Lennox (2001a; 2001b); Nussbaum (1978); Sauvé Meyer (1992); Sorabji (1980); and Wieland (1975). On the metaphysics of Aristotle's teleology, see in particular Charles (1994); Mirus (2004); Pavloupoulos (2003); and Witt (1998). On the scope of Aristotle's teleology, see in particular Cooper (1982); Furley (1985); Matthen (2001) and (2007); Owens (1968); Sedley (1991); and Wardy (1993).
[4] See especially Johnson (2005), who brings together many of the recent new insights in Aristotle's notion of teleology as a principle of nature in his monograph, and explicitly addresses and eliminates some of the most persistent 'popular misconceptions' about Aristotle's teleology. See also Cooper (1982; 1985; 1987) and Lennox (2001a), 225; 251.

the task of the natural philosopher is foremost (although not exclusively) to provide teleological explanations. This suggests that Aristotle assigns special explanatory power to explanations that pick out final causes. However, studies have not made sufficiently clear yet what this explanatory power exactly amounts to in each of the various types of teleological explanations used, nor how teleological explanations actually explain each of the specific kinds of natural phenomena they are supposed to explain.[5]

Secondly, the wide range of teleological explanations found in Aristotle's works is often taken as one homogeneous category, unified by the fact that they all refer in some way or another to teleology. The existing literature hardly differentiates between, for instance, explanations that refer directly to final causes and explanations that operate through the supposition of teleological principles (such as 'nature does nothing in vain').[6] It often fails to take the different explanatory contexts into account.[7] The unifying approach to teleology overly simplifies several questions: What types of answers can constitute teleological explanations according to Aristotle, how other types of causes can be integrated in a teleological explanation, and especially how the various types of teleological explanations are applied in practice.[8]

A third question pertains to the understanding of references to necessity *as part of* (instead of 'as opposed to') explanations that also contain references to teleology. Scholars have often tried to reconstruct the nature of Aristotle's teleology by contrasting it to forces such as material necessity and spontaneity. In doing so, however, they have either overlooked or misunderstood those teleological explanations that refer to both final causes and material necessity to explain the same

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[5] These questions have been addressed on a general level by Code (1997) and by Bolton (2004; unpublished) within the context of Aristotle's methodological remarks in *Ph.*II and *PA.*I; the analysis called for here is one that addresses this question at the level of Aristotle's actual teleological explanations in the varieties of contexts in which they are applied.

[6] Johnson (2005), for instance, does not distinguish between these two types of explanations.

[7] Although Lennox's work on the principle that nature does nothing in vain (2001a, 205-222) suggests that Aristotle uses all his teleological principles in a very specific way to explain very specific explananda, scholars still seem to think that they are just 'didactic mantras', reminding his students that he believes nature is goal-directed. See, for instance, Quarantotto (2005), 13.

[8] Sorabji (1980, 155-174) offers an account of how according to him the various kinds of teleological explanations work, but I believe his distinctions are not subtle enough to cover Aristotle's actual practice of explaining natural phenomena in a teleological way.

natural phenomenon.[9] What is lacking is an account of Aristotle's use of teleological explanations that integrates these references to material necessity instead of explaining them away.

A fourth question concerning the use of teleology in explanations of natural phenomena arises from a research program initiated relatively recently by scholars such as Lennox and Lloyd.[10] This program has set out to explore the interplay between Aristotle's philosophy of science and his practice in the sciences themselves. Although there have been some studies on Aristotle's (teleological) explanations within the context of the first book of the *Parts of Animals* and the second book of the *Physics*,[11] with a few exceptions,[12] Aristotle's theoretical remarks on the structure of teleological explanations in the *Analytica Posteriora* (*APo.*II.11) have been ignored. So have many other passages in the Aristotelian corpus that bear on these issues.[13] Consequently, there have only been a few attempts to give a more comprehensive view of Aristotle's practice of providing teleological explanations including some of the other key treatises in Aristotle's natural philosophy, such as *De Anima* and *De Caelo.*[14]

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[9] I mainly disagree with scholars who have either explained away the role of material necessity in teleological explanations (Balme, 1987c); reduced it to conditional necessity (Cooper, 1987; Johnson, 2005); or assigned only a negative role to it in constraining the realizations of function (Lennox, 2001a).

[10] Lennox, who focuses on the similarities between theory and practice, summarizes his main views on the relation between Aristotle's theory and practice in the sciences in (2001a), 1-6; see also Lennox (1997a), (2004a), (2006). Lloyd, who focuses on the dissimilarities between theory and practice, formulates his main views on this issue in (1990) and (1996), 7-37.

[11] Next to the aforementioned literature by Lennox and Lloyd, see especially Balme (1987b); Bolton (1987; 1997); Charles (1997; 1999); Detel (1997; 1999); Gotthelf (1987; 1997); Pellegrin (1986); note, however, that not all of these works deal specifically with teleological explanations.

[12] Bolton (1997), Detel (1997), and Johnson (2005).

[13] Cf. Quarantotto (2005), 27: "Le interpretazioni del concetto aristotelico di 'causa finale' avanzate negli ultimi decenni, come si è già osservato, si basano spesso su passi differenti o su brani divesi di uno stesso testo. E tale selezione del materiale documentario è, almeno in parte, la causa della loro difformità e motlteplicità." Quarantotto points to *Ph.*II.8-9 and *PA.*I.1 as the key texts on which most scholars have based their interpretation of Aristotle's notion of teleology; in her own work, she studies teleology from a more comprehensive perspective, including the whole of *Ph.*II, the whole of *PA*, a few passages from *DA,* and *Mete.*I.3-10.

[14] With the exception of Quarantotto (2005). Johnson (2005, 1 and 7) introduces his investigations into Aristotle's teleology as an investigation of "how ends are used by Aristotle as explanations in natural philosophy" (2005, 1). However, the core of his monograph contains a discussion of the sorts of things that according to Aristotle behave in a goal-directed way, and of the reasons for why these things behave that way (and are thus explainable by reference to teleology). I have found no analysis of the different types of teleological explanations Aristotle uses, or any reflections upon why Aristotle uses the types of teleological explanations he uses, or what he thinks these explanations amount to, which is the sort of reflection I intend to offer in this dissertation.

The present dissertation intends to fill these gaps in our understanding of Aristotle's use of teleology as a principle of explanation, especially as it is used in the natural treatises.

Its main purposes are, first, to determine the function, structure, and explanatory power of teleological explanations in four of Aristotle's natural treatises, that is, in *Physica* (book II)*, De Anima, De Partibus Animalium* (including the practice in books II-IV)*,* and *De Caelo* (book II). These are the treatises that I believe to be most relevant to the present investigation.

Its second purpose is to confront these findings about Aristotle's practice in the natural treatises with the theoretical picture of the structure of teleological explanations gained from Aristotle's theory of scientific demonstration. For this purpose I will present a new interpretation of *APo.*II.11, a notoriously difficult chapter in which Aristotle introduces his theory of four causes into the syllogistic framework of scientific demonstration. This study thereby contributes to recent scholarship on the relation between Aristotle's philosophy of science and philosophy of nature, while at the same time adding to our knowledge of Aristotle's notion of teleology in terms of its explanatory merits and limits.

Although this dissertation attempts to explore Aristotle's theory and practice of providing teleological explanations as broadly as possible, due the limits of space and time I have narrowed down this study to Aristotle's *science of living nature*. The ethical and political works of Aristotle fall outside the scope of this dissertation. My central tenet is that Aristotle's notion of teleology has been developed primarily and applied most successfully in the context of Aristotle's investigations of living nature; a further study of the use, function, and explanatory power of teleological explanations in, among others, his ethics or politics, would have to start from and build upon the more 'basic' uses in the natural treatises.

This dissertation comprises five separate, but interrelated studies into the function, structure, and explanatory power of teleological explanations in Aristotle's philosophy of nature.

The core of my dissertation, consisting of chapters one to four, is devoted to an analysis of actual teleological explanations provided by Aristotle in the

selection of his natural treatises stated above. In these chapters, I do not intend to provide a comprehensive picture of Aristotle's views on the nature and scope of teleology in the natural world (although it must be understood that any study dealing with Aristotle's teleology will have to discuss these issues somewhat), but rather focus on exploring the function, structure, and explanatory power of the teleological explanations used.

In the final chapter, chapter five, I will relate these findings concerning Aristotle's practice to the theory of scientific demonstrations described in *APo.*II.11. in order to determine the relationships between them and the extent to which his theory is reflected in his practice. Let me conclude by briefly introducing the main subject matter and the lines of argument set out in the five chapters of this dissertation.

In chapter one, I will examine Aristotle's defense of natural teleology in the second book of the *Physica*, and discuss its consequences for Aristotle's views on the use and function of teleological explanations in natural philosophy. Aristotle introduces his theory of causal explanation in the context of his general project of trying to gain knowledge of natural phenomena. He then singles out teleological explanations for further discussion in the light of potential objections raised by his materialist predecessors. The purpose of this chapter is, first, to illuminate the place of final causes in Aristotle's theory of causal explanation. This constitutes an analysis of: (a) the relation of final causes to the other three types of causes (here the formal identity between formal, efficient, and final causes will turn out to be important); (b) the different notions of final cause that Aristotle seems to employ (i.e. 'structural' versus 'generative' ends); and also includes (c) an attempt to answer the question why and in what sense Aristotle attributes priority to final causes over the other three types of causes. Secondly, I will analyze the causal patterns underlying the three major domains of teleological explanations from which Aristotle draws his examples in the *Physics* (i.e. artistic production, deliberative action, and natural generation), and assess how he uses the analogy between nature and art. An important part of my argument will be that art and nature are used as analogies by Aristotle *because* of the absence of deliberation in either domain. Thirdly, I will turn to Aristotle's defense of teleology

itself. For Aristotle, the for-the-most-part character of natural processes and the regularity of their outcomes offer empirical evidence that they cannot be due to spontaneity but must have intrinsic causes. The operation of final causality must then be assumed to be an inference to the best explanation of our perception of the regular coming to be and presence of natural phenomena. Here it will be necessary to distinguish between the operations of two types of teleology (i.e. 'primary teleology' and 'secondary teleology') and hence of two – structurally different – types of teleological explanations in order to be able to determine more precisely the domain of things to which teleological explanations are to be applied if we want to gain knowledge of it.

Next, in chapter two, I will provide an analysis of Aristotle's bio-functional notion of the soul and the soul-functions, and their relationship to the body, as described in *De Anima*. The main purpose of this chapter is to show how in this treatise Aristotle lays the foundations for the teleological explanations of living nature in the biological works by differentiating the various life-functions and then grounding them teleologically. That is, living beings have the functions they have for a natural purpose. For Aristotle, the soul is not only the principle of life in an ontological sense; it is also the explanatory principle of living beings and their features in an epistemological sense. Thus, while in the *Physica* Aristotle grounds the existence of natural teleology itself, in the *De Anima* he rather grounds the possibility of providing teleological explanations for the domain of living nature: the life-functions will form the starting-points of the explanation of the realized living being with its kind specific parts and features. Two issues will receive my main attention in this chapter. First, I explore the function, structure, and explanatory power of the teleological explanations Aristotle uses in his account of the nature of the soul and of its functions. Here it will be important to recognize Aristotle's use of the teleological notion of conditional necessity to describe the relationship between functions and the natural body in which they are realized. Further, I will differentiate between necessary and non-necessary functions of the soul. Secondly, I will analyze Aristotle's teleological model of human and animal locomotion. In an appendix, I will discuss the role of intentionality in this model, while distinguishing between 'objective' and 'subjective' teleology; the causal framework provided in *De Anima* will

thus be shown to ground the paradigm of action used for didactic purposes in the *Physica.*

In chapter three, the heart of this dissertation, I will examine the rich material of actual teleological explanations found in *De Partibus Animalium.* It is in the biological works that Aristotle builds upon the foundations laid out in his *De Anima* and employs final causes and teleological principles most successfully to explain the presence, absence, and material differentiation of living beings. The purpose of this chapter is to get a clearer understanding of the various types of explanations, and especially of the teleological ones, that Aristotle offers for biological phenomena. In particular, I will clarify their structure, the roles played by the various types of causes picked out in the explanations, and their explanatory power. I will set the stage by introducing Aristotle's explanatory project in *De Partibus Animalium* as a demonstrative science of living nature. Next, I will discuss the types of explanations provided by Aristotle that refer directly to causes, while paying special attention to the interrelatedness of the different causes picked out in one and the same explanation, and to the issue of causal versus epistemological priority. Third, I will turn to those explanations that make use of teleological principles, and argue how they are used heuristically as a framework for explanation in those cases where final causes are not immediately discernable. A final issue to be addressed in this chapter is the relation between teleology and necessity, both in theory and in practice. Here I hope to show that Aristotle does not deny any causal role for material necessity in the coming to be of sublunary natural generations, but rather attributes a positive role to it in the formation of non-necessary, luxurious parts. The distinction between primary and secondary teleology, and between the explanation of the coming to be of natural phenomena and the explanation of their presence, will prove to be crucial in this context.

In chapter four, I will reveal the limits of Aristotle's use of teleology as a principle of explanation in *De Caelo.* In this treatise, Aristotle tries to gain scientific understanding of otherwise incomprehensible cosmological phenomena almost exclusively through mathematical reasoning. The only exceptions are formed by seven teleological explanations. It is striking that these latter explanations, which are the only 'physical' explanations given, all make use of teleological principles. I will

argue that Aristotle uses teleological principles to explain the presence and absence of heavenly phenomena, on the assumption that they are part of the realm of nature, and that they therefore have to be explained in terms of the four causes. The principles Aristotle uses are well-established in biology, and by applying them to the heavenly domain Aristotle hopes to make as much sense of the heavenly phenomena as possible. I will first discuss the teleological explanations offered for the *presence* of heavenly phenomena and next the explanations that are set out to account for the *absence* of heavenly phenomena. The purpose of this chapter is to show that although the *use* of teleological principles in the heavenly realm is similar to that in biology (in both cases they are used because the final causes are not immediately discernable), their explanatory power in biology is much stronger than in cosmology. As I will show, the lack of empirical evidence in the heavenly domain weakens the inferences Aristotle draws within his cosmology: as he himself points out repeatedly, the teleological explanations presented are plausible, but do not reach the same level of detail as the ones presented in biology.

In chapter five, I finally turn to Aristotle's theoretical account in the *Posterior Analytics* of how the four causes, and in particular the final cause, are to be picked out within the syllogistic structure of explanations in order for those explanations to qualify as 'demonstrations of the reason why', and thereby to generate scientific knowledge. The main part of the chapter consists of a careful reinterpretation of *APo.*II.11 in which Aristotle discusses these vexed issues. The aim of this chapter is to show how comprehensive and flexible Aristotle's theory of scientific demonstration truly is. Of particular interest, is how in teleological demonstrations, material, formal, and efficient causes can all play an explanatorily basic role in establishing a teleological relation between two states of affairs. On the other hand, the final cause itself, so I will argue, never plays such a role, but is always demonstrated to hold of something else. The scientific value of final causes is primarily one of explanatory priority: final causes are picked out first in explanations, but have no causal priority in the world. Once the theoretical picture has become clear, I will relate this picture to my findings concerning Aristotle's practice of providing teleological explanations in the previous chapters, and in particular to the findings from the biology discussed in chapter three. This will show how the

'theoretical format' as presented in *APo.*II.11 can easily accommodate the variety of types of teleological explanations that are found in practice, and how closely the two domains are related.

In the conclusion, I will bring together the various findings and distinctions drawn concerning the practice and theory of providing teleological explanations in Aristotle's philosophy of nature, so as to lay out the merits and limits of the use of teleology as a principle of explanation.

## CHAPTER ONE: ARISTOTLE'S DEFENSE OF NATURAL TELEOLOGY
## SETTING THE STAGE FOR TELEOLOGICAL EXPLANATIONS IN THE *PHYSICA*

### 1.0 Introduction

The *Physica* forms Aristotle's first treatise of a didactically sequenced series of studies of nature.[1] In this treatise, Aristotle investigates the principles and causes of all things that have a nature, that is, of all things that have an internal principle of change and rest. In the course of doing so, Aristotle defines a large number of key notions of his natural philosophy, such as motion and change, space and time, matter and form, causal explanation, teleology and necessity. The conceptual apparatus and framework laid out in the *Physica* are consequently applied and reshaped for the inquiries into the more specific and more complex segments of the natural world. These inquiries are written down in numerous other treatises dealing with natural philosophy.[2]

In this chapter, I will focus mainly on book II of the *Physica*, in which Aristotle introduces his theory of causal explanation and offers a defense of natural teleology against the views of his predecessors. In this context, teleology is primarily put forward by Aristotle as the internal goal-directed tendency of natural processes towards their actualization, which is to be contrasted with the operations of spontaneity and necessity in the natural world. It is from this perspective that the concept of teleology has received most of its attention in the scholarly debate. While trying to do justice to the progress that has been made in the study of teleology as a natural tendency, I will focus here also on the use and function of teleology as a principle of explanation. In particular an attempt will be made to reconstruct the ways in which final causes or teleological principles feature in causal accounts of natural processes. The second book of the *Physica* is of programmatic interest not only with regard to Aristotle's theoretical views on teleological explanation, but also

[1] I believe that the cross-references in Aristotle are his own, and that they reflect a didactic order in which his treatises should be studied; on this issue, see Burnyeat (2001), 87-125 and Nussbaum (1978), 107-109.
[2] As Aristotle makes clear in his programmatic opening of *Meteorologica*, I.1 (338a20-339a10), the whole investigation of nature will comprise the study of change and motion in the heavens (*De Caelo*), the elements and coming to be and perishing in general (*De Caelo*, *De Generatione et Corruptione*), atmospheric causes and changes (*Meteorologica*), and finally soul (*De Anima*) and living beings (biological works). On the importance of the *Meteorologica* passage for the systematic connection between Aristotle's works, see Burnyeat (2001), 118-119 and Nussbaum (1978), 107-109.

with regard to his actual use of teleological explanations. In the following sections I will address the question of the place of final causes in Aristotle's theory of causal explanation (section 1.1), analyze the three models operative in Aristotle's teleological explanations (human action, artistic production, and natural processes; section 1.2), and finally discuss Aristotle's defense of the need to use teleology in the explanation of natural phenomena (section 1.3).

The chapter will thus serve a threefold purpose. In the first place, it will provide an introduction to the basic concepts necessary for the understanding of Aristotle's use of teleological explanations in the other natural treatises, some of which will be discussed in the following chapters. In the second place, it will offer a status quaestionis of recent work on Aristotle's teleology, which will be taken as a reference point for the next chapters. In the third place, it will also give us some indications of the expectations Aristotle himself has with regard to the cash-value (in terms of explanatory force and broadness) of the use of teleological explanations.

## 1.1 The theory of causal explanation of the *Physica*

In the first two chapters of the second book of the *Physica*, Aristotle discusses the question of what nature is, and consequently of what subjects the student of nature should study. In the course of answering these questions, Aristotle subtly introduces and connects his four notions of cause to his definition of nature as the internal principle of motion and rest. However, it is not until the third chapter that Aristotle explicitly introduces his four causes (here presented by the names derived from their medieval appellations): the material cause, the formal cause, the efficient cause, and the final cause.

In the first section (1.1.1), I will discuss Aristotle's 'theory of the four *aitiai*' and its relation with knowledge according to *Ph.*II.3,[3] and its relation with Aristotle's notion of nature according to *Ph.*II.1-2. In the next section (1.1.2), I offer an analysis of the way in which the four causes are related to each other, while paying special attention to Aristotle's account of the final cause and its role in teleological explanations.

[3] The account in *Ph.*II.3 is virtually identical to the entry on *aition* in Aristotle's 'philosophical dictionary' in *Met.*V.2, 1013a24-1014a25.

### *1.1.1 Four ways to answer the question 'why?'*

#### *1.1.1.a Knowledge, explanation, and causation*

In recent years, scholars of Aristotle have shifted away from older interpretations of Aristotle's doctrine as a theory of causation towards a reading of it as a theory of explanation. Under this interpretation, the four categories Aristotle distinguishes represent four types of explanation, or perhaps four types of causation that provide corresponding explanations.[4] Accordingly, 'explanation' (or, 'explanatory factor'), rather than 'cause', has become the preferred translation[5] of *to aition* and *hê aitia* (these terms are usually used interchangeably by Aristotle).[6] In addition, discussions have focused on Aristotle's supposed instrumentalist stance towards explanation. This is the theory that Aristotle's four categories of causes (and in particular the material, formal, and final cause, which – unlike the efficient cause – do not resemble our modern cause-and-effect conception of causation in any way) are not supposed to represent actual causal factors operative in physical reality. The four causes are merely considered to be kinds of factors that are explanatory in virtue of being appropriate answers to why-questions – appropriate in view of the interests, contexts, and presuppositions of the questioner.[7]

I agree with Freeland's conclusion[8] that Aristotle was most certainly a realist both concerning causes and explanations, which means that the four types of explanation Aristotle distinguishes are grounded in four types of causal relations that obtain in the world. In some sense, this renders the discussion about the distinction

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[4] See e.g. Annas (1982); Moravcsik (1974a&b) and (1991); and Sorabji (1980). Freeland (1991), although critical of the interpretation of *aitia* as explanations, ultimately also endorses this view. I agree with Johnson (2005), 41n.3 that part of Freeland's problems with this interpretation (namely that Aristotle's presentation of explanation in the *Physica* does not correspond with the 'canonical presentation' in the *Posterior Analytics*) stem from not taking *APo.*II.11 sufficiently into account; in chapter five on the *Posterior Analytics* I hope to show that Aristotle makes both a philosophical and a lexical distinction between causes and explanations, and that both play a vital role in Aristotle's theory of scientific demonstration. This distinction does not hold in the context of the *Physica*, but as I will show in the following paragraphs the general frameworks still stands: knowledge is defined as knowledge of explanations of things, and explanations are accounts that bring out causal relevant factors under their right description.

[5] See e.g. Barnes (1975), 89-90; Gill (1980), 129; and Hankinson (1998), 132.

[6] Both terms go back to the adjective form *aitios* which originated in legal context, designating the person responsible or culpable for something. The two substantive forms probably had different meanings before Aristotle; in Plato, for instance, *to aition* meant 'cause', while *hê aitia* meant 'causal account' or 'explanation.' On these issues, see Frede (1980), 222-223, Sedley (1998), 115(n.1), and Lennox (2001a), 282-283. See also chapter five.

[7] Van Fraassen (1980), 21-22.

[8] Freeland (1991).

between causation and explanation futile. Aristotle's theory of four *aitiai* is a theory of four types of *causal explanations*. The four *aitiai* are the kinds of answers one gives to four different why-questions, and these answers will only be explanatory if they pick out real causes (and not merely epistemic reasons why) under their causally relevant description.

I hold that both his account of explanation in the *Posterior Analytics* (especially in *APo.*I.2 and *APo.*II.11) and in the *Physica* show Aristotle's erotetic approach to the project of gaining knowledge of nature and natural processes.[9] The context in which Aristotle introduces his four types of causal explanation in *Ph.*II.3 is significant in this respect (*Ph.*II.3, 194b17-23):

> ἐπεὶ γὰρ τοῦ εἰδέναι χάριν ἡ πραγματεία, εἰδέναι δὲ οὐ πρότερον οἰόμεθα ἕκαστον πρὶν ἂν λάβωμεν τὸ διὰ τί περὶ ἕκαστον (τοῦτο δ' ἐστὶ τὸ λαβεῖν τὴν πρώτην αἰτίαν), δῆλον ὅτι καὶ ἡμῖν τοῦτο ποιητέον καὶ περὶ γενέσεως καὶ φθορᾶς καὶ πάσης τῆς φυσικῆς μεταβολῆς, ὅπως εἰδότες αὐτῶν τὰς ἀρχὰς ἀνάγειν εἰς αὐτὰς πειρώμεθα τῶν ζητουμένων ἕκαστον.
>
> "Since this undertaking is for the sake of knowing – and we think that we have knowledge not earlier than when we grasp the reason why with regard to each thing (and that is, to grasp the first *aitia*) – it is clear that we must do this also with regard to generation and corruption and every natural change, so that once we know the first principles we can try to lead back to them each of the things that we inquire about."[10]

The opening sub-clause of this passage ("Since...knowing") is revealing: it is *because* knowledge of the reason why is a necessary prerequisite for the understanding of natural processes such as change, generation, and motion, that Aristotle now opens up the discussion of the nature and number of causes. The "since" in *Ph.*II.3, 194b17 picks up on the general project of the *Physica* that was defined in a similar manner (*Ph.*I.1, 194a10-16): since knowledge concerns the knowing of the principles, causes, and elements of things, the 'science' of nature too must start with an attempt

[9] Aristotle's categorization of answers that can be given to questions why are rooted in what Schofield calls 'the explanatory projects' of Aristotle's predecessors; Schofield (1991), 29-40. However, based on the doxographical discussion in *Met.*I.3-9, I believe that Aristotle thinks that all four of his 'explanatory projects' go back to his predecessors, and not only the investigations into the material and formal cause as Schofield holds.

[10] All translations are mine, unless indicated otherwise.

to establish those principles. If Aristotle's prime goal is to gain scientific knowledge of how things actually are in nature, then the explanations he will introduce must pick out real causes; purely *linguistic* explanations will not do the trick.[11]

Aristotle conceives of scientific inquiry as a questioning procedure in which the answer to the question why provides the most fundamental knowledge, because it brings out the cause of something.[12] In *Ph.*II.3, Aristotle introduces four types of causes that may figure in such explanations: (1) the 'that out of which' (*Ph.*II.3, 194b24: τὸ ἐξ οὗ) or the material[13] cause; (2) the 'what it is to be' (*Ph.*II.3, 194b27: τὸ τί ἦν εἶναι) or the formal cause; (3) the 'that from which the origin of motion or rest comes' (*Ph.*II.3, 194b29-30: ὅθεν ἡ ἀρχὴ τῆς μεταβολῆς ἡ πρώτη ἢ τῆς ἠρεμήσεως) or the efficient cause; and (4) the 'that for the sake of which' (*Ph.*II.3, 194b33: τὸ οὗ ἕνεκα) or the final cause. Aristotle exemplifies his concern for causal explanation most clearly in his introduction of the final cause (*Ph.*II.3, 194b33-35):

> ἔτι ὡς τὸ τέλος· τοῦτο δ' ἐστὶν τὸ οὗ ἕνεκα, οἷον τοῦ περιπατεῖν ἡ ὑγίεια· διὰ τί γὰρ περιπατεῖ; φαμέν 'ἵνα ὑγιαίνῃ', καὶ εἰπόντες οὕτως οἰόμεθα ἀποδεδωκέναι τὸ αἴτιον.
>
> "Moreover, there is [the cause] in the sense of the end. This is that for the sake of which, such as health of walking. Because of what does he walk? We say 'in order to be healthy', and in so saying we think that we have expressed the cause."

We know why someone walks when we know that he walks *for the sake of being healthy*, and in stating this explanation we have expressed the final cause of walking.[14] In the remainder of the chapter, Aristotle discusses among others how causes (and their effects) need to be picked out under their causally relevant description in our statements in order for its expression to be truly explanatory (*Ph.*II.3, 195a29-b15). The purpose of this discussion is to specify which modes of reference are most appropriate and precise in the context of explanation (*Ph.*II.3, 195b21-22: δεῖ δ' ἀεὶ

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[11] Cf. Hankinson (1998), 132; pace Van Fraassen (1980).

[12] *APo.*I.2, 71b9-13; *APo.*II.11, 94a20-27. On Aristotle's erotetic concept of inquiry, see Hintikka (1989), 73.

[13] The name 'material cause' is somewhat misleading, since for Aristotle 'matter' in the sense of physical stuff (*hulê*, literally, wood; the ancient Greeks did not have a term for matter in our modern sense) is just one sort of thing among many others that can be causative as a 'that out of which'; cf. the examples Aristotle states in *Ph.*II.3, 195a16-20: "for the letters of syllables, and the material of processed things, and fire (and such things) of bodies, and parts of a whole, and hypotheses of a conclusion are causes as that out of which." Cf. Hankinson (1995), 119n12.

[14] Cf. also Aristotle's summary of this theory in *Ph.*II.7, 198a22-24: "And since there are four types of *aitiai*, it belongs to the physicist to know about them all, and by leading the reason why (τὸ διὰ τί) back to all [of them] he will *supply* (ἀποδώσει) it [i.e. the reason why] in the way of natural inquiry: the matter, the form, the mover, and that for the sake of which."

τὸ αἴτιον ἑκάστου τὸ ἀκρότατον ζητεῖν). This shows that Aristotle is concerned with both cause and explanation.[15]

According to Aristotle, causes need to be picked out, in the first place, at the right level of generality between the particular and the universal. We might refer to the cause of health as 'doctor' or as 'skilled man', and although the two causes are equal in form (ὁμοειδής) – both terms are designations of the efficient cause – 'doctor' is prior (*Ph.*II.3, 195a29-32). In the second place, causes should be picked out in an intrinsic and thus definite way, rather than in an incidental and thus indefinite way. In the causal explanation of the coming to be of a statue, 'Polycleitus' picks out an incidental cause of the statue, while 'a sculptor' picks out an intrinsic cause: it is *qua* being a sculptor that Polycleitus is the cause of the statue, not qua being Polycleitus (*Ph.*II.3, 195a32-b3). In the third place, causes might also be designated singly (e.g. 'Polycleitus' or 'sculptor') or in combination ('Polycleitus the sculptor'); in this case the latter is more specific, because it reveals both the property in virtue of which the statue comes to be and the particular substance in which this property resides (*Ph.*II.3, 195b10-16). Finally, one needs to say whether the cause is actually or potentially operative: for instance, the cause of the building of a house is most appropriately picked out in an explanation by designations such as 'the house-builder' or 'the house-builder while building' (*Ph.*II.3, 195b3-6).

In the example of the statue, the cause picked out in the appropriate explanatory way is the following predicative complex expression: 'the instantiation of the sculptor's art in Polycleitus.' Polycleitus sculpts a statue *in virtue of* his possession of the art of sculpting, and it is his possession of the art of sculpting which gives the most accurate specification of the originator of the production that culminated in this particular statue.[16] An explanation of the coming to be of the statue thus needs to refer in the appropriate way to both the art of sculpting and the agent in which

[15] For instance, if Aristotle were only interested in knowing the causes of things, it would not matter to him how one refers to them (e.g. 'Polycleitus' and 'the man in the beret' may both refer to the same efficient cause of a particular statue). If Aristotle is *also* interested in explanation (that is, in the type that is conductive to knowledge), then one has to refer to causes under their causally relevant description (e.g. 'the sculptor' or 'the art of sculpting' refer to same efficient cause of a particular statue, but do so while identifying it in a way that reveals the explanatory property). I have adopted this view that Aristotle's explanations are intensional in form and the example, from Hankinson (1998), 133.
[16] Matthen (2007), 1-2.

the art resides (and without which the art could not initiate the process of sculpting).[17]

Aristotle's sensitivity to how people speak about causes and to how causes are most properly picked out in explanations (i.e. to the focalization and the categorization of causes) shows Aristotle's causal realism (and emphatically not his supposed scientific instrumentalism concerning explanations):[18] explanations need to pick out the causal relevant features that actually obtain in the world under their appropriate descriptions. Explanations that do not exhibit the real structure of the world are simply not conductive to scientific knowledge.

#### *1.1.1.b Nature defined by the four causes*

Aristotle defines nature as an inner source of change and rest (in respect of place, or of growth and decline, or by way of alteration) in that to which it belongs primarily of itself, and not accidentally (*Ph.*II.1, 192b13-14; 192b20-23). This conception of nature is later characterized as a hypothesis that belongs to the first principles of the science of nature (*Ph.*VIII.3, 253b2-6).[19] It cannot be demonstrated through a syllogistic proof, and the same holds for the proposition that the world of natural changing things exists.[20] The fact that there are such things as natures or natural things having natures (such as animals and their parts, plants, the simple elements) is evident (*phaneron*) – the attempt to demonstrate this would in fact be ridiculous (*Ph.*II.1, 193a1-9). Aristotle's exploration of the concept of nature precedes his introduction of his theory of causal explanation, but as I said before, the notions of nature and the four causes are linked from the outset: the ways in which people speak about nature and the ways they speak about causes of things that are natural largely coincide. For natural phenomena, natures form the grounds for causal explanation.

Aristotle introduces his notion of nature as an internal origin of change, by distinguishing it from the class of artifacts. Artifacts are characterized as things that

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[17] See Moravcsik (1991), 37-38.
[18] As Freeland points out, the different contexts "are generated by the world itself, and diverse kinds of causal statements are about relations that obtain in the world itself." Freeland (1991), 66.
[19] For arguments for the view that the claim 'nature is a source of motion' is a *hypothesis* rather than a definitional posit, see Lennox (2001a), 209-210.
[20] Bolton (1991), 19-21.

do not in themselves have the source of their making or coming to be (*Ph.*II.1, 192b28-32), but need an external efficient cause (the art, hand, or tool of the artist) to become what they are. The main difference between natural things and artifacts is thus that the latter lack an internal efficient cause through which they can effect their own realization. This shows that for Aristotle natures are in the first place conceived of as the efficient causes of the motions, changes, and rests they bring about. In the context of Aristotle's psychology and biology, nature in the sense of the internal principle of motion of a living being will be identified with that living being's the soul: the principle of life is thus in an important sense a principle of motion.[21]

Artifacts, on the other hand, only have an inner source of motion in so far as they are constituted from natural things. The natural capacities and tendencies of an artifact do not belong to the artifact qua that artifact, but qua being composed of particular combinations of natural elements, just as a man who heals himself does so only accidentally because the art of healing and the person healed happen to concur in the same person (*Ph.*II.1, 192b23-27). Antiphon's example of a bed, cited by Aristotle in *Ph.*II.1, 193a11-17, brings out this difference very clearly:

> εἴ τις κατορύξειε κλίνην καὶ λάβοι δύναμιν ἡ σηπεδὼν ὥστε ἀνεῖναι βλαστόν, οὐκ ἂν γενέσθαι κλίνην ἀλλὰ ξύλον, ὡς τὸ μὲν κατὰ συμβεβηκὸς ὑπάρχον, τὴν κατὰ νόμον διάθεσιν καὶ τὴν τέχνην, τὴν δ' οὐσίαν οὖσαν ἐκείνην ἢ καὶ διαμένει ταῦτα πάσχουσα συνεχῶς.
>
> "If someone planted a bed, and the decomposition acquired the ability to send up a shoot, what would come up would not be a bed but wood: this seems to show that the arrangement in accordance with habit and art belongs accidentally, while its substantial being is that which persists continuously while being affected in these ways."

The bed is an artifact (something that exists by convention and art, not by nature) and as such does not have an internal source of change: it cannot on its own accord (re)produce itself. The wood from which the bed is made, on the other hand, is not an artifact, but a natural thing: it has the *dunamis* (given that the required background conditions are fulfilled) to replicate itself on its own accord. Being shaped into the structure of a bed is incidental to the wood, which can be inferred from the fact that in the absence of other external efficient causes the bed will still 'act' and change like

[21] Bodnár (2006), 3.

wood (the only conceivable kind of generation a bed might produce is that of a tree).[22] The nature of the bed is thus its internal efficient cause of its own actualization, perseverance, and reproduction, which can be seen to inhere in the wood (not in the bed qua bed), for a tree begets a tree.

Note that for the most part, where nature acts as an efficient cause in natural generation, the first efficient cause (of the father) and its effect (the efficient cause of the offspring) will be the same (not numerically, but) in kind.[23] That means that, in natural generation, efficient causes transmit the form they possess in actuality to the entities they change, which must possess this form in potentiality; natural generation consists in the replication of form. Hence Aristotle's famous adage that 'man begets man':[24] only a human being who possesses the form of a human being in actuality can produce a human being from that which possesses this form in potentiality.[25]

After having identified nature as an efficient cause, Aristotle takes up the example of Antiphon's bed in order to link nature with formal and material causes. He argues that the nature of a thing is rather its form than its matter, and also that artifacts (at least in some sense) possess their form only accidentally. Nature is always in what underlies change, and substantial being (*ousia*) is such an underlying thing (*Ph.*II.1, 192b32-34): in artifacts the substantial being is the material constituent, in natural things, it is the thing itself, or rather its form. Aristotle's analysis of the concept of nature in language of change and efficient causality thus becomes intertwined with his hylomorphism.[26] According to Aristotle, there is always something that persists (at whatever level) throughout the process of change, i.e. the substrate or matter, and something that is generated in the change, i.e. the form. Every substance consists of (several stages or 'layers' of) informed matter – of matter arranged and determined by form. Some people called the first thing a 'nature', describing it as (*Ph.*II.1, 193a29-30):

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[22] Cf. Bodnár (2006), 3.
[23] Bodnár & Pellegrin (2006; 277-281) label this 'the principle of synonymy'.
[24] See for instance *Ph.*II.1, 193b8-9; *Ph.*II.1, 193b 12; *PA.*I.1, 640a23-26; *Met.*VII.7, 1032a25; *Met.*VII.8, 1033b32; *Met.*IX.8, 1049b25, *Met.*XII.3, 1070a8, and *Met.*XIV.5, 1092 a 16.
[25] For Aristotle's general analysis of natural change in terms of potentialities that are actualized, see *Ph.*III.1-3.
[26] The question of the metaphysics of Aristotle's teleology is outside the scope of this dissertation, but see Charles (1994), Mirus (2004), and Witt (1994a&b), who all connect teleology to Aristotle's metaphysics of matter and form, and potentiality and actuality.

> ἡ πρώτη ἑκάστῳ ὑποκειμένη ὕλη τῶν ἐχόντων ἐν αὑτοῖς ἀρχὴν κινήσεως καὶ μεταβολῆς.
>
> "The in each case primary underlying matter[27] of those things that have in themselves a principle of motion and change."

The name 'nature' is also used for the second thing, which is described as (*Ph.*II.1, 193a30-31):

> ἡ μορφὴ καὶ τὸ εἶδος τὸ κατὰ τὸν λόγον.
>
> "The shape and form that is according to the definition."

Although Aristotle argues that form is *more* a nature than matter (for forms are what is actual and what is transmitted in reproduction; *Ph.*II.1, 193b6-12), ultimately nature is both: it is both the matter out of which things are constituted, and the form that picks out their essence (*Ph.*II.2, 194a12-27). Since natural things cannot be defined without change – "they are like the snub nose, not like curved (*Ph.*II.2, 194a3-7)", and since change involves matter and form, the student of nature should study both kinds of nature – "as if we were to investigate what snubness is (*Ph.*II.2, 194a12-27)."[28]

Finally, after having analyzed nature in terms of the efficient, formal, and material cause, Aristotle connects his concept of nature to that of the final cause. In providing an etymological argument[29] for why form has more claim to be called a nature than matter (*Ph.*II.1, 193b12-18), Aristotle touches upon an important difference between natural processes and artificial processes concerning the 'towards which' (*eis ho*) the process takes place. Without using the technical language of teleology yet, Aristotle points out that in artificial processes the end lies not in the performance of the art, but in something outside the art (for instance, doctoring proceeds from the art of medicine towards health). In natural processes, on the other hand, the process of generation is towards the realization of the thing's own

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[27] This is presumably the 'proximate matter,' i.e. the highest level of enformed matter that is used in the generation of some compound (e.g. 'instrumental body' or 'brick', and not the matter that underlies these materials, such as 'earthy elements'); for the distinction between proximate and non-proximate matter, see *Met.*V.6, 1016a19-24; *Met.*VIII.4, 1044a15-25; *Met.*IX.7, 1049a24-7. Cf. Bodnár & Pellegrin (2006), 274-275.

[28] For a similar discussion about the task of the natural philosopher and the relation between matter, function, essence and substance, see *DA.*I.1 and *Met.*VII, discussed below in 2.1.2.

[29] Charlton (1970), 91.

nature or form: nature is that towards which natural generation takes place. A natural thing 'grows', so to speak, into its own nature.[30]

Aristotle makes a similar point, but this time more explicitly and in a more technical manner, in the context of his discussion of the task of the student of nature. For the student of nature also needs to have knowledge of the 'that for the sake of which' (*Ph.*II.2, 194a27-33):[31]

> ἔτι τὸ οὗ ἕνεκα καὶ τὸ τέλος τῆς αὐτῆς, καὶ ὅσα τούτων ἕνεκα. ἡ δὲ φύσις τέλος καὶ οὗ ἕνεκα (ὧν γὰρ συνεχοῦς τῆς κινήσεως οὔσης ἔστι τι τέλος, τοῦτο <τὸ> ἔσχατον καὶ τὸ οὗ ἕνεκα· διὸ καὶ ὁ ποιητὴς γελοίως προήχθη εἰπεῖν "ἔχει τελευτήν, ἥσπερ οὕνεκ' ἐγένετο"· βούλεται γὰρ οὐ πᾶν εἶναι τὸ ἔσχατον τέλος, ἀλλὰ τὸ βέλτιστον)·
>
> "Moreover it belongs to the same [study] [to know] that for the sake of which and the end, and whatever is for the sake of those [ends]. Now nature is an end and a 'what something is for'. (For if there is some end to things which undergo a continuous change, that [end] will be its end point and that for the sake of which. That is also why the poet was carried away into making the comical statement that 'he reached his end, for the sake of which he was born.' For not every end point wants to be an end, but only the one which is best.)"

In this passage, Aristotle argues that nature is an end, too, for the reason that if there is a (natural) end to a continuous change, this end must be what the change was for. The ends towards which natural processes tend are inherent and intrinsic to the natures of the things undergoing those processes. Aristotle is eager to point out that not every final point of a continuous change is 'naturally disposed'[32] to be an end, but only that stage which is best. At least part of what it is to be an end properly so called is to be a good,[33] that is, to constitute the culmination of the process whose

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[30] Cf. Hankinson (1998), 134-135.

[31] As Charlton (1970; 97), points out: "if you study that which is for something, you should study what it is for".

[32] Aristotle uses verbs as *boulomai* (*Ph.*II.3, 195a24-25) or *ethelô* (*Ph.*II.2, 194a32) to describe the relation of ends and what is good or best.

[33] The reference to the 'being the best' of natural ends is significant: 'goodness' – in the sense of being contributory to the actualization of the living being's nature and well-being – is a defining property of natural ends. End results that do a living being no good are not part of the nature of that living being, but must be the result of material necessity or spontaneity (Cf. *Met.*VIII.5, 1044b34-1045a2). This will become important in the context of biology, where one of the most important principles is that nature does nothing in vain or superfluous: nature is not responsible for *all* ends in the sense of end-results, but only for those that contribute to the larger whole of which they are part. We should be careful not to read any values or intentions into Aristotle's use of the good or best in these contexts: the good is used as a functional and relative term picking out what is good or best for the relevant organism in terms of its coming to be, surviving, and reproducing. This does not imply any awareness on the part of the organism to the goodness of the end that is being realized (Charles (1991), 108-109n.7), or a metaphysical notion of

end it is. The culmination of processes occurring in the natural realm is generally the realization of a form.

After this explanation of the nature of the final cause, Aristotle immediately returns to his analogy between art and nature (*Ph.*II.2, 194a33-34):

> ἐπεὶ καὶ ποιοῦσιν αἱ τέχναι τὴν ὕλην αἱ μὲν ἁπλῶς αἱ δὲ εὐεργόν, καὶ χρώμεθα ὡς ἡμῶν ἕνεκα πάντων ὑπαρχόντων.
>
> "Indeed,[34] the arts make their matter, some [make it] without qualification, others [make it] good to work with, and we use everything that there is as if it is for the sake of us."

That is, the arts are goal-directed, too: they make the matter such that it is good for us and usable for the sake of something.[35] What Aristotle indicates here is that the final cause in artistic productions lies outside the performance of the art, and is always relative to what is beneficial to us: our desires and needs determine what will be the end-results of art. Therefore, indirectly and on a secondary level, Aristotle states that we are ends, too (*Ph.*II.2, 194a34-35):

> ἐσμὲν γάρ πως καὶ ἡμεῖς τέλος· διχῶς γὰρ τὸ οὗ ἕνεκα· εἴρηται δ' ἐν τοῖς περὶ φιλοσοφίας.
>
> "For we, too, are ends in some way: for that for the sake of which is double; this has been said in *On Philosophy*."

The doubleness of the term 'that for the sake of which' pertains to the two senses of end: that of which and that for which. In the strict sense, an end is that towards which something tends; in a non-technical sense, it is the beneficiary of something.[36] For instance, the generation of trees takes place for the sake of realizing the numerical replication of trees; in natural processes, the end of a continuous change is the realization of the form that is inherent in the natural thing itself. On the other hand, since we benefit from the coming to be of trees (we use them to produce artifacts such as beds and tables), in some sense, one could say that trees come to be for our sake, too.

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the absolute good. In a later chapter, Aristotle adds to his identification of the end with the best that "there is no difference between the good itself and the apparent good" (*Ph.*II.3, 195a23-26); I submit that the good here means the practical good, which is capable of being otherwise; cf. *DA.*III.10, 433a28-31.

[34] The '*epei*' picks up on the conditional sentence in *Ph.*II.2, 194a21-22 "if art imitates nature".

[35] Cf. *Ph.*II.2, 194b7-8: "in the case of artifacts, we make the matter for the sake of the function, in the case of natural things it is already available."

[36] I will discuss this distinction in more detail in section 2.1.1.c.

In sum, natural beings possess in themselves all the causal factors needed to bring about their own realization: they are matter, form, internal source of motion, and end in one. In some contexts, Aristotle reduces these four 'causal' uses of nature to two, i.e. to 'formal nature' and 'material nature'.[37] The animal's formal nature incorporates its formal, efficient, and final cause: nature in this sense is the goal-directed efficient cause, directed at the realization of its own form. The animal's material nature, on the other hand, is nature in the sense of the underlying material in which the form is realized. Thus, in realizing itself, the formal nature interacts with the living being's material nature, which helps define the actions of the formal nature.

### *1.1.2 Final causes in causal explanations*

The predominant type of teleological explanations given in *Ph.*II is the one in which that for the sake of which is picked out as the cause for why some process or action takes place. However, we have also seen that the causal patterns and structures underlying natural the things or processes that are to be explained teleologically in fact may exhibit all four causes, and that Aristotle claims that all four of them need to be known in order for something to be fully understood. In this section, I will discuss in more detail Aristotle's notion of the final cause and its causal role, and lay out its relations with the other three causes.

#### *1.1.2.a Types of final causes in Ph.*II

Aristotle introduces a wide variety of kinds of final causes in the second book of the *Physica.*[38] These include final causes such as:

(a) man as the end of natural generation;[39] mature animal as the end of seed;[40] house as the end of the art of building;[41]

(b) cutting as the 'work' of a saw;[42] biting as the 'work' of front teeth;[43] and

[37] See e.g. *PA.*III.2, 663b22-24 and *Met.*VII.7, 1032a23. On this distinction and its use in the biological works, see Lennox (2001a), 182-204.
[38] Charles (1991), 102-103.
[39] *Ph.*II.9, 200b3-4.
[40] *Ph.*II.8, 199b8.
[41] *Ph.*II.8, 13-14.
[42] *Ph.*II.9, 200b5-8.
[43] *Ph.*II.8, 198b24-28.

(c) health as the end of walking.[44]

Broadly speaking, Aristotle identifies as final causes (a) actual natural substances or artifacts that are the outcome of a process of generation; (b) functions that are performed by parts of living beings or by tools; and finally (c) objects of desire that are acquired through actions.

The first type of final cause, constituted by actual natural substances or artifacts, is picked out in explanation of why processes of natural or artificial generation take place. For Aristotle, processes of coming to be always involve the reproduction of form,[45] consisting in the realization of a pre-existing form in a new entity.

In natural processes, the form of the natural being that comes to be is present in potentiality in the seed of its father, who possess this form in actuality. The mother of the natural being contributes the matter in the form of the menstrual fluid, which is blood that is concocted up to a certain point: it is in potentiality the same in form as the mother is, but lacks the source of soul (*GA* II.3, 737a28-9; *GA* II.4, 740b19-25). The source of soul or the initial efficient cause are provided by the father, or more specifically by his seed, which possess 'movements' (*GA*.I.22, 730b5-32); however, once the heart of the embryo has come into being, this provides the new being's own source of motion through which it can realize its form (*Ph*.II.8, 199b15-17). The goal of the process of natural generation is the full realization of this potentiality for form[46] that is transmitted by the father into the new entity and that is inherent in the new entity from the moment of its fertilization.[47]

The core of Aristotle's teleological theory of natural generation lies thus in the fact that whatever comes to be already possesses that form in potentiality, and that its source already possesses that form in actuality.[48] Empedocles is criticized by Aristotle exactly because he failed to see these facts (*PA*.I.1, 640a22-26):

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[44] *Ph*.II.3, 194b33-34.
[45] Lennox (2001a), 231.
[46] Gotthelf calls this potential the 'irreducible potentiality for form'; Gotthelf (1987), passim. I will later return to the question of to what extent this potential is really 'irreducible'.
[47] Bradie & Miller (1999, 79) label this type of final cause 'the actualization of natural potentialities'.
[48] Witt (1994b), 222-228.

> ἀγνοῶν πρῶτον μὲν ὅτι δεῖ τὸ σπέρμα τὸ συνιστὰν ὑπάρχειν τοιαύτην ἔχον δύναμιν, εἶτα ὅτι τὸ ποιῆσαν πρότερον ὑπῆρχεν οὐ μόνον τῷ λόγῳ ἀλλὰ καὶ τῷ χρόνῳ· γεννᾷ γὰρ ὁ ἄνθρωπος ἄνθρωπον, ὥστε διὰ τὸ ἐκεῖνον τοιόνδ' εἶναι ἡ γένεσις τοιάδε συμβαίνει τῳδί.
>
> "He failed to see, first, that the seed previously constituted must already possess this sort of potentiality, and, next, that the producer was prior not only in definition but in time; for it is the man that generates a man, and therefore it is because that man is such, that this man's coming to be happens so."[49]

There is thus no backwards pull by final causes from the future:[50] it is the form that is present from the outset, received from another natural being in which that form has already been realized, that determines the outcome of the process of generation which is its actualization and final cause; it is the fully actualized form of the father that is used as a starting point of the explanation of the development of the offspring.

In artificial processes, the form of the artificial product that comes to be is present in the art, which is present in the soul of the craftsman. The matter is provided by whatever natural materials are available to the craftsman. It is through the movements of the tools employed by the craftsman following the form that is present in his soul that the form of the artificial product is transferred to some new material (which possess this form in potentiality) and is realized (so that the material possesses this form in actuality). Art is thus both the formal and the efficient cause in artificial production, both of which are residing in the craftsman (*GA*.II.1, 735a2-4; *GA*.II.4, 740b25-29). The goal of the process of artificial production is the full realization of the potentiality for form that is transmitted by the craftsman into some new material; (unlike nature) the craftsman thus does not reproduce his own form, but rather that of the art that he possesses in his soul.[51]

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[49] Cf. *GA*.II.1, 735a3-4.

[50] This misunderstanding of Aristotle's theory of natural teleology still persists among some philosophers of biology; see, for instance, Buller (1999), 5.

[51] Note that while the form of art is mediated by the mind of the craftsman (he works with a mental model of the finished product; *Met*.VII.7, 1032b1-25; cf. Hankinson(1998), 134), his intentions or aims are not strictly speaking part of the causal explanation of artifacts. This is why Aristotle uses artificial productions as an analogy to natural generation, and why he does not recognize mistakes of conception (i.e. in the sense that there is something wrong with the design drawn up by the craftsman), but only of production and of failing materials (*Ph*.II.8, 199a34-b5; pace Matthen, 2006; 2). I will return to this subject below in 1.2.1.

The second type of final cause, which is constituted by functions, is invoked in the explanations of the presence of (the material make-up and formal structure of) natural and artificial instruments. Just as actual natural beings and artifacts are the realizations of pre-existing forms, so are these functions the actualizations of pre-existing capacities for activities (residing in the soul or in the material potentials of something).[52] The functions play a contributory role in the system of which they are part; they are ends "above and beyond actuality (*EN*.I.1, 1094a4-5: τὰ μὲν γάρ εἰσιν ἐνέργειαι, τὰ δὲ παρ' αὐτὰς ἔργα τινά)," that is, they supervene on the actual natural substances (or their parts) and artifacts that are ends themselves (e.g. a finished house is the final cause of the art of building, while shelter is the function of that house). Natural functions are the capacities to perform the distinctive life-functions of each kind of animal, which are grounded in and activated by the animal's soul. Artificial functions will be the various uses made by artists of tools for the sake of artistic production.

The third type of final cause, constituted by objects of desire, is picked out in the explanation of action. Since action does not involve a replication of form, the model of teleological explanation that Aristotle employs in these cases is very different from that of natural or artificial generation in that it is *intentional* in nature. It is the desire of a living being for something that directs that living being towards that object as an efficient cause; the living being is both awareness of the goodness that the goal has to him, and – in the case of human beings – also of the best means towards the achievement of that goal.[53] The object of desire are ends only in the sense that once they (as efficient causes) have activated the animal's capacity of perception, desire, and locomotion, the movements of the animal are directed towards this object.

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[52] The functions are those *erga* that play a contributory role in the system of which they are part. The addition of 'contributory' reflects the way Aristotle connects something's 'work' to his notion of the good: not every feature of a system is an end (e.g. the fact that the beating of the heart produces noise), but only those features that contribute to the system to which they belong (e.g. the fact that the beating of the heart – in Aristotle's theory – produces heat).

[53] Cf. Charles (1991), 107-108. By distinguishing art and agency in this way, I hope to solve the problem Charles (1991; 106) notes with regard to the plurality of types of final causes and teleological relations sketched in *Ph*.II.; the concept of teleological causation is unified in the cases of art and nature in that both consist in the replication of a pre-existing form, where the realization of this form constitutes the final cause; for the cases of agency, Aristotle employs a completely different concept of teleological causation, namely one that is intentional in nature.

I will use these distinctions between three types of ends to lay out the causal relations between final causes and the other three causes.

### *1.1.2.b Material potentials and function*

Let me start by giving a basic sketch of the interdependence of matter and the final cause. The material make-up of artifacts and (parts of) natural substances alike is *determined* (to various extents in artifacts and natural substances) by final causes in the sense of function. For Aristotle, the relation between function and the material constitution of something is one of conditional necessity (*Ph.*II.9, 200a10-15):

> οἷον διὰ τί ὁ πρίων τοιοσδί; ὅπως τοδὶ καὶ ἕνεκα τουδί. τοῦτο μέντοι τὸ οὗ ἕνεκα ἀδύνατον γενέσθαι, ἂν μὴ σιδηροῦς ᾖ· ἀνάγκη ἄρα σιδηροῦν εἶναι, εἰ πρίων ἔσται καὶ τὸ ἔργον αὐτοῦ. ἐξ ὑποθέσεως δὴ τὸ ἀναγκαῖον, ἀλλ' οὐχ ὡς τέλος· ἐν γὰρ τῇ ὕλῃ τὸ ἀναγκαῖον, τὸ δ' οὗ ἕνεκα ἐν τῷ λόγῳ.
>
> "Thus on account of what is a saw like this? That this may be, and for this. It is impossible, however, that this thing which it is for should come to be, unless it is made of iron. *It is necessary, then, that it should be made of iron, if there is to be a saw, and its work to be done*. The necessary, then, is necessary starting from some hypothesis,[54] and not as an end: the necessary is in the matter, the 'that for the sake of which' in the form."

If there is to be a saw that *saws*, it must be made from some strong and solid material, like iron, and the same holds for bodily instruments:[55] if there is to be a functioning (natural or artificial) instrument, then it has to be made from a certain type of material with certain material potentials[56] which will have to be present first and undergo certain changes,[57] if the instrument is to come about. The final and the

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[54] On the connection between the expression '*ex hypotheseôs*' and the idea of conditionality, see Bobzien (2002), 363.

[55] Cf. *PA.*I.1, 642a8-13: "And this is, as it were, conditionally necessary; for just as, since the axe must split, it is a necessity that it be hard, and if hard, then made of bronze or iron, so too since the body is an instrument (for each of the parts is for the sake of something, and likewise also the whole), it is therefore a necessity that it be of such a character and constituted from such things, if that is to be."

[56] In the case of the generation of natural parts and substances, the material properties will even be more strongly determined by the function(s) they will need to perform; on this issue, see below 2.1.2.

[57] Aristotle's notion of conditional necessity seems to be restricted to material conditions that are necessary for the performance of a function. On the other hand, Aristotle sometimes gives examples that at least seem to imply that a 'maker' or 'producer', i.e. an efficient cause, also belongs to the necessary conditions; see, for instance, *PA.*I.1, 639b25-30 ("It is necessary that a certain sort of matter be present if there is to be a house or any other end, and this must come to be and *be changed first*, then that, and so step by step up to the end and that for the sake of which each comes to be and is.") and *GA.*II.6, 743a21-26 ("But it is not anything whatever that is made into flesh or bone by the heat, but only something naturally fitted for the purpose; nor is it made in any place or time whatever, but only in a place and time naturally

material cause are thus intrinsically connected to each other: the need for some function to be realized conditionally necessitates the coming to be of a material with certain potentials, while the presence of those materials with their particular material potentials facilitates the performance of functions.

### *1.1.2.c The efficient cause as the producer of end products*

The efficient and final cause in natural generation and artificial production are always complementary to each other:[58] the efficient causes in these generations are always limited by and directed towards the final cause, while the end that constitutes the final cause is the outcome of this efficient causal process.

Aristotle describes the interrelation between efficient and final causation as follows: (*GA*.II.6, 742a16-b18; 742a28-36):

> τριῶν δ' ὄντων—ἑνὸς μὲν τοῦ τέλους ὃ λέγομεν εἶναι οὗ ἕνεκα, δευτέρου δὲ τῶν τούτου ἕνεκα τῆς ἀρχῆς τῆς κινητικῆς καὶ γεννητικῆς (τὸ γὰρ ποιητικὸν καὶ γεννητικόν, ᾗ τοιαῦτα, πρὸς τὸ ποιούμενόν ἐστι καὶ γεννώμενον), (…) πρῶτον μὲν ὑπάρχειν ἀναγκαῖόν τι μόριον ἐν ᾧ ἡ ἀρχὴ τῆς κινήσεως (…), ἔπειτα μετὰ τοῦτο τὸ ὅλον καὶ τὸ τέλος, (…).
>
> "Thus there are three things: first, the end, by which we mean that for the sake of which something else exists; secondly, the principle of movement and of generation, existing for the sake of the end (for that which can make and generate, considered simply as such, exists only in relation to what is made and generated); (...). Accordingly, there must first be some part in which the principle of movement is (...); next after this the whole and the end (…)."

The efficient cause is the origin or beginning of the continuous movement or change, which needs to stay operative throughout this movement or change (or transmit its motion to another moving cause; causation for Aristotle requires contact).[59] In the case of natural generation, we saw that the efficient cause is first identified with the father who sets the process of generation in motion, then with the motive power residing in the male semen, and finally with the formal nature or the soul of the living being which, as it were, 'produces' or 'makes' and then sustains

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so fitted. *For neither will that which exists potentially be made except by that moving agent which possesses the actuality, nor will a box be made out of the wood without the carpenter.*"); cf. Lennox (2001a), 102 and Lewis (1988), 87n8.

[58] Broadie (1990), 391.

[59] For this distinctive aspect of efficient causation in Aristotle, see Hankinson (2007), 5.

that living being from the inside out.[60] The actual living being, and its parts, comes to be as an end result of this process of 'natural production'. In the case of artistic production, we saw that the efficient cause is the art, which is present in the soul of the craftsman. In both cases, the endpoint of this movement or change is given with the form that is being realized: once this form is realized, and the generation has reached the end that constitutes its final cause, the process ends.[61] Aristotle argues that the two causes are in fact complementary (*Ph.*II.3, 195a8-11):[62]

> ἔστιν δέ τινα καὶ ἀλλήλων αἴτια, οἷον τὸ πονεῖν τῆς εὐεξίας καὶ αὕτη τοῦ πονεῖν· ἀλλ' οὐ τὸν αὐτὸν τρόπον, ἀλλὰ τὸ μὲν ὡς τέλος τὸ δ' ὡς ἀρχὴ κινήσεως.
>
> "And some are also causes of one another, as training is a cause of fine condition, and this in turn is a cause of training, though again not in the same way, but the one as end and the other as source of motion."

This means that final causes can never operate in a vacuum – ends are realized in conjunction with an efficient cause that is directed towards this end. The actual realization of an end implies that some kind of active efficiency has taken place.[63] The reason for this is that in natural generation, as in artificial production, the final, the formal, and the efficient cause "coincide" (*Ph.*II.7, 198a24-7):

> ἔρχεται δὲ τὰ τρία εἰς [τὸ] ἓν πολλάκις· τὸ μὲν γὰρ τί ἐστι καὶ τὸ οὗ ἕνεκα ἓν ἐστι, τὸ δ' ὅθεν ἡ κίνησις πρῶτον τῷ εἴδει ταὐτὸ τούτοις· ἄνθρωπος γὰρ ἄνθρωπον γεννᾷ.
>
> "In many cases three [of these causes] run together; for what something is and that for the sake of which it is are the same, while that from which motion first originates is the same as them in kind: for man generates man."

The efficient cause of the father is not numerically the same as the efficient cause of the son, but they are the same in kind: both efficient causes are directed towards the realization and maintenance of the same form,[64] which in its fullest expression constitutes the final cause.

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[60] Hankinson (2007), 7-9.

[61] Cf. *DA.*II.4, 416a15-18: "For while the growth of fire goes on without limit so long as there is a supply of fuel, in the case of all complex wholes formed in the course of nature there is a limit or ratio which determines their size and increase, and limit and ratio are marks of soul but not of fire, and belong to the side of account rather than that of matter."

[62] Cf. *EE.*I.8, 1218b11-22; *Met.*I.3, 983a31: "in a third way [we speak of a cause as] the source of the change, and in a fourth the cause opposed to this (τετάρτην δὲ τὴν ἀντικειμένην αἰτίαν ταύτῃ), that for the sake of which and the good – for this is the end of all generation and change."

[63] Cf. Broadie (1990), 391.

[64] Moravcsik calls it a 'built-in schedule of development and maintenance;' Moravcsik (1994), 236.

### *1.1.2.d Forms are realized for the sake of activities*

Aristotle analyzes natural generation and artistic production in terms of the transmission of form from something which has that form in actuality to something which is capable of receiving it because it possesses that same form in potentiality.[65] This relation between form in potentiality and form in actuality is a teleological one, since potentiality is for the sake of actuality (*Met.*IX.8, 1050a4-10).[66]

> Ἀλλὰ μὴν καὶ οὐσίᾳ γε, πρῶτον μὲν ὅτι τὰ τῇ γενέσει ὕστερα τῷ εἴδει καὶ τῇ οὐσίᾳ πρότερα (οἷον ἀνὴρ παιδὸς καὶ ἄνθρωπος σπέρματος· τὸ μὲν γὰρ ἤδη ἔχει τὸ εἶδος τὸ δ' οὔ), καὶ ὅτι ἅπαν ἐπ' ἀρχὴν βαδίζει τὸ γιγνόμενον καὶ τέλος (ἀρχὴ γὰρ τὸ οὗ ἕνεκα, τοῦ τέλους δὲ ἕνεκα ἡ γένεσις), τέλος δ' ἡ ἐνέργεια, καὶ τούτου χάριν ἡ δύναμις λαμβάνεται.
>
> "But [actuality] is also prior in substance; firstly, because the things that are posterior in becoming are prior in form and in substance (e.g. man is prior to boy and human being to seed; for the one already has its form, and the other has not), but also because everything that comes to be moves towards a principle, namely an end (for that for the sake of which a thing is, is its principle, and the becoming is for the sake of the end); *and the actuality is the end, and it is for the sake of this that the potentiality is acquired*."

Forms are transmitted in generation for the sake of the realization of that form in a new natural being (or artifact), and this realization of form is itself for the sake of activity (*PA.*I.5, 645b14-20):

> Ἐπεὶ δὲ τὸ μὲν ὄργανον πᾶν ἕνεκά του, τῶν δὲ τοῦ σώματος μορίων ἕκαστον ἕνεκά του, τὸ δ' οὗ ἕνεκα πρᾶξίς τις, φανερὸν ὅτι καὶ τὸ σύνολον σῶμα συνέστηκε πράξεώς τινος ἕνεκα πολυμεροῦς. Οὐ γὰρ ἡ πρίσις τοῦ πρίονος χάριν γέγονεν, ἀλλ' ὁ πρίων τῆς πρίσεως· χρῆσις γάρ τις ἡ πρίσις ἐστίν. Ὥστε καὶ τὸ σῶμά πως τῆς ψυχῆς ἕνεκεν, καὶ τὰ μόρια τῶν ἔργων πρὸς ἃ πέφυκεν ἕκαστον.

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[65] Hankinson (2007), 10; for the principle of 'causal synonymy' (i.e. the principle that the causes that transmit form in effecting change are synonymous with their effects), see Bodnár (2006), 5-7.

[66] This type of explanation in terms of 'potential being' being for the sake of 'actual being' in answer to the question of the being (the identity and unity) of substances, is what Witt (1998) singles out as 'metaphysical teleology'. I disagree with her claim, however, that "metaphysical teleology has not a word to say" on the central explananda of natural teleology, which are according to her the presence and formation of parts and the generation of animals; see Witt (1998), 257. In the chapter on teleology in biology, I will show that Aristotle in his explanations of animal development is *also* concerned with being. For, as it turns out, the causes that explain the coming to be of a part are not always the same as those that explain its presence; often, Aristotle needs to provide an extra explanation for why animals have the features they have or why certain available materials are not disposed off but put to a good use. Moreover, while Aristotle may not address the question of what it is to be a substance in the biological works, he does address the question of what it is for an animal to be the animal it is (which pertains to the questions of the unity and identity of substance), both in his biology and in his psychology.

> "Since every instrument is for the sake of something, and each of the parts of the body is for the sake of something, and *what they are for the sake of is a certain action*, it is apparent that the entire body too has been constituted for the sake of a certain manifold action. For sawing is not for the sake of the saw, but the saw for sawing; for sawing is a certain use. So the body too is in a way for the sake of the soul, and the parts are for the sake of the functions in relation to which each of them has naturally developed."

Potentiality is for the sake of actuality, and this is for the sake of activity:[67] the whole process of generation is directed towards an ever fuller realization of form, which culminates in a state of full actuality, which constitutes the final cause. It is in this sense that formal and final causes are said to be "almost one (ἕν τι σχεδὸν)."[68] The ultimate final cause is the living being's life.[69]

In some cases, Aristotle also pairs the four causes together in two contrasting groups. This may suggest an ontological division of types of causes that do and do not go together, but I think it rather means that Aristotle singles out certain aspects of the causal pattern (that in fact may or may not include all four causes) for the sake of clarity of explanation.

For instance, sometimes Aristotle contrasts matter and form with efficient and final causes. The combination of matter and form is taken to provide mainly an explanation of being, that is, of the static composition of things that are (i.e. the composite substances). If one focuses on the *result* of a process of generation, the properties of that thing can be explained best in terms of its structure and material potentials. On the other hand, the combination of efficient and final causes is invoked in particular to explain the dynamic processes of coming to be (i.e. natural generation, artistic production, and deliberative action). If one focuses on the process of generation itself, the properties of that process can be explained best in terms of the origin of change and the direction and destination of the change.

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[67] *Met.*IX.8, 1050a21-23.
[68] E.g. *GA*.I.1, 715a4-6.
[69] Formal and final causes are also connected in the sense that forms or essences are themselves "determined by their role in a teleological system;" Charles (1988), passim; Charles (1991), 102. For Aristotle's claim that things are defined by their function or typical activity, see e.g. *Meteor.*IV.12, 390a10-12 and *Pol.*I.2, 1253a19-25.

At other times Aristotle joins the formal and final cause together,[70] while contrasting them with the material and efficient cause.[71] The first pair is singled out as the basis of proper teleological explanation, which stands out from all other types of explanation in that it concerns a formal cause whose full realization is the final cause of the process. Processes that do not have a fully realized form as an outcome that can properly be defined as its end *and* that do not involve some kind of form that is prior to and causative for the process, do not generate teleological explanations. The latter pair of material and efficient causation is supposed to pick out the typical workings of necessity (usually material necessity), which involves materials moving and acting according to their own natures without the structuring presence of form and unconditional upon some end that is to be realized.

## 1.2 Three Models of Teleology: Natural Generation, Artistic Production, and Deliberative Action

The most striking characteristics of Aristotle's introduction of teleological explanation in the *Physica* are his appeal to art or artistic production as an analogue for his conception of nature, and his use of examples of both artistic production and deliberative action to illustrate natural goal-directedness. This indicates that Aristotle in fact employs a threefold model of teleology, according to which nature, artists, and agents in general are all claimed to act along similar, but different teleological patterns. This plurality of teleological models has been thought to threaten the unity of Aristotle's theory of teleology, and hence his success in justifying his use of teleology as a principle of explanation in the natural sciences.[72] Others believe that the analogy between natural teleology and cases involving agency, and Aristotle's failure to distinguish clearly between these two,[73] bring in false or unsubstantiated claims concerning the operation of natural teleology.[74]

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[70] E.g. *GA*.I.1, 715a4-6; *GA*.I.1, 715a8-9; *GA*.V.1, 778b11-19; *DA*.II.4, 415b10-12.
[71] E.g. *GA*. II.1, 731b18-24; *GA*.V.1, 778b1-10; *GA*.V.8, 789b19-22. Cf. Cooper (1982), 201; Dudley (1997), 111.
[72] E.g. Charles (1991), 102-104; 109-110.
[73] Charles (1991), 118-119; 124; 127.
[74] E.g. Bolotin (1998), 35; Broadie (1990), 401; Owens (1981), 145.

In this section, I will explore the teleological models of artistic production and of deliberative action, each in conjunction with the model of natural teleology. I shall argue for the (more charitable) position that Aristotle puts each analogy to its own specific use, and is very clear about what parts of the base domain of the analogy (i.e. art, agency) may be mapped onto the target domain (i.e. nature) so as to prevent faulty inferences. The model from the arts will prove to be much more important as an analogy to natural generation than the agency model, exactly because Aristotle does not want to introduce intentions into the operations of nature. However, both the agency and the art model – so I will argue – are used for didactic purposes; Aristotle's model of natural teleology is not dependent on either of these two models, and therefore I do not believe that his justifications for assuming the internal, non-intentional goal-directedness of nature are threatened.

### *1.2.1 The analogy between nature and art in teleological explanations*

#### *1.2.1.a Preliminary overview of Aristotle's uses of the concept of art in the Physica*

The concept of *technê* (here translated by 'art')[75] plays an important role in Aristotle's exposition and defense of natural teleology. Within the *Physica*, the term *technê* is only used in the second book, and always in analogy to or in contrast with nature. Many of the examples used in the second book of the *Physica* are taken from the arts (see especially the examples used to illustrate Aristotle's theory of causal explanation in *Ph.*II.3 and *Ph.*II.7), and Aristotle often draws an analogies between the two domains.

For instance, as we have seen already, Aristotle first employs the model of the arts in his preliminary investigation into the concept of nature in *Ph.*II.1. In this chapter, nature is defined in *contrast* with art or products of art that do not have an internal source of change. The question of whether or not something has an internal source of change will remain a crucial difference between art and nature throughout the *Physica*,[76] also when Aristotle uses the concept of art as analogous to that of

[75] 'Art' seems the most common translation of *technê*; but see Hankinson (1998), 128n.2 and Löbl (2003), 258-264, who point out that the notion of *technê* is in fact broader than that of the arts: it includes what we would call crafts, skills, and applied sciences.

[76] This distinction is even more crucial than the question of the presence or absence of intentionality, as I will explain below.

nature. In this context, Aristotle uses the concept of art to accentuate the defining features of nature.

The analogy, rather than the contrast between art and nature, figures prominently in *Ph.*II.2, 194a22-27. In this passage, Aristotle introduces his famous adage that 'art imitates nature', but framed in a conditional sentence: *if* indeed art imitates nature, and *if* it belongs to the same branch of knowledge to know both form and matter as it belongs in art, then the student of nature, too, should study both matter and form. Aristotle does not argue for the analogy between art and nature, but rather posits it in a hypothetical way. The suggested inference serves as an *a fortiori* argument: because in art it is obvious that a craftsman, such as a builder, has to have knowledge of both the form of a house and of which kinds of materials to use, we may draw the conclusion that the same holds for the student of nature. In this context, Aristotle uses the argument primarily to *induce* further conclusions concerning nature and thereby to *strengthen* his argumentation.

However, it is not until in *Ph.*II.8, 199a8-20 that we touch upon Aristotle's most important and complicated use of the analogy. Here Aristotle uses the analogy between the goal-directedness of nature and the goal-directedness of art in order to *defend* the very existence of natural teleology. I will not go into the details of this argument just yet, but would instead like to call attention to the fact that again the argument that is established is an *a fortiori* one. The argument for the goal-directedness of nature hinges on the acceptance of the claim that art is goal-directed and that nature is ontologically prior to art.

This overview of the various uses of the analogy between nature and art should suffice as a preliminary framework within which we can assess the importance of the model of artistic production.

#### *1.2.1.b The importance of the teleological model of artistic production*

In modern scholarship, there is little agreement over the overall importance of the teleological model of artistic production.

According to some interpreters, Aristotle's model of natural teleology is in fact based on the etiology of artifacts.[77] Because the active exercise of art is evidently goal-directed, it is argued that therefore the model of art must have offered Aristotle the metaphysical schema for his theory of natural generation.[78] This interpretation places the analogy between nature and art at the heart of Aristotle's defense of natural teleology, and considers the analysis of art to be a central heuristic within Aristotle's scientific methodology. Other interpreters have downplayed the importance of the art analogy. In their view, the analogy is not fundamental to Aristotle's concept of natural teleology,[79] but rather serves a didactic function in explaining how natural teleology operates.[80] I believe this latter view to be right, for the following two reasons.

First, Aristotle offers a more fundamental argument in favor for the assumption of final causality in nature independently of the analogy between art and nature (this is the notorious rainfall example in *Ph.*II.8, 198b32-199a2, which will be discussed below in 1.3).[81]

Second, Aristotle does not fail to stress the differences between the two domains. This is important, for Aristotle inherited the teleological model of the arts from Plato,[82] whose concept of natural teleology was itself modeled on and perhaps also metaphysically grounded in (intelligent) artistic production.[83] Against this view, Aristotle argues for the ontological priority of nature which is imitated and improved by art,[84] while attributing to art only epistemological priority (because it is 'closer to us').[85] Aristotle's analysis of art is based on the same ontological framework as his analysis of nature, only because art is itself dependent on nature.[86] I believe that

[77] Granger (1993), 168 (Granger actually takes Aristotle's theory of action to be the model behind Aristotle's teleology, which is then exemplified in art); Matthen (2007), 1.
[78] This position is defended by Broadie (1990), 393-396; see e.g. 395-6: "Now this is the conception that the art analogy is surely intended to hammer home: the conception, namely, of particular physical things as themselves metaphysical centres of the development towards form. (...) By taking art as model for the specific natures of particular physical objects, Aristotle unambiguously declares their status as metaphysical centres of activity. Without the art analogy we should still have teleological explanation, but not the Aristotelian concept of natural substances."
[79] E.g. Wieland (1975), 151.
[80] E.g. Cooper (1982), 198n.2.
[81] Cooper (1982), 198; 216.
[82] Furley (2004), 71-72.
[83] Johansen (2004), 83-86; Lennox (2001a), 281.
[84] Pace Charles (1991), 115.
[85] Cf. Granger (1993), 174.
[86] Cf. Katayama (1999), 79-80; 101-108.

Aristotle uses the teleological model of art to illuminate the workings of nature, but does not need this model to justify his assumption of natural teleology.

The key passage in determining the importance of the analogy is the first argument Aristotle provides in favor of the existence of natural teleology. Let me quote the passage in full (*Ph.*II.8, 199a8-20):

> ἔτι ἐν ὅσοις τέλος ἔστι τι, τούτου ἕνεκα πράττεται τὸ πρότερον καὶ τὸ ἐφεξῆς. οὐκοῦν ὡς πράττεται, οὕτω πέφυκε, καὶ ὡς πέφυκεν, οὕτω πράττεται ἕκαστον, ἂν μὴ τι ἐμποδίζῃ. πράττεται δ' ἕνεκά του· καὶ πέφυκεν ἄρα ἕνεκά του. οἷον εἰ οἰκία τῶν φύσει γιγνομένων ἦν, οὕτως ἂν ἐγίγνετο ὡς νῦν ὑπὸ τῆς τέχνης· εἰ δὲ τὰ φύσει μὴ μόνον φύσει ἀλλὰ καὶ τέχνῃ γίγνοιτο, ὡσαύτως ἂν γίγνοιτο ἧ πέφυκεν. ἕνεκα ἄρα θατέρου θάτερον. ὅλως δὲ ἡ τέχνη τὰ μὲν ἐπιτελεῖ ἃ ἡ φύσις ἀδυνατεῖ ἀπεργάσασθαι, τὰ δὲ μιμεῖται. εἰ οὖν τὰ κατὰ τέχνην ἕνεκά του, δῆλον ὅτι καὶ τὰ κατὰ φύσιν· ὁμοίως γὰρ ἔχει πρὸς ἄλληλα ἐν τοῖς κατὰ τέχνην καὶ ἐν τοῖς κατὰ φύσιν τὰ ὕστερα πρὸς τὰ πρότερα.
>
> "Further, in those things in which there is an end, what is earlier and successive is done for the sake of that. As it is done, so is it by nature, and as it is by nature, so is each thing done, if nothing interferes. But it is done for the sake of something: and therefore it is also by nature for the sake of something. For example, if a house were to be among things that come to be by nature, it would come to be in the same way as it does now by art. And if things that come to be by nature came to be not only by nature but also by art, they would come to be in the same way as they do now by nature. Each is for the sake of the other. In general, art will complete on the one hand the things which nature cannot bring to a finish, on the other hand imitate her. If now the things according to art are for the sake of something, it is clear that so too are the things that are according to nature. For the relation of things that are later to those which are earlier are the same among the things that are according to art and in those that are according to nature."

The analogy for which Aristotle argues here between the teleological processes of production in art and generation in nature is twofold:[87] (i) if there is a sequence of which there is an end, the previous motions leading up to this end must have been for the sake of this end; the sequence is organized and teleological (*Ph.*II.8, 199a8-9); (ii) the temporal ordering of the various steps in the sequence leading up to the end are determined by this end (and are thus to be explained teleologically; *Ph.*II.8, 199a18-20).

[87] Charles (1991), 114-115.

The whole argument in which these basic features of teleological generation are presented runs something like this: 'artistic processes supervene on natural processes (art is limited to the imitation and completion of natural goals, which it achieves by means congenial to nature), and if artistic processes are for the sake of something, then evidently (δῆλον; *Ph.*II.8, 199a17) natural processes, too, are for the sake of something – evidently, because the relations of priority and posteriority are the same in natural and artistic processes.' Aristotle does not offer any evidence for the goal-directedness of artistic production, nor for the ontological priority of nature over art.[88] The goal-directedness of both is presupposed in this passage, which suggests that Aristotle's defense of natural teleology does not lie in this analogy.

*1.2.1.c The four main points of analogy between the workings of art and nature*

The analogy Aristotle draws between art and nature to illustrate the workings of the latter usually pertains to one of the four following aspects:[89]

First of all, because Aristotle holds that the causes that are involved in artificial production are the same as in natural genesis, but are more clearly differentiated, the model of art exemplifies Aristotle's account of natural generation really. For instance, both artifacts and the products of nature are compounds of matter and form, but in artifacts the two 'components' are more easily distinguishable, because the material component can actually persist outside the compound (bricks are still bricks long after the house has been broken down), which is not the case in the products of nature (a severed hand is only a hand homonymously). Moreover, what is replicated in both cases is form:[90] in the one case it is the form of the specific art's product (which is molded in the material by an external artist guided by that form), in the other the form of the specific animal species (which comes to exemplify itself in an organic body by its own internal source of change).

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[88] Aristotle simply seems to consider it to be a basic fact that artistic processes are goal-directed and that ends are present more in nature than in art; cf. *PA*.I.1, 639a19-21: "Yet that for the sake of which and the good are present more in the works of nature than in those of art."

[89] In this overview, I draw heavily from Broadie (1990), 396-397, and Lennox (2001a), 287-290 (the latter actually discusses five distinctive features of craftsmanship in Plato; not all of these features are taken over by Aristotle). I have not tested the four features I list against evidence concerning Aristotle's use of the image of art outside the *Physica* or the *De Partibus Animalium*.

[90] On the pattern of formal replication in the arts and in nature, see Lennox (2001a), 230-232.

A second point of analogy is the way the end and the means to realize the end (or the efficient cause) are not only complementary to each other, but also adjusted to each other. In nature, the efficient, formal, and final causes coincide, such that the formal nature becomes its own internal goal-direct agent of the realization of its *own* form (and not of some other form). In the case of art, the knowledge the craftsman has acquired is precisely for the sake of the reproduction of some specific form in matter: the art of house-building is acquired for and guides the use of tools for the production of houses, the art of shipbuilding is acquired for and guides the use of tools for the production of ships, etc.[91] (For this reason the teleological model of deliberative agency constitutes a less good analogue for nature: there is much more flexibility between the end and the means to an end in cases of deliberative agency, while such a choice is usually absent in art and nature.)[92]

Related to this is the third point of analogy. This concerns the specialization of the arts which resembles the ontological classification of natures: the arts are divided into different kinds of specializations, each of which aims at producing its own specific object. Things with a nature are similarly split into different kinds and species, each of which tends towards the realization of its own specific form or essence.

The fourth and final point of analogy is the reliability and regularity of efficient causation in both domains: because of the above mentioned specialization of the arts, artists will always or for the most part produce the objects that they are supposed to produce, and they will do so almost 'automatically' and without mistakes. Ideally, (and it is the ideal case that is the paradigm) the experienced artist or craftsman will not have to deliberate about which object to produce (a shoemaker produces shoes, not dresses), nor about the means to produce it; his art dictates both.[93] Nature as an internal efficient cause of change and generation operates much in the same way: it realizes on a regular bases its own form, without deliberating over

[91] Cf. Broadie (1990), 397: "It is not as if the capacity, in any given case, could have been used to some other end, or is more than is needed for this."
[92] These first two similarities between nature and art pertain to similarities in the causal framework of generation: in both cases, the same four kinds of cause are operative, but they are easiest distinguishable in the case of arts; this adds to the didactic force of the analogy.
[93] Broadie (1990), 398; cf. Lennox (2001a), 245n.9: "In the established arts, the practitioner need not deliberate how to achieve his desired end."

the ends or the means to this ends, and realizes this form, unless something impedes it, without mistakes.

In sum, Aristotle mainly focuses on art as another source of goal-directed coming to be in addition to nature (as opposed to necessity, luck, and spontaneity), and whose operations are in many ways like those of nature: form is realized in matter through a source of change, and the realized form is the end for the sake of which the change took place; each specific form is realized through its own specific source of change and these realizations are achieved regularly or for the most part, by following a particular sequence of operations, and usually without mistakes (but cf. *Ph.*II.8, 199a33-b7).

The largest difference is, as pointed out above, that natures possess their own *internal* efficient causes through which they realize their own forms, by permeating their material and by realizing form from the inside out. The products of art, on the other hand, are dependent for their realizations on external efficient causes, which are imposed from without on the material in order to dictate the appropriate form on it.

#### *1.2.1.d The non-intentional model of art and nature*

Some scholars believe that the above mentioned difference between art and nature with respect to the internality or externality of the source of change also entails the greatest weakness of the analogy. In the case of art, the efficient cause is located in and operates through a human artist, and human beings are held to operate through intentions, desires, and external needs. If such psychological concepts are to be found crucial for Aristotle's depiction of artistic production, as some scholars think they are,[94] then Aristotle must be accused of introducing intentionality into his concept of natural teleology. On the other hand, if psychological attitudes are not to be included in the causal story of natural teleology because they are not central to artistic production either (which is the view I will defend), we are faced with the challenge of answering the question whether Aristotle can coherently treat nature as

[94] This seems in part to be due to the fact that scholars have insufficiently distinguished between deliberative action (which involves intentions and deliberation) and artistic production (which does not involve intentions or deliberation); see, e.g., Charles (1991), 108 and Johnson (2005), 126; 157; 166.

teleological at all. We will have to explain how a non-psychological natural teleology makes sense.[95]

Let me first refute the view that Aristotle 'psychologizes' natural teleology through the analogy with artistic production. There are two passages in *Ph.*II.8 in which Aristotle points out explicitly that the notion of art that he employs in analogy to nature does not involve deliberation.

The first passage I would like to draw attention to follows immediately upon Aristotle's use of the analogy between art and nature to argue for the existence of natural teleology. In this passage, Aristotle offers support for this conclusion by focusing emphatically on examples of natural processes in which psychological states are absent (*Ph.*II.8, 199a20-30):

> μάλιστα δὲ φανερὸν ἐπὶ τῶν ζώων τῶν ἄλλων, ἃ οὔτε τέχνῃ οὔτε ζητήσαντα οὔτε βουλευσάμενα ποιεῖ· ὅθεν διαποροῦσί τινες πότερον νῷ ἢ τινι ἄλλῳ ἐργάζονται οἵ τ' ἀράχναι καὶ οἱ μύρμηκες καὶ τὰ τοιαῦτα. κατὰ μικρὸν δ'οὕτω προϊόντι καὶ ἐν τοῖς φυτοῖς φαίνεται τὰ συμφέροντα γιγνόμενα πρὸς τὸ τέλος, οἷον τὰ φύλλα τῆς τοῦ καρποῦ ἕνεκα σκέπης. ὥστ' εἰ φύσει τε ποιεῖ καὶ ἕνεκά του ἡ χελιδὼν τὴν νεοττιὰν καὶ ὁ ἀράχνης τὸ ἀράχνιον, καὶ τὰ φυτὰ τὰ φύλλα ἕνεκα τῶν καρπῶν καὶ τὰς ῥίζας οὐκ ἄνω ἀλλὰ κάτω τῆς τροφῆς, φανερὸν ὅτι ἔστιν ἡ αἰτία ἡ τοιαύτη ἐν τοῖς φύσει γιγνομένοις καὶ οὖσιν.
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> "And this is most obvious in the case of the other animals, which make things, neither with art, nor by inquiring, nor by deliberating. Because of this, people wonder whether spiders, ants, and the like produce things by means of intelligence or something else. Proceed a little further and you will find even among plants things that conduce towards an end, like leaves for the sake of protection of the fruit. So if it is both by nature and for the sake of something that the swallow makes the nest, and the spider the web, and the plant the leaves for the sake of the fruit, and the roots do not grow up but down for nourishment, then it is evident that this kind of cause exists in the things that come about and exist naturally."

According to Aristotle, natural teleology is present most obviously in the case of animals and plants that make or do things for the sake of something, but which do not possess art, nor are incapable of having the necessary psychological states

[95] These are the problems raised and addressed by Broadie (1990), 390-391; passim; cf. also Charles (1991), 114-119, and Furley (1996), 67.

involved in purposeful agency (animals lack deliberation, plants lack intentional states altogether).[96] The accomplishment of their goal-directed activities, therefore, cannot be dependent on or caused by intentions or deliberations, which shows that the ends they achieve exist naturally and are not the product of any kind of deliberation. The activities of animals and plants exhibit natural teleology because they are natural, not because of something else.

The second passage that is relevant in this context is the conclusion of *Ph.*II.8. In this passage, Aristotle claims that art does not deliberate and that it is absurd to suppose that the goal-directedness of natural beings is dependent upon deliberation (*Ph.*II.8, 199b26-33):

> ἄτοπον δὲ τὸ μὴ οἴεσθαι ἕνεκά του γίγνεσθαι, ἐὰν μὴ ἴδωσι τὸ κινοῦν βουλευσάμενον. καίτοι καὶ ἡ τέχνη οὐ βουλεύεται· καὶ εἰ ἐνῆν ἐν τῷ ξύλῳ ἡ ναυπηγική, ὁμοίως ἂν τῇ φύσει ἐποίει· ὥστ' εἰ ἐν τῇ τέχνῃ ἔνεστι τὸ ἕνεκά του, καὶ ἐν τῇ φύσει. Μάλιστα δὲ δῆλον, ὅταν τις ἰατρεύῃ αὐτὸς ἑαυτόν· τούτῳ γὰρ ἔοικεν ἡ φύσις. ὅτι μὲν οὖν αἰτία ἡ φύσις, καὶ οὕτως ὡς ἕνεκά του, φανερόν.
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> "It is absurd to suppose that a thing comes to be for something unless the thing which effects the change is seen to have deliberated. *Art too does not deliberate.* If the art of shipbuilding were present in wood, it would act in the same way as nature; so if the 'for something' is present in art, it is present in nature too. The point is clearest when someone doctors himself: nature is like that. So then, it is apparent that nature is a cause, and a cause in the manner of that for the sake of which."

Aristotle not only 'de-psychologizes' nature, but also eliminates deliberation from his conception of art.[97] Artistic productions would come to be in the exact same way if the art of shipbuilding were part of a nature, instead of present in the soul of a shipbuilder: this implies that the presence of intentional states in the shipbuilder does not add anything to the generative process because it does not cause it. Psychological states only matter in the sense that art cannot exercise itself and depends for its actualization on the 'rational potentiality' of the artist, which is a separate psychological component. The example of the person doctoring himself is crucial in this context: it shows that the point of analogy between nature and art is strongest in the case of a process (rare and accidental in art) where the source of

[96] Note that Aristotle mentions three items that plants and animals lack (art, inquiry, and deliberation): presumably, if art involved deliberation, Aristotle would not have mentioned it separately.
[97] This point is well brought out by Broadie (1990), 398 and passim.

change and the end are brought about in and through the same substance, as in this case where "the cause of the patient's health lies within himself."[98] Psychological states are left completely out of the picture.

Although the teleological model of art is didactically prior to that of natural teleology, because 'it is closer to us', what we see here is that Aristotle makes art analogous to nature, and uses nature as the paradigm.[99]

In Aristotle's account, psychological states play no role in type of teleology that is at play in artistic production, and hence should not be mapped onto the workings of natural teleology. This 'de-psychologized' picture of art, however, might encompass another problem for the coherence of the analogy. As has been brought out by Broadie, art is not autonomous in the way nature is.[100] The ends aimed at by art are not themselves intrinsic to that art, but depend on and are determined by human desires and needs. In reality, the arts are dependent on their social context in which they function, and because Aristotle leaves this aspect out of the picture in drawing his analogy between nature and art, he in fact distorts the notion of art.[101] This distortion is considered to be a flaw in the analogy, which threatens the inferences from the one domain to the other altogether.

However, Broadie's demands on the analogy seem to be a bit harsh. She claims that "he [i.e. Aristotle] cannot safely model nature on art, since if we take one thing as model for another, we expect the latter's structure to exhibit *all* that is essential in the former (my italics)."[102] I hope my previous discussions have made clear that Aristotle is well aware of the differences between art and nature on a metaphysical level (and points out these differences if relevant),[103] and that he presents art and nature as being analogical only in certain ways.[104] Since I see no evidence for the belief that Aristotle uses (or needed) the analogy as an argument to metaphysically ground natural teleology, a few disanalogies between the two notions are not necessarily a problem (but are rather to be expected – otherwise art and

[98] Johansen (2004), 77.
[99] Cf. Depew (1997), 222.
[100] Broadie (1990), 400.
[101] Broadie (1990), 401.
[102] Broadie (1990), 401.
[103] E.g. in *Ph.*II.2, 194b7-9; *GA.*II.1, 735a2-4.
[104] Cf. Granger (1993), 174n.9.

nature would be the same). For Aristotle, the analogy between art and nature is a didactic tool, applied to point out and explain the underlying structures of a lesser known system (nature) through its similarities with a well understood system (art). The non-similar aspects of the base domain are not taken into consideration exactly because not all aspects can or need to be mapped onto nature; those that are, on the other hand, are highlighted by Aristotle.

Aristotle's depiction of art might be misleading for the understanding of art itself as Broadie thinks (that is, perhaps, for a historical understanding of the arts in the Greek world),[105] but I believe it is part of the philosophical tradition and therefore not totally alien to Aristotle's students.[106] Plato's Demiurge, the ultimate model of the craftsman, creates the world in a rational and intelligent way, and surely Plato depicts him as having intentions and thoughts.[107] However, this does not make the Demiurge a free agent at all, nor is the model of teleology essentially psychological.[108] According to the *Timaeus*, the world is good and ordered because the Demiurge wanted it to be good, but this order and goodness can only be secured by the assumption of eternal forms as the paradigms of the world. The Demiurge *must* look at the eternal forms and imitate them as well as possible, if he wants to realize his aims.[109] The reason why Timaeus 'opts' for the explanation of the creation of the cosmos through the postulation of a divine craftsman, is because the model of a craftsman who looks at eternal models ensures and necessitates the beauty and

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[105] Although the philosophical emphasis on the proficiency and specialization of the arts is also confirmed by other sources; see, for instance, Xenophon, *Cyropaedia* VIII.2, 5: "That this, however, should be so is no marvel. For just as all other arts are developed to superior excellence in large cities, in that same way the food at the king's palace is also elaborately prepared with superior excellence. For in small towns the same artist makes chairs and doors and plows and tables, and often this same artist builds houses, and even so he is thankful if he can only find employment enough to support him. And it is, of course, impossible for a man of many trades to be proficient in all of them. In large cities, on the other hand, inasmuch as many people have demands to make upon each branch of industry, one trade alone, and very often even less than a whole trade, is enough to support a man: one man, for instance, makes shoes for men, and another for women; and there are places even where one man earns a living by only stitching shoes, another by cutting them out, another by sewing the uppers together, while there is another who performs none of these operations but only assembles the parts. It follows, therefore, as a matter of course, that he who devotes himself to a very highly specialized line of work is bound to do it in the best possible manner." I thank Peter Stork for bringing this passage to my attention. Cf. also Pl.*Rep.*II, 369e-370a.

[106] Pace Broadie (1990), 403.

[107] Johansen (2004), 70; this sketch of Plato's Demiurge relies heavily on the interpretation defended by Johansen (2004), 69-91.

[108] Pace Furley (1996), 62-65, who takes the creation by the Demiurge to be a paradigmatic case of intentional action.

[109] Pl.*Tim.*28a4-b1; Pl.*Gorg.*503d6-504a1. On Plato's concept of craftsmanship, see Lennox (2001a), 287-298.

goodness of the end result, and therefore offers the best explanation of our orderly world.[110] The 'psychology' of the craftsman as an *individual* does not form an important aspect of the philosophical representation (or idealization) of the Demiurge or of the arts in general. On the contrary, Plato often personifies art and makes it produce things seemingly without the interference of craftsmen.[111] As Johansen puts it: "The main difference between Plato's and Aristotle's ordering principle remains that Plato's craftsman works on nature from without whereas Aristotle's works from within. However, our explanation of the ways in which order is realised in nature need not make reference in either case to conscious desires or intentions. Plato's divine demiurge is in this respect at least not unlike Aristotle's master craftsman, nature."[112]

Aristotle rejects Plato's concept of an ultimate and independent goodness, and de-psychologizes the concept of art even more than Plato already did: one could say that for Aristotle the artist is nothing but the tool of the art that he represents. Art operates through the artist,[113] just as the soul operates through the natural body to which it belongs. Moreover, it is the presence of form as the organizing principle of change in *both* processes, which is causally relevant, not the ontological status of form as such.

This also answers the second objection against Aristotle's non-psychological, natural teleology. For Aristotle returns the capacity of natural 'production' to nature itself: natures carry within themselves their own potentials to realize themselves and do not need an external efficient cause in the form of divine craftsmanship. Aristotle thereby dismisses Plato's picture of the natural world as the product of a divine personification of art[114] – while retaining the analogy for didactic purposes. In Aristotle, nature[115] becomes its own non-deliberating craftsman.[116]

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[110] Johansen (2004), 71-76.
[111] For references, see Johansen (2004), 84.
[112] Johansen (2004), 86.
[113] Cf. e.g. *GA*.I.22, 730b15-20: "It is his [i.e. the artist's] hands that move his tools, his tools that move the material; it is his knowledge of his art, and his soul, in which is the form, that move his hands or any other part of him with a motion of some definite kind, a motion varying with the varying nature of the object made."
[114] Lennox (2001a), 280-281.
[115] As Lennox has shown convincingly, nature, in this context, is the nature (or soul) of individual substances, rather than a personified Demiurgic or Cosmic nature over and above the individual natures of natural substances; see Lennox (2001a), 165-171; 183-184.

### *1.2.2 The teleological model of deliberative action*

#### *1.2.2.a Deliberative action contrasted to nature*

The teleological model of deliberative action pertains to human beings who act in a goal-directed way, in virtue of being able to deliberate about the means to a certain end and to make rational choices (*prohairesis*) about which aims to pursue. (These actions should thus be distinguished from movements of animals who also move or act for the sake of something, but only possess a limited form of deliberation and are not able to make rational choices.)

The model is much less pervasive in the second book of the *Physica* than the model of artistic production: only a few of the examples Aristotle offers in this book are taken from the realm of human agency. These examples involve a man who has deliberated as an example of efficient causation (and not teleology; see *Ph.*II.3, 194b30; *Ph.*II.3, 195a22) and the goal-directed actions of walking and going to war (*Ph.*II.3, 194b32-195a3; *Ph.*II.7, 198a19-20). The model is also virtually absent in Aristotle's defense of natural teleology; surely the introduction of the analogy between art and nature in *Ph.*II.8, 199a8-11 is couched in terms of what is 'done' (the verb used is *prattein*), but this is because both art and action are forms of human agency. Examples of goal-directed actions figure most prominently in the account of *tuchê* (luck or fortune) in *Ph.*II.4-6 and *Ph.*II.8, to which I will turn later.

The reason why Aristotle makes so little use of this model is that he does not feel the need of postulating any intentions lying behind the goal-directedness of natural processes so as to be able to account for them. However, intentionality is exactly what makes deliberative actions goal-directed. Aristotle thus uses the model of deliberative action to illustrate goal-directedness in general, but cannot and does not use it as an analogy to natural teleology.[117] Nature is not like a deliberative agent, but like a highly skilled artist. The difference is twofold.

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[116] This also explains why Aristotle will often describe the actions of the formal natures of living beings in terms of craftsmanship; see e.g. *PA.*I.5, 645a9 (*hê dêmiourgêsasa physis*); *PA.*II.9, 654b27-655a4; *PA.*II.1, 647b5-6; *PA.*IV.10, 686a12; and *IA.*12, 711a18. For the close analogy between the generative process in biology and the productive process originated by artists or craftsmen, see e.g. *GA.*I.22, 730b5-32; *GA.*II.1, 734b20-735a4; *GA.*II.4, 740b25-741a4.

[117] Pace Charles (1991), 118-119 (especially n.20).

In the first place, the desires of individual agents play a major role as efficient causes in the account of action, while their role is minimalized in the account of artistic production and absent in natural teleology.

In the causal account of artistic production, it is not really relevant whether Polycleitus or Pheidias made the statue of Aphrodite: the true efficient cause is the art of sculpting that inheres in these individuals, and the true formal cause is the form or the functional definition of a statue of Aphrodite.[118] Both individuals would have followed the same rules of the art of sculpture and the same model in producing the statue. As was pointed out earlier, the (philosophical) concept of art exploits the professionalization and standardization of the productive process, while the individuality of the artist is minimized. Art, represented by or localized in craftsmen, produces the same outcomes on a regular basis, and mostly without mistakes.

In the causal account of deliberative action, on the other hand, the individual's desires, deliberations, beliefs, and choices are crucial. Deliberation in human beings takes the form of a mental plan of a series of actions that are anticipated to lead to some desired state of affairs (*NE*.III.3, 1112b11-1113a2). Moreover, human beings, in virtue of being rational self-movers, are autonomous in their choice for particular ends. The connection between ends and means to this end are less close in the case of deliberative action than they are in nature and art: the connection is not an ontological one, or one that has come forward in the process of the professionalization and streamlining of the arts; rather, the connection is produced by our own human desires and beliefs.[119] There is also more room for mistakes, both in the choice for goals to pursue and in the choice for the means of achieving that goal (*EE*.II.11, 1227b19-22).

In the second place, unlike artistic production and natural teleology, deliberative action is not a process of generation. It represents a different kind of motion (that is, the models differ in genus; see *NE*.VI.5, 1140b1-4), with a different underlying causal structure.

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[118] Cf. Johansen (2004), 83.

[119] This, incidentally, also explains why a given action might result in a completely unforeseen outcome: actions do not involve formal replications through an agent that possesses the form in actuality into matter that possesses the form in potentiality.

The model of deliberative action thus only has a modest didactic function in the context of *Physica*, book two, namely in illustrating goal-directedness.

### *1.2.2.b Deliberative action in the analysis of luck*

In *Ph.*II.4-6 Aristotle focuses his investigation of causes on the notions of luck (*hê tuchê*) and spontaneity (*to automaton*). It is in this context that the teleological model of deliberate action is used most extensively, and mainly in order to differentiate proper teleological human actions from incidental ones which are due to luck;[120] the notion of spontaneity (which is in fact the wider class to which luck belongs) is then explained in analogy to the many examples already offered for the case of luck.

Aristotle points out that according to some people luck and spontaneity are to be counted among the causes of the coming to be of things, but that according to him they are merely 'accidental causes'. This is not to say that Aristotle thinks that things that happen by luck or by spontaneity do not have a cause at all. He rather thinks that they do not have a determinable cause, and in particular, that they do not have a proper final cause. Things that happen by luck or by spontaneity are things that have an outcome that might be profitable or good in some way and thus seem to have happened for the sake of something, but did not happen for the sake of that good (this is called good fortune; luck can of course also be the cause of a bad result, which is then called bad fortune; see *Ph.*II.5, 197a25-32). In any case, the causes of such events are usually not identifiable.

It is in this context that Aristotle offers his famous example of the person who goes to the marketplace for some reason or another, but happens to run into someone "whom he wanted to meet, but did not expect to be there" (*Ph.*II.4, 196a3-5: καὶ καταλαβεῖν ὃν ἐβούλετο μὲν οὐκ ᾤετο δέ). The reason for going to the marketplace could have been, as Aristotle elaborates later (*Ph.*II.5, 196b29-197a8), that the person he met owed him money, and meeting his debtor would give him a chance of getting his money back. So would he in fact have known that his debtor was going to the marketplace, he might have gone there too for the sake of collecting his money. But, as it turns out, this was not the reason why he went to the marketplace (although, of course, he probably had *some* reason for going the market,

[120] For the examples, see *Ph.*II.4, 196a3-5; *Ph.*II.5, 196b29-197a8; *Ph.*II.5, 197a16-18; *Ph.*II.6, 197b23-26; *Ph.*II.6, 197b30-32; *Ph.*II.8, 199b18-22.

such as for instance wanting to go the theatre; *Ph.*II.5, 197a16-18). However, he did receive his money back as the incidental result of going to the market; and this is what Aristotle calls being lucky. Aristotle adds that some people think such a meeting has a definite cause (namely the person's wish to go and attend the market), and that it was not luck that caused it, but Aristotle ridicules this option and also the way his predecessors made use of the notions of luck and spontaneity in their explanations of natural phenomena. His predecessors apparently held that some things are the outcome of luck or spontaneity, yet did not offer a proper account of the way in which these 'forces' were supposed to be causally responsible for the coming to be or presence of things. Other people delegated luck and spontaneity to the realm of the divine and supernatural, making these causes inscrutable for the human mind. This, however, is certainly not Aristotle's view, as he is eager to point out.

After a dialectical discussion of the views of his predecessors, Aristotle starts off his own definition of the notions by pointing out that luck and spontaneity belong to the realm of things that do not happen always or for the most part; they belong to irregular events. However, because we know that there are such things that do not happen always or for the most part, clearly there must be such things as luck and spontaneity (*Ph.*II.5, 196b10-17). More specifically, Aristotle counts luck and spontaneity among the things that come to be for the sake of something.[121] Luck belongs to beings that are able of making rational choices and thus belongs to the realm of deliberative agency (*Ph.*II.5, 197a5-8; *Ph.*II.6, 197b2-13). Spontaneity encompasses all things that might have happened to animals and inanimate beings from nature, but in this case did not. For example, when a horse runs away all of a sudden, and happens to be saved because of that, but did not run away in order to be saved[122] – then Aristotle says it happened accidentally (*Ph.*II.6, 197b14-18).

In sum, the terms luck and spontaneity are used to indicate the causes of irregular and unexpected outcomes. These are outcomes that *typically* come to be due to thought, choice, or nature, but whose cause in these particular cases is either:

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[121] On these two requirements which an event must satisfy to qualify as an outcome of luck or spontaneity (i.e. being rare, and being among the things that are in general for the sake of something), see Judson (1991), 76-82. See also Lennox (2001a), 250-258.

[122] For how could it reasonably have done so – horses do not possess the capacity to think and act in that way.

(i.) An indeterminable cause; the event seems to have been for a purpose, but the expected corresponding action that typically leads to this outcome did not take place. For instance, in the case of luck, when some outcome z ('a falling stone that hits a person') could have been the result of an action that was for the sake of z (e.g. 'someone throwing that stone with the purpose of hitting the other person'), but in fact, that action did not take place, while z did. In that case, z must be the result of some other action that is from our perspective indeterminable; the outcome is called a case of (good or bad) luck. In this scenario, lucky or spontaneous events are only for the sake of something in a non-causal sense: they *might* have been for the sake of something, but in fact, they are not.[123] The examples also suggest another scenario, where the cause is:

(ii.) A determinate cause that has incidental and unforeseen results in addition to having a proper result and final cause. For instance, to take again the case of luck, when a person does x for the sake of y (e.g. 'going to the marketplace in order to litigate as a plaintiff'), and the result was (not only y but also) z (e.g. 'meeting his debtor and getting his money back'), then x is the incidental cause of z and we say that z happened by luck.[124] The outcome is the result of a goal-directed process, but the outcome is not what the process was for, and is thus not explanatory of it.

Proper cases of the teleological model of deliberative action are thus actions that happen for the sake of something, because the agent has decided that this is the action that will allow him to achieve his self-chosen goal, and where the outcomes of those actions are that for the sake of which the actions were undertaken (where the outcome is explanatory of the action, and not in an incidental way). If the goal is not achieved, the action was in vain; if it has an accidental, unforeseen, or unintended outcome, the action was an incidental cause of some good or bad fortune.

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[123] This is largely in agreement with the interpretation of luck and spontaneity defended by Lennox (2001a), 250-258.

[124] Lennox (2001a), 250-258 rejects this second option, first put forward by Porphyry, in favor of the first option, put forward by Simplicius. However, the examples Aristotle offers support both options; Aristotle primary goal in his discussions of luck and spontaneity as I read it is to see in what sense luck and spontaneity can legitimately called causes and how they are to be differentiated from proper goal-directed processes. Both options show luck and spontaneity to be incidental causes, although they might be incidental in different ways. Cf. Boeri (1995), 87-96, who argues along much the same lines.

### 1.3 Aristotle's defense of natural teleology

Aristotle's defense of natural teleology in *Ph.*II.8, and in particular the aporia he raises in this context with regard to the proper explanation of rainfall and the coming to be of animal parts (*Ph.*II.8, 198b16-199a8), are among the most disputed passages in the whole Aristotelian Corpus.

In what follows, I will first offer a general outline of the passage and indicate the problems involved. In the next sections, I will pick up on these problems and offer my solutions to them. Aristotle's purpose in this passage as I understand it is to demonstrate that (while granting the workings and importance of material necessity as a cause of coming to be to his opponents) form, *more* than matter, qualifies as a nature defined as an origin of change. Accordingly, one needs to assume the existence of formal natures that operate as an overarching, but internal and goal-directed source of change in order to account for regular beneficial outcomes. These formal natures are also operative in those cases where material necessity (rather than primary teleology and conditional necessity) is the cause of the coming to be of natural phenomena, as are exemplified by winter-rain and the generation of animal parts such as teeth. That material necessity is a part of nature seems to be presupposed; what Aristotle tries to establish here is that final causation, embedded in the actions of the formal nature, is a part – and that a crucial one – of nature, too.

Ultimately, I hope to show that the crux for the understanding of this passage lies in my distinction between 'primary' and 'secondary' teleology in Aristotle. This is not a distinction Aristotle himself draws explicitly in any of his works,[125] but it is rather evidenced in the separate explanations he gives of the

[125] My distinction between primary and secondary teleology does not rely on Aristotle's own distinction between two types of final causes, that for the sake of which and that for the benefit of which. For instance, when Kullman (1985) uses the term 'secondary teleology' he means that some end is a beneficiary of something, but not a that for the sake of which in a strict sense (see e.g. Kullman (1985), 173). Bodnár (2005; 24-25) distinguishes between two types of teleology in a similar way: in 'straightforward' teleology the goals are not also the beneficiary of the teleological structure, while in inter-species teleology the goals are the beneficiary of the teleological structure. However, I am not sure how this can be right: the natural goal of plants is to realize their own nature and it is the realized plant that benefits from its own realization; the goal of plants imposed by human activity is to serve as food: here the goal (serving as food) and the beneficiary (human beings) of plants are different. Finally, Johnson (2005) uses the distinction between the that for the sake of which and the beneficiary as one of his central

coming to be of natural phenomena and of their presence, and in addition in his use of different verbs of agency to describe the productive actions of the formal nature in the biological works (i.e. 'making' versus 'using'). I will return to this distinction when discussing Aristotle's explanations in the biological works in chapter three (where this distinction is most obvious); for now let me briefly explain what I mean by 'primary' and 'secondary' teleology.

Primary teleology is the teleology that is operative in the realizations of pre-existing forms. Natural beings or their parts are *present* because they are the realizations of some pre-existing form, and their constitutive materials and their structure have *come to be* as the result of conditional necessity. The formal nature of some natural being 'makes' the necessary materials for the realizations of its own form. The natural being or parts that are the full actualizations of those forms are the final causes of both their presence and their coming to be. This is so to speak the default type of teleology. I use the term 'secondary teleology' for those cases in which natural beings or their parts have a final cause (in the strict sense of a that for the sake of which, and not 'merely' in the sense of a beneficiary), but where the constitutive materials or even the whole natural structure did not come to be for the sake of that final cause. In other words, in some cases Aristotle allows things to be for the sake of something even if they are not technically speaking the realizations of some pre-existing form. Usually, Aristotle refers to material necessity as the cause of the coming to be of such materials or structures,[126] which are then 'used' by the formal nature of that natural being for the sake of some good, *because* those materials or structures possess properties that are usable by the formal nature. While primary teleology only pertains to individual formal natures and the realization of their own form, secondary teleology applies both to individual formal natures and – as will

tools to make sense of Aristotle's explanations, but does differentiate between 'primary' and 'secondary' teleology in the way that I do.

[126] Van der Eijk (1997, 238) also hints at a notion of 'indirect teleology' in Aristotle's account of variations: "Thus variations that seem to be merely necessary concomitants of other, purposive biological structures and processes – and thus seem to be *kata phusin* only in the mechanical sense – can sometimes be accounted for *indirectly* as being *kata phusin* in a teleological sense as well" (Van der Eijk's italics). This notion seems to indicate that for Aristotle variations that are the result of incidental material necessity are then *explained* by him as also being for the sake of something. This comes somewhat close to my own notion of secondary teleology, but Van der Eijk does not specify the causal patterns underlying this 'indirect' teleology, nor does he develop this notion any further.

become relevant in my discussion below – to what has been called 'inter-species' teleology, where living beings use each other (for instance) as food.[127]

### *1.3.1 Problems involved in Aristotle's defense of natural teleology in Ph.II.8*

#### *1.3.1.a Teleology versus necessity; intrinsic versus incidental causation*

As often at the beginning of a new section, Aristotle announces the issues to be investigated (*Ph.*II.8, 198b10-12):

> Λεκτέον δὴ πρῶτον μὲν διότι ἡ φύσις τῶν ἕνεκά του αἰτίων, ἔπειτα περὶ τοῦ ἀναγκαίου, πῶς ἔχει ἐν τοῖς φυσικοῖς·
>
> "We must state first the reason why nature (as a source of change) is among the things that are for the sake of something, and next, about necessity, how it is present among the things that are natural."

The reason why Aristotle wants to discuss this subject here is because all his predecessors seem to trace final causation – or at least processes with beneficial outcomes – back to this cause.[128] They claim that things are and come to be in the way they do because of necessity, which is the necessity of the material elements acting according to their own natures and potentials. Even if occasionally they touch upon other causes ('movers' such as love and strife, and mind), they soon wave them goodbye (*Ph.*II.8, 198b14-16; cf. *Met.*I.3-9). While (at least according to Aristotle's account) his predecessors explained all natural phenomena in terms of necessity, Aristotle wants to establish that there are other causes involved, *too*, in addition to and above material necessity.[129] In particular, he wants to establish that nature as a source of change acts for the sake of something.

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[127] Things that have come to be for whatever reason can – if they possess the right properties *from the perspective of the user* – be used for the sake of something within natural beings (e.g. earthy material, because of its defensive potentials, can be used by the formal nature of deer for the production of horns), or among them (e.g. the branches of a tree, because of their water resistancy, can be used by the shipbuilder for the production of ships). The outcomes of these processes of 'using' (e.g. horns or the body of the ship) have genuine functions or final causes (e.g. defense or floating), even though it would not be right to say that they have come to be for the sake of these functions or final causes.

[128] Aristotle does not state explicitly that it is final causation that is traced back (*anagousi*) to necessity, but this reading makes the most sense in the light of the aporia Aristotle raises subsequently about 'beneficial' outcomes that are explained by reference to material necessity. Cf. *GA.*V.1, 778a34-778b1 and *GA.*V.8, 789b2-4.

[129] As Sauvé Meyer rightly points out, Aristotle's complaint about his predecessors is not that they refer everything to necessity as such, but that they are unwilling to seriously consider other types of causes *in addition to* the cause of necessity; Sauvé Meyer (1992), 792-793.

The way Aristotle introduces the issue here pertains directly to one of the most pressing problems in the scholarship on Aristotle's teleology: how exactly does Aristotle think teleology and necessity in nature are related to each other?[130] Recent scholarship has proposed four different interpretations for the way Aristotle perceives this relation between necessity and teleology.

In the first place, based on the way Aristotle contrasts his own teleological view of nature with the views of his predecessors who explain everything in terms of material necessity, scholars have argued that Aristotle must have thought the two views were incompatible with each other, and that Aristotle ultimately denies that there is such thing as material necessity operative in nature that is independent on the operation of teleology.[131]

Others think that for Aristotle the two 'forces of nature' are compatible,[132] but that the operation of material necessity and the actualizations of element potentials as such are *not sufficient* to produce regular, good, or complex results. According to these scholars, natural phenomena could not come about without the operation of a final cause, and therefore explanations in terms of formal and final causation cannot be reduced to explanations in terms of efficient and material causation.[133]

Still others agree that necessity and teleology are compatible in Aristotle's worldview, but do so on the grounds that teleology as opposed to necessity has no ontological consequences. They claim teleology is an explanatory framework which has the sole purpose of making things understandable for us humans. Accordingly they think that teleology is merely used by Aristotle as a heuristic device in his attempt to explain natural phenomena. It is argued that on the level of causation, material and efficient causes are all that is needed to bring about natural phenomena;

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[130] I will return to the question of the relation between teleology and necessity in section 3.4. For the present purposes, an outline of the problem and possible interpretations will have to suffice.

[131] This position has mainly been defended by Balme (1965, 1987a).

[132] This must certainly be true: as we have seen already, Aristotle thinks that final causes are real factors in the natural world, and as we will see in his actual explanations of natural phenomena, Aristotle often refers to both teleology and necessity in accounting for one and the same phenomenon, where this necessity cannot simply be identified with conditional necessity. Moreover, as I will argue more extensively in the chapter on biology, Aristotle acknowledges the existence and operations of material necessity in the realm of sublunary nature.

[133] Stronger and weaker versions of this so-called 'irreducibility thesis' have been defended by amongst others Bradie & Miller (1999), 75; Charles (1988), 1-53; Cooper (1982), 197-222; Gotthelf (1987), 204-242; Irwin (1988), 109-112; Lennox (1982; 2001b); and Waterlow (1982), 69.

on the level of explanation and understanding, however, we need the language of ends and functions in order to make sense of the natural phenomena.[134]

All three views discussed above focus on the question of the compatibility and ontological reducibility of teleology and necessity. However, my own view on these matters is congenial to a fourth type of interpretation, first introduced by Sauvé Meyer (1992) and also defended in some form in Judson (2005) and Matthen (2007), which addresses the problem from a somewhat different perspective. This interpretation dismisses the question of whether or not teleology and necessity are compatible or even reducible to each other as besides the point from the perspective of Aristotle,[135] and focuses on the other hand on the issue of intrinsic versus accidental or incidental causation.

Under this interpretation, the question of whether materially necessitated processes suffice to bring about particular results with beneficial characteristics (such as a horn with a defensive potential) is answered to the affirmative. For Aristotle thinks that the interactions of the elements might on occasion result in a particular sequence of realizations of element-potentials that bring about this particular result. However, he also thinks – and this is crucial – that the result, and even more so its beneficial characteristics, will be incidental to these material interactions and hence will not come about regularly (there is nothing that prevents the sporadic and spontaneous coming to be of horns with a defensive potential by material necessity). The operations of an overarching final cause are necessary to explain the *regularity* of particular results, and especially those with beneficial characteristics. Things that happen 'always or for the most part', and in particular complex things that happen regularly, cannot be the result of the coincidental occurrence and sequencing of actualizations of element potentials, but must happen for a reason and be due to an overarching cause that orders and times the complex sequence of events. Matthen summarizes this position as follows: "the material explanation that cites only E [a particular series of materialist causes] is deficient, then, not because it gives causally

[134] Stronger and weaker versions of this pragmatic viewpoint have been defended by Charles (1988); Irwin (1988); Nussbaum (1978); Sorabji (1980); and Wieland (1975).
[135] Of course, the question of the compatibility and reducibility might still be of interest and relevant to us, but it is not something Aristotle himself was directly concerned about.

insufficient conditions, but because it does not specify all the causes of O [an event]."[136]

The reason why Aristotle contrasts his own teleological worldview with that of his materialist predecessors is that the latter deny that higher-order natural phenomena, such as animals and plants, have any privileged ontological status: according to them, only the elements are natures in a true sense, and things that are constituted from them are mere accidents or qualities or arrangements of these elements.[137] The materialist view of nature eliminates those very things that Aristotle takes as ontologically basic, and which in his view are in particular need of explanation: for Aristotle an animal is a natural substance, for a materialist an animal is a coincidental conglomeration of elements (and elements are the only natures materialists acknowledge). The heart of the debate does not appertain (or at least not directly) to the question of reductionism, but rather to that of eliminativism: the mistake of the materialists is not so much that they reduce plants and animals to their material elements, but rather that they deny that plants and animals are substances at all.[138]

As we saw above, Aristotle introduces his defense of natural teleology not in terms of the question whether or not phenomena with beneficial outcomes can or must be reduced to material necessity, but in terms of what forces *in addition to* material necessity can or must be responsible for these phenomena. The question pertains to the differentiation between different kinds of causality operative in the natural world, and to the clarification of what these different natural causes amount to. I thus think that the fourth and last type of the interpretations outlined above best captures the problems Aristotle introduces and discusses in *Ph.*II.8. Accordingly, I will follow Sauvé Meyer (1992) in her conclusion that the problem is really about intrinsic versus accidental causation, rather than about necessity versus teleology. Here I will provide additional evidence in support of her thesis, the main points of which I have outlined above. However, before turning to a detailed interpretation of the chapter let me first offer a preliminary discussion of the

[136] Matthen (2007), 8.
[137] For Aristotle's criticism of his materialist predecessors, see also chapter 3.4.1.c.
[138] Sauvé Meyer (1992), 794-795; 820-825; Johnson (2005), 98-99.

remainder of the section, and conjointly introduce two other problems that have larger implications for the interpretation of Aristotle's defense of natural teleology.

*1.3.1.b Problems in the analogy between rain and an Empedoclean theory of generation*

Aristotle continues his argument in favor of the assumption of natural teleology as a cause in nature in addition to material necessity by raising an aporia. This aporia expresses an objection supposedly or possibly raised by one of Aristotle's materialist predecessors entailing an analogy between rain and the generation of parts of animals (*Ph.*II.8, 198b16-32). What the analogy tries to establish is that there is nothing that prevents nature from not acting for the sake of something or for the better, but in some other way exemplified by rain (*Ph.*II.8, 198b17-18). The base domain of the analogy runs as follows (*Ph.*II.8, 198b18-23):

> ἔχει δ' ἀπορίαν τί κωλύει τὴν φύσιν μὴ ἕνεκά του ποιεῖν μηδ' ὅτι βέλτιον, ἀλλ' ὥσπερ ὗει ὁ Ζεὺς οὐχ ὅπως τὸν σῖτον αὐξήσῃ, ἀλλ' ἐξ ἀνάγκης (τὸ γὰρ ἀναχθὲν ψυχθῆναι δεῖ, καὶ τὸ ψυχθὲν ὕδωρ γενόμενον κατελθεῖν· τὸ δ' αὐξάνεσθαι τούτου γενομένου τὸν σῖτον συμβαίνει), ὁμοίως δὲ καὶ εἴ τῳ ἀπόλλυται ὁ σῖτος ἐν τῇ ἅλῳ, οὐ τούτου ἕνεκα ὗει ὅπως ἀπόληται, ἀλλὰ τοῦτο συμβέβηκεν.
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> "The difficulty is what prevents nature to acts in the way Zeus makes it rain, not in order to make the crops grow, but of necessity (for it is necessary that that which has risen turns cold, and that water that has turned cold comes down: after this has happened, it turns out (*sumbainei*) that the crops grow), and in the same way also that if the crops is ruined on the threshing floor, it does not rain for the sake of this, in order to make the crops go bad, but that it just happened (*sumbebêken*)."

Aristotle's opponent thus suggests that nature does not act for the sake of something, but rather operates by necessity and has incidental beneficial outcomes. It is equally absurd to suppose that Zeus makes it rain in order for the crops to grow as it is to suppose that it rains in order to ruin the crops: rain is a natural phenomenon that can be explained completely in terms of material necessity, and what occurs as a result of the falling of rain is a mere accident. As Sedley points out,[139] the expression 'Zeus rains' indicates that Aristotle's opponent is being portrayed as a materialist trying to provide a materialist explanation for something that is popularly viewed as an act of a providential god. This latter view, representing

[139] Sedley (1991), 185.

a naïve, religious, and anthropocentric assumption about the supposed providential teleology of the world, is ridiculed and rejected in favor of an explanation in terms of the interactions of material elements.

In the account provided by the materialist, there can be no misunderstanding of the causal relationship between an event and its outcome: first there is the event of rain, fully explained by the mechanical cycle of evaporation, next there is the result (either good or bad), which is unrelated and incidental to the event of rain itself. The end result does not explain the occurrence of the event, nor does the event itself intrinsically necessitate this particular end. Clearly, Aristotle's opponent (and on a meta-level of course Aristotle himself) intends the example of the rainfall to be a very strong example of a natural process that occurs not for the sake of something, but which has a beneficial (or detrimental) outcome incidentally.

Now suppose we agree with Aristotle's opponent that this is the correct explanation of rain (and the argument assumes that we do in fact agree with the opponent), what does that mean for other natural processes, such as the generation of parts of animals? This is where the target domain of the analogy comes in (*Ph.*II.8, 198b23-27):

> —ὥστε τἰ κωλύει οὕτω καὶ τὰ μέρη ἔχειν ἐν τῇ φύσει, οἷον τοὺς ὀδόντας ἐξ ἀνάγκης ἀνατεῖλαι τοὺς μὲν ἐμπροσθίους ὀξεῖς, ἐπιτηδείους πρὸς τὸ διαιρεῖν, τοὺς δὲ γομφίους πλατεῖς καὶ χρησίμους πρὸς τὸ λεαίνειν τὴν τροφήν, ἐπεὶ οὐ τούτου ἕνεκα γενέσθαι, ἀλλὰ συμπεσεῖν ·
>
> "- in the same way, what prevents that things are also that way with regard to the parts in nature, for example that teeth shoot up of necessity, the ones in the front sharp, with the fitness (*epitêdeious*) for tearing, the molars broad and useful (*chrêsimous*) for grinding down the food – since they did not arise for the sake of this, but they fell together that way (*sumpesein*)."

Aristotle's opponent here suggests that there is no reason not to think that the way parts of animals come to be will be similar to the occurrence of rain: their coming to be can be explained completely in terms of material necessity, and their functions just happen to follow accidentally from their material potentials and coincidental structure. The causal relation between event and result is the same as in the example of the rainfall: teeth come to be the way they are of material necessity, and once they have appeared, it turns out that they have various potentials for use, some of which

are beneficial to the animal which has them. However, in this case, too, the beneficial outcomes are unrelated and incidental to the coming to be of the parts.

The opponent goes on to elaborate on the second part of the analogy (*Ph.*II.8, 198b27-32):

> ὁμοίως δὲ καὶ περὶ τῶν ἄλλων μερῶν, ἐν ὅσοις δοκεῖ ὑπάρχειν τὸ ἕνεκά του. ὅπου μὲν οὖν ἅπαντα συνέβη ὥσπερ κἂν εἰ ἕνεκά του ἐγίγνετο, ταῦτα μὲν ἐσώθη ἀπὸ τοῦ αὐτομάτου συστάντα ἐπιτηδείως· ὅσα δὲ μὴ οὕτως, ἀπώλετο καὶ ἀπόλλυται, καθάπερ Ἐμπεδοκλῆς λέγει τὰ βουγενῆ ἀνδρόπρῳρα.
>
> "And the same holds for all the other parts, in as many as it seems (*dokei*) that they are for the sake of something. Wherever then all [the parts] turned out (*sunebê*) in such a way as they would also [had turned out] if they had come to be for the sake of something, such things survived, having been organized in a fitting way (*epitêdeiôs*) by spontaneity (*apo tou automatou*). So many as did not in such a way, perished and continue to perish, as Empedocles says about the man-faced ox-progeny."

The opponent now moves from parts of animals to their wholes: not only parts, but even whole animals could have come to be as the accidental results[140] of necessary processes. Taking the present biological diversity of species as a starting point, there is according to the materialist no evidence that forces us to assume that nature in facts acts for the sake of something. Instead he offers a causal account in terms of necessary processes with accidental beneficial outcomes. According to this account, the animals that came to be in a 'fitting way' (how this 'fittingness' must be understood will be addressed below), that is, as it turns out, the presently existing animals, were preserved, while the mismatches and monsters perished. Finally, Aristotle identifies Empedocles as a possible propagator of this 'incidental' account of generation.

With this addition Aristotle rounds off the analogy (*Ph.*II.8, 198b32-34: "This then is the argument, through which one might get into an aporia, or if there is another like this one."). It is time for Aristotle to present his own resolution of the aporia (*Ph.*II.8, 198b34-199a8):

> ἀδύνατον δὲ τοῦτον ἔχειν τὸν τρόπον. ταῦτα μὲν γὰρ καὶ πάντα τὰ φύσει ἢ αἰεὶ οὕτω γίγνεται ἢ ὡς ἐπὶ τὸ πολύ, τῶν δ' ἀπὸ τύχης καὶ τοῦ αὐτομάτου οὐδέν. οὐ γὰρ ἀπὸ τύχης οὐδ' ἀπὸ συμπτώματος δοκεῖ ὗειν πολλάκις τοῦ χειμῶνος, ἀλλ' ἐὰν ὑπὸ κύνα·

[140] Aristotle actually speaks of 'by spontaneity' here, and not of 'by accident'; Sauvé Meyer (1992; 797n.6) argues that Aristotle uses these terms interchangeably in setting out the opponents view of nature.

> οὐδὲ καύματα ὑπὸ κύνα, ἀλλ' ἂν χειμῶνος. εἰ οὖν ἢ ἀπὸ συμπτώματος δοκεῖ ἢ ἕνεκά του εἶναι, εἰ μὴ οἷόν τε ταῦτ' εἶναι μήτε ἀπὸ συμπτώματος μήτ' ἀπὸ ταὐτομάτου, ἕνεκά του ἂν εἴη. ἀλλὰ μὴν φύσει γ' ἐστὶ τὰ τοιαῦτα πάντα, ὡς κἂν αὐτοὶ φαῖεν οἱ ταῦτα λέγοντες. ἔστιν ἄρα τὸ ἕνεκά του ἐν τοῖς φύσει γιγνομένοις καὶ οὖσιν.
>
> "It is impossible that things are that way. For those things, and all things that are by nature, either always come to be that way, or for the most part, and none of them belongs to things that are due to luck or spontaneity. For it does not seem that it is due to luck or spontaneity that it rains often in wintertime, but [it does seem so] each time when [it rains] during the dog-days. Nor [does it seem that it is due to luck or spontaneity that it is] hot during the dog-days, but only each time [when it is hot] during winter. If, then, these things seem to be either accidental or for the sake of something, [and] if they cannot be by accident or by spontaneity, they would be for the sake of something. But that those things are by nature would also be claimed by those very same people who say such things. Therefore that for the sake of something is present in things that come to be and are by nature."

The argument Aristotle offers in order to repudiate the opponent's depiction of the workings of nature and to defend the operation of natural teleology in constituting outcomes with beneficial characteristics is quite complex.[141] The first premise posits that natural things happen regularly (i.e. always or for the most part), and not by accident (i.e. incidentally and only on occasion, by luck or by spontaneity). In support of this premise Aristotle refers to the natural events of winter-rain and summer-heat: even the opponent would admit (this is the bearing of *dokei*) that these events are regular and thus cannot be incidental. The second premise posits, supposedly in agreement with the view of the opponent (Aristotle again uses *dokei* to suggest accordance), that regular natural events are either by accident or for the sake of something. In the first premise, however, Aristotle had already ruled out the possibility that regular events can be by accident, and thus it follows that they must

[141] Schematically the argument runs as follows (note that the argument is represented differently by different scholars, but that there is consensus about its basic structure and purpose; cf. Quarantotto (2005), 90-95):
Premise 1: R (regularity) holds of N (natural things and events) and
A (being by accident) does not hold of N;
Example: R seems to hold of NW (the natural phenomenon of winter-rain) and
R seems to hold of NS (the natural phenomenon of summer-heat);
Premise 2: (A or T (being for the sake of something)) seems to hold of RN;
Conclusion 1: A does not hold of RN;
Conclusion 2: T holds of RN;
Example: N holds of W and S;
Conclusion 3: T holds of N.

be for the sake of something. Because the opponent would also agree that the examples mentioned (winter-rain, summer-heat, and perhaps also the generation of parts and animals) are natural, the general conclusion is that they must all be for the sake of something.

Besides the fact that it is not at all clear that Aristotle's opponent would accept the premises leading up to the conclusion about the goal-directedness of nature,[142] I see three other problematic features of the rebuttal that are worth mentioning.

First of all, Aristotle couches the dispute over the causes operative in nature exclusively in terms of luck, spontaneity, and the accidental on the one hand, and goal-directedness on the other hand; the notion of necessity is not mentioned at all. Where Aristotle's opponent (or perhaps rather Aristotle in his representation of the opponent's views) drew a distinction between processes that came to be due to necessity and (beneficial) results that were accidental, Aristotle now turns away from the talk about results, but focuses instead on the causes of the natural events. The causation involved must either be incidental or for the sake of something. This points to our earlier conclusion,[143] that for Aristotle the issue at stake is whether natural phenomena can be explained incidentally or whether they exhibit intrinsic causation. According to Aristotle, the regularity of natural processes and especially their regular beneficial outcomes require an explanation in terms of intrinsic causes, and this requires the assumption of teleology: of the existence goal-directed formal causes that guide and limit the interactions of material elements so as to constitute beneficial outcomes.

However, the 'disappearance' of necessity in Aristotle's argument in favor of natural teleology is suspicious, for Aristotle usually acknowledges (material) necessity to be a cause for event that happens always or regularly.[144] In fact, Aristotle often draws from examples of meteorological phenomena such as the evaporation cycle producing rain to illustrate the regularity of material necessity.[145] As Aristotle

[142] Cf. Waterlow (1982), 77.
[143] Adapted from Sauvé Meyer (1992), 797.
[144] Cf. Charlton (1970), 120.
[145] The key passage is *GC*.II.11, 338a14-b19, which will be discussed in more detail below in 3.4. See also *APo*.II.12, 96a2-7 and *Met*.VI.2, 1026b27-35: "Since, among things which are, some are always in the same state and are of necessity (nor necessity in the sense of compulsion but that which means the impossibility of being otherwise), and some are not of necessity nor always, but for the most part, this is the principle

explains elsewhere,[146] rainfall is due to the circulation of material elements in the atmosphere, and so is a regular phenomenon, depending on the orbit of the sun and the change of seasons. Rainfall is a necessary and regular phenomenon in the winter-season, but Aristotle states nowhere (or at least not explicitly; some argue that the statement is implicit in the passage quoted above from the *Physica*) that rain is for the sake of something.

This brings us to the second remarkable and problematic feature in Aristotle's solution to the aporia: the argument implies that if winter-rain and summer-heat are regular natural phenomena, and they cannot be incidental, they must be for the sake of something. This poses a problem for the interpretation of Aristotle's teleology: does Aristotle endorse the view that (winter)rain is for the sake of something, or not? The traditional view has been that Aristotle does not think that it rains for a purpose,[147] but more recently scholars have to my mind rightly pointed out that this conclusion would make the solution of the aporia incomprehensible.[148] If the argument is to be coherent, then for Aristotle winter-rain must be for the sake of something. Moreover, if Aristotle is indeed committed to the view that winter-rain is for the sake of something, the question naturally arises of for the sake of what Aristotle thinks winter-rain comes to be.

More importantly, and this is the third major problem in this passage, there is the question of whether it follows from the conclusion that winter rain is for the sake of something that the scope of Aristotle's teleology is not restricted to individual natures and their structures and development as the more traditional view holds,[149] but is in fact anthropocentric (the goal-directedness of natures is *ultimately*

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and this the cause of the existence of the accidental; for that which is neither always nor for the most part, we call accidental. For instance, if in the dog-days there is wintry and cold weather, we say this is an accident, but not if there is sultry heat, because the latter is always or for the most part so, but not the former."

[146] The key passages where Aristotle discusses the phenomenon of rain in terms of material and efficient causes are *Meteor.*I.9, 346b16-31 and *Meteor.*I.11, 347b12-33; in the biological works, Aristotle sometimes uses the material circulation of rain by way of analogy to biological processes in the body: see e.g. *DS.*III, 457b31-458a9 and *PA.*II.7, 653a2-7: "As a comparison of a great thing to a small, one should take this to happen similarly to the generation of rain – once vaporized and transported by the heat from the earth to the upper region, the mist, when it comes to be in the cold air above the earth, is reconstituted into water because of the cold and falls back down to earth."

[147] See e.g. Charlton (1970), 120-123; Gotthelf (1987); and Irwin (1988), 102-107; the traditional view has recently been defended by Pellegrin (2002), 309; Johnson (2005), 149-158; and Judson (2005), 345-348.

[148] See e.g. Cooper (1982); Furley (1985); Sedley (1991); Wardy (1993); and Waterlow (1982), 80n.29.

[149] See in particular Gotthelf (1987).

for the benefit of man)[150] or cosmic (the goal-directedness of nature is *ultimately* for the sake of preserving the existing balance in the cosmos)?[151]

In the next sections, I will first offer a more detailed interpretation of the Empedoclean account of the origin of species. Next I will return to the questions concerning the rainfall and the scope of Aristotle's teleology.

### *1.3.2 The nature and scope of natural teleology*

#### *1.3.2.a An Empedoclean theory of the origin of species and the actions of nature according to Aristotle*

The account of the generation of parts of animals and their wholes, attributed to Empedocles, has not received as much attention as it deserves in the context of Aristotle's defense of teleology. The debates usually concentrate on the rainfall-example, which is arguably the more problematic part of the analogy, while the part about natural generation tends to be used to applaud Empedocles for offering a pre-Darwinian theory of natural selection, supposedly involving both the survival of the fittest and the transformation of species.[152] The details of this zoogony of Empedocles have been the subject of much debate. Especially after the publication of the new Strasbourg-papyrus (which contains some new material),[153] Empedocles' theory of the origin of species has received renewed attention. A short overview of my own interpretation of the zoogony of Empedocles will suffice to put the present passage from Aristotle's *Physica* in context.[154]

In his cosmogony, Empedocles distinguishes four stages of the generation of animals and plants.[155] The first two stages probably occur under the increasing influence of Love, in which animals come to be in a way that could be described as bottom up, moving from parts to wholes. For the coincidental interactions amongst the four Empedoclean elements or roots lead to the coming to be of animal tissues such as flesh and bone. Similar interactions of these tissues lead to the coming to be

[150] This controversial but thought-provoking interpretation is defended by Sedley (1991).
[151] A cosmic view of Aristotle's teleology is assumed or defended by Cooper (1982); Furley (1985), 115-116; (1996), 75; Kahn (1985); Matthen (2001) and (2006); and Wardy (1993), 19.
[152] For instance in Ross (1936), 78, but also more recently in Sedley (2003), 2 and 11.
[153] Martin & Primavesi (1999).
[154] On the zoogony of Empedocles, see Martin & Primavesi (1999), Parry (2005), Sedley (2003).
[155] *DK*31A72.

of animal parts, such as foreheads and arms. Finally, interactions of these isolated parts roaming the earth lead to the coming to be of different kinds of animals.[156] Once Love's influence is strong enough, the parts will randomly stick together, forming all kinds of hybrids. Stages three and four probably occur under the increasing influence of Strife, in which complete plants, animals, and human beings come to be spontaneously from the earth.[157] They rise up like shoots of plants, grow limbs, and then mature naturally to the point where they are able to reproduce themselves sexually (Strife, as it were, pulls the uniform masses apart and thereby creates the extremities). Presumably, this is the world in which we live now. Finally, Strife will break up the organisms into their four elements again and soon Love's influence will make itself felt.

Empedocles' account of the biological past is thus cyclical, just as his cosmogony, and draws on two conceptually different models of the origin of species. One model is in the fashion of the mythological tradition of living beings coming to be spontaneously from the earth, while the other one seems to be original to Empedocles and follows a more materialist fashion current in early Greek philosophy. The first origin of species under Strife is explained as a transition from the stage of spontaneous generation of both male and female living beings, growing out the moisture due to fire, to a stage of sexual reproduction. This transition resembles a botanical process of plants getting more differentiated and mature, but without undergoing some kind of transformation of species. The second zoogony under Love, on the other hand, offers a fully naturalistic account of the growth of more complex organic compounds, resulting from random collisions of organic parts. The examples of creatures thus produced are rather fantastic hybrids, like the man-faced ox-progeny mentioned by Aristotle. The fragments do not rule out the possibility that these combinations might also have resulted in living beings like the ones that are alive now, such as for example ox-faced ox progenies. The reference to Empedocles we find in Aristotle's defense of natural teleology fits the pattern of this second zoogony.

Crucial for the understanding of this passage in *Ph.*II.8, 198b23-32 is the distinction of two levels of 'incidental fitness' mentioned in the second part of the

[156] Cf. *DK*31B57, B59, B60, and B61.
[157] Cf. *DK*31B62 and Strasbourg fr.D.

analogy, set up to undermine Aristotle's thesis of the goal-directedness of nature. At the first level, a materialist opponent such as Empedocles seems to think that material necessity alone can produce *parts* that by coincidence turn out to be fit (or have the potentials) for the performance of certain functions. At the second level, the materialist opponent thinks that material necessity could have produced *whole* beings that – if by coincidence they turned out to be composed in a fitting way – survived, and if not, they died.

The first case of parts turning out to be fit for a certain function is not all that problematic to Aristotle. He, too, recognizes cases in nature where material necessity is the cause of the coming into being of parts or their constitutive material, which is then used by the formal nature of an animal (to be identified with its goal-directed efficient cause, or soul) for the sake of something. These cases are teleological in Aristotle's view, but not without qualification: the formal nature of the animal attributes a function (or use) to a part or to a flow of material *after* this part or material has already come to be. The formal nature is not properly speaking the cause of the coming to be of this part (rather, material necessity is), but it is the cause of its presence: the goal-directed actions of the formal nature of an individual animal explain the presence, structure, location, and the ultimate function of the part, because it is the cause of these. The kind of teleology involved is thus 'indirect' or 'secondary' to material necessity, as opposed to what I have called 'primary' teleology in which the formal nature is both the cause of the coming to be (through conditional necessity) and of the presence of a part. Parts and functions that are due to 'direct' or 'primary' teleology belong in general to the definition of the substantial being of the animal.

A paradigmatic case of a part that comes to be due to secondary teleology is a complete set of teeth *PA*.III.2, 663b22-35:

> πῶς δὲ τῆς ἀναγκαίας φύσεως ἐχούσης τοῖς ὑπάρχουσιν ἐξ ἀνάγκης ἡ κατὰ τὸν λόγον φύσις ἕνεκά του κατακέχρηται, λέγωμεν. (…) Τὴν γοῦν τοιούτου σώματος περισσωματικὴν ὑπερβολὴν ἐν τοῖς μείζοσι τῶν ζῴων ὑπάρχουσαν ἐπὶ βοήθειαν καὶ τὸ συμφέρον καταχρῆται ἡ φύσις, καὶ τὴν ῥέουσαν ἐξ ἀνάγκης εἰς τὸν ἄνω τόπον τοῖς μὲν εἰς ὀδόντας καὶ χαυλιόδοντας ἀπένειμε, τοῖς δ' εἰς κέρατα.
>
> "But we must say what the character of the necessary nature is, and, how nature according to the account *makes use* of things present of necessity for the sake of

> something. (…) For the residual surplus of this sort of body [i.e. earthen], being present in the larger of the animals, is *used* by nature *for* protection and advantage, and the surplus, which flows of necessity to the upper region, in some cases it *distributes* to *teeth* and tusks, in other cases to horns."

This passage bolsters the arguments originally put forward by Sauvé Meyer (1992) that the issue for Aristotle is not the fact that material necessity is picked out as the cause of the coming to be of a part; nor does Aristotle deny the possibility of events or parts on occasion turning out to have functional or beneficial outcomes by coincidence and due to their material nature. Rather, it is the fact that the outcomes of these processes turn out to be beneficial *on a regular basis*: if there are events or structures that have functional or beneficial results or features regularly, then these events must be due to the actions of a goal-directed nature and be for the sake of these outcomes, either on a primary or on a secondary level. For such regular beneficial outcomes cannot be due to accidental interactions of material elements alone, especially not to the kind of material necessity Empedocles advances. For in Aristotle, the movements of the material elements are – unless prevented – goal-directed towards their natural places; in Empedocles, the elements do not have any definite natural movements, but instead their movements are completely random.[158] The teleology does not necessarily have to precede the process of becoming (that is, functions do not necessarily have to be part of the definition of the substantial being or formal nature); the formal nature that is realized also acts goal-directedly with regard to 'materials' or 'potentials' that are not part of (and therefore conditionally necessitated by) the original form.[159] Functions, however, do not just follow from

[158] That is, at least according to Aristotle's interpretation of material necessity in Empedocles; see e.g. *Ph.*II.4, 196a17-24: "This is strange, whether they supposed that there is no such thing as luck or whether they thought there is but omitted to mention it – and that too when they sometimes used it, as Empedocles does when he says that the air is not always separated into the highest region, but as luck has it. At any rate he says in his cosmogony that it happened to run that way at that time, but it often ran otherwise. He tells us also that most of the parts of animals came to be by luck." Cf. *GC.*II.6, 334a1-5.

[159] Aristotle's criticism of Empedocles in *PA.*I.1, 640a22-26 discussed above (in 1.1.2.a) is different in this very aspect, because in this passage it is Empedocles' failure to recognize a case of primary teleology, while in the *Physica* passage the causation involved is secondary teleology. However the criticism is similar to remarks Aristotle utters with regard to the account of teeth by Democritus (*GA.*V.8, 789b2-15): "Democritus, however, neglecting the final cause, refers back to necessity all the things that are used by nature. Now they are such [i.e. necessary], but yet they are for a final cause and for the sake of what is best in each case. Thus nothing prevents the teeth from being formed and being shed in this way; but it is not on account of these but on account of the end – and 'these' are causes in the sense of being the mover and the instruments and the material. (...) But to say that it are the causes of necessity is as much as if someone would think that the water has been drawn off from a dropsical patient on account of the lancet alone, not on account of health, for the sake of which the lancet made the incision."

the material potentials (e.g. the function of 'defense' does not follow necessarily from a flow of material with hard and solid potentials) – it is because the formal nature puts them to a certain use and organization that these potentials actually and on a regular basis produce certain functions (e.g. the formal nature turns a flow of material with hard and solid potentials in some animals into teeth for the sake of cutting and in other in horns for the sake of defense).[160] While the coming to be of teeth in a weak sense (that is, teeth qua their constitutive material with certain potentials) is due to material necessity, their presence and their regular beneficial characteristics can only be accounted for teleologically.

In this context, the terms Aristotle uses to indicate the 'fitness' of the organic parts are significant. 'Useful' (*chrêsimos*) is commonly used by Aristotle to indicate what one might call 'emerging functions', that is, the potentials for functions a particular part (that is, organs, but most often residues such as milk and sperm) has on account of its material constitution. This potential is often a result of material necessity; for Aristotle claims in these cases that the material referred to is not produced for the sake of having this particular potential or 'usability'.[161] With regard to milk, for example, Aristotle makes the following remark (*GA*.IV.8, 776a23-26):

> διὸ πρὸ τῶν ἑπτὰ μηνῶν ἄχρηστον τὸ γάλα ταῖς γυναιξί, τότε δ' ἤδη γίγνεται χρήσιμον. εὐλόγως δὲ συμβαίνει καὶ διὰ τὴν ἐξ ἀνάγκης αἰτίαν πεπεμμένον εἰς τοὺς τελευταίους χρόνους·
>
> "Hence in women the milk is useless before the seventh month and only then becomes *useful*. That it is only concocted at the last stages is what we should expect to happen also [i.e. in addition to being for the sake of something] as being due to a necessary cause."

The 'usability' a part has is thus due to the material potentials the part has, but the way that part is consequently 'used' and retained in the animal's body, is determined by the formal nature of an animal, which puts the part to the best possible use for this particular animal. The same holds for the term 'suitability for' (*epitêdeios*), a term which may be used to designate foodstuffs, natural places, or even thoughts that have certain 'favorable' or 'function-inducing' characteristics, which they just happen

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[160] Cf. Pellegrin (2002), 310.

[161] A few paradigmatic examples of the use of *chrêsimos* are *GA*.I.15, 720b34-35; *GA*.I.18, 725a3-7; *GA*.II.6, 742a27-32; *GA*.III.3, 754b6-7; *GA*.III.10, 760b13-14; *GA*.V.2, 781b26-28; *HA*.II.1, 500a15; *HA*.VI.22, 576a14-16; *IA*.1, 704a4-5; *PA*.II.3, 650b11-13.

to have (again, they were not 'produced' for the sake of exhibiting these characteristics).[162] As in the following example, Aristotle also uses the term to indicate material mixtures that possess a suitability for a particular function (*PA*.IV.10, 686a8-11):

> Ἐξέθετο δ' ἡ φύσις ἐν αὐτῇ καὶ τῶν αἰσθήσεων ἐνίας διὰ τὸ σύμμετρον εἶναι τὴν τοῦ αἵματος κρᾶσιν καὶ ἐπιτηδείαν πρός τε τὴν τοῦ ἐγκεφάλου ἁλέαν καὶ πρὸς τὴν τῶν αἰσθήσεων ἡσυχίαν καὶ ἀκρίβειαν.
>
> "And nature placed some of the modes of perception on the outside of it [i.e. the head] as well, on account of the blend of the blood being well proportioned and *ensuring*[163] both the warmth of the brain and the quietness and accuracy of perception."

This usage comes close to what Empedocles might have meant when claiming that teeth have the fitness for a certain function, but not in virtue of being for the sake of that function, but in virtue of the (coincidentally generated) quantitative ratio of their elemental mixture.[164] Aristotle does not deny that combinations of materials and their potentials have certain potentials for functions (in fact, the material potentials a part has are a necessary part of the explanation of the function that part performs), but the reason why the mixture is organized the way it is and is put to the use it is in a particular kind of animal needs further explanation in terms of an overarching goal-directed efficient cause in the form of the formal nature or soul of a living being.

What is mainly problematic for Aristotle is to see how parts can be claimed to be fit for a certain function *in isolation from the whole* of which they are part: it is not clear how teeth as such can be said 'to be for biting' without making reference to the digestive system of which they are part and to the animal to which benefit they

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[162] For instance, Aristotle uses it with respect to a certain area in the sea which induces spawning (*HA*.VIII.13, 589b3-6): "They [fish] penetrate into this sea for the purpose of breeding; for there are regions there favorable for spawning, and the fresh and sweet water has an invigorating effect upon the spawn." Other paradigmatic examples of the use of *epitêdeios* are *HA*.III.21, 522b22-23; *HA*.III.21, 523a3-4; *HA*.V.13, 544b8-9; *HA*.X.5, 636b21-23; and *MA*.8, 702a17-19.

[163] Lennox (2001b; 97) translates *epitêdeian pros* somewhat misleadingly as 'adapted for' (it seems to me that the function here follows the potentials this mixture of blood already has, rather than that the mixture is made for the sake of this function). For this use of the term, see also *Pol*.VII.4, 1325b40-1326a4: "As the weaver or shipbuilder or any other artisan must have the material proper (*epitêdeian*) for his work – and in proportion as this is better prepared, so will the result of his art be nobler – so the statesman or legislator must also have the materials suited (*epitêdeiôs*) to him."

[164] Cf. *DK*31B96.

operate (consequently, since Aristotle defines things functionally, it is not even clear that we can call teeth 'teeth' in any meaningful way without making reference to the larger whole of which they are part, and the same holds for 'eyes' or 'hands').

This problem brings us to the second level of fitness. For what exactly does it mean for whole animals to come to be 'composed in a fitting way'? Aristotle's example of an Empedoclean animal that is not 'composed in a fitting way', the 'man-faced ox-progeny', suggests a very literal interpretation of wholes that are put together out of homogeneous parts, as for example ox-faces combined with oxen, and man-faces with men. According to Empedocles, animals assembled from parts that belong to different kinds of animals (where 'kinds' are identified with respect to the present biological diversity of species), and are thus assembled 'wrongly', are non-matching wholes that will ultimately (if not immediately) die. 'Fitting wholes' are the non-hybrids, which 'turn out' to be the current species.[165] For Aristotle, on the other hand, the well-adaptedness of each particular kind of animal comprises not only its internal well-functioning but also the relation between the animal and its environment: an animal is equipped to do well (enough) in its own particular niche. It is this notion of 'fitness' and the regularity of the generation of animals that prove to Aristotle that there is a prior and eternal form underlying their presence, and that there is a formal nature that always, unless prevented, acts for the sake of something and the best.

These conclusions point again to what is at stake for Aristotle: while Empedocles explains whole animals from the bottom up, taking the material elements to be the only proper natural substances and explaining wholes (and their possible beneficial characteristics) as the coincidental outcomes of random combinations, Aristotle explains animals in a top-down manner,[166] starting from the

[165] For that matter, Empedocles' notion of fitness is thus quite different from that of modern Darwinian theories, which Empedocles is supposed to foreshadow. To point out just two important differences: (i.) there is no selection for the fittest, but only for the fit; and 'fitness' does not refer to a relation between the animal and its environment, but presumably to an internal match of parts having the right proportions; (ii.) the concept of chance involved in Empedocles is one of non-purposive randomness, not one of statistical probability: all homogeneous hybrids survive, all heterogeneous hybrids die. The selection procedure that is implied is a purely negative force, eliminating creatures that have already been created by other means, *until* the actual range of present-day species is reached which will then be preserved until a new cycle begins.

[166] Cf. Furley (1996), 77.

animals' form and working down to its specific parts and their material constitutions.[167]

What Aristotle tries to establish here is not just the priority of form, but primarily the necessity of postulating goal-directed actions of formal natures to account for regular beneficial outcomes *also* in those cases where material necessity is the predominant cause in the coming to be of a part or structure.

### *1.3.2.b The rainfall example and the scope of natural teleology*

We now have a clearer picture of the analogy between the rainfall example and the Empedoclean theory of generation: both 'generations' are claimed to be due to material necessity, and to have incidental beneficial outcomes, rather than involving a purposive agent (in the form of Zeus) *making* something for the sake of something. The materialist thus refutes the providential, external, and anthropocentric teleology of Zeus in favor of purely material causation; results – whether beneficial or detrimental – are incidental to the processes which bring about these results. At the same time it should be noted that Aristotle's solution of the aporia is not directed against explanation in terms of material causes as such, nor is it likely to be have been developed to argue for the kind of providential and divine teleology presumably accepted by the common people. Aristotle's argument will have the materialist accept the biological and immanent teleology of formal natures interacting with material nature in such a way that things 'are made' for the sake of something. This at least must be the implication of Aristotle's statement that it is 'impossible for things to be that way' (*Ph.*II.8, 198b34). We know for sure that in the case of the coming to be of animals and their parts Aristotle embraces whole-heartedly the immanent teleology of nature, but – and this is the question we will have to address next – what is Aristotle's view of rain?

As indicated above, it is hard to make sense of Aristotle's solution to the aporia if we refuse to attribute to Aristotle a teleological perception (and explanation) of winter-rain (and of summer-heat for that matter). Let me stress from the outset, however, that we do not need to attribute to Aristotle a *primary*

[167] These levels of explanation and the interactions between form/function and material constitution will be discussed in more detail in the chapters two and three.

teleological view of winter-rain.[168] Following the analogy with the case of teeth, a secondary teleological picture of winter-rain would suffice (Aristotle's refutation of the materialist explanation of teeth amounts in practice to an argument in favor of secondary teleology; the alternative explanation for winter-rain therefore may well be one in terms of secondary teleology also). In other words, what we are looking for is a purpose of winter-rain that is *secondary* to the coming to be of rain and that thus need not be directly responsible or causative of the phenomenon in a strict sense (just as 'biting' is not the cause of the coming to be of teeth in a strict sense, but only the cause of the organization and presence of teeth). In other discussions of rain, Aristotle has already identified the sun and the obliquity of its orbit as the overarching cause responsible for the circularity of the seasons and the regularity of winter rainfall: the simple elements imitate this circular motion, and this is what intrinsically and non-accidentally (and regularly during the winter) causes rain by material necessity.[169]

One possible purpose of winter-rain has already been suggested in the text: winter rainfall could be for the sake of the growth of crops. This is the view that is rejected and ridiculed by Aristotle's opponent as a legitimate explanation, but could it be accepted by Aristotle? Sedley has argued that this is indeed the case: winter rainfall is for the sake of man's growing crops (human beings are the 'that for the sake of which' in the sense of beneficiary of a goal-directed process).[170] If his reading is right, then Aristotle identifies a highly anthropocentric purpose for winter-rain: the purpose is not just the growth of plants, which is a natural purpose, but the growth of crops, which is an agricultural goal depending on human beings. Professedly, this interpretation is consistent with other passages in Aristotle that according to Sedley support an anthropocentric teleology.[171] However, as Sedley admits,[172] it does not

[168] This is in fact impossible for reasons I will indicate below. Aristotle would agree with his materialist opponent that the phenomenon of winter rainfall itself is an accidental property of the water elements that regularly fall down to the earth in a particular time of the year. The primary teleology of the water elements pertains to their internal principle of change that tends towards the elements natural place; from this perspective, there is no difference between (regular) winter rainfall or (occasional) summer rainfall – in both cases the water elements reach their own natural place.

[169] Matthen (2007), 9 and 13; *GC*.II.10, 337a1-7; *Mete*.I.9, 346b35-36: "So we get a circular process that follows the course of the sun. For according as the sun moves to this side or that, the moisture in this process rises or falls."

[170] Sedley (1991), 179 and passim.

[171] The other passages Sedley refers to as evidencing an anthropocentric interpretation of Aristotle's teleology are *Met*.L.10, 1075a11-25 and *Pol*.I.8, 1256b10-22; I will discuss these passages below.

necessarily follow from Aristotle's acceptance of a teleological view of winter-rain that he is also committed to the anthropocentric aspect of it, namely that winter-rain is ultimately for the benefit of human beings. This holds even less so for the religious-providential aspect of it: surely no one would want to attribute these qualities to Aristotle's notion of natural teleology.

Concerning the anthropocentric aspect, however, I see no problems in attributing the view to Aristotle that – in a *secondary* sense – winter rainfall is for the sake of making crops grow and therefore ultimately for the sake of the benefit of human beings. For this anthropocentric end is a secondary end, as it is only achieved through the intervention of human beings who perform the art of agriculture, and who thereby perfect the workings (and teleology) of nature.[173] In other words, human beings imitate the goal-directed actions of the formal nature in generation in putting to some good use whatever is available of necessity,[174] which is in this case the regular rainfall. Because water is what makes plants grow, the regular provision of water is what can be used to make the land produce plants more abundantly and to make it grow those plants which can serve as food for human beings. For Aristotle, human beings themselves instead of some god must act for the sake of something in order to ascertain beneficial outcomes from a necessary phenomenon such as seasonal rain.

It therefore goes too far to claim that Aristotle's teleology is essentially anthropocentric. Firstly, rain does not fall in the winter just because it is necessary for human survival, and winter-rain makes any plant grow, not just the seeds planted by human beings; therefore the growth of crops cannot be a proper, primary final cause of winter-rain.[175] Secondly, I have found no evidence in Aristotle for attributing the view to him that ends in the sense of the beneficiary can ever be the intrinsic final causes of the becoming of the processes of which they are the beneficiary.[176] Rather, the growth of crops is a secondary function following the

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[172] Sedley (1991), 185.
[173] Matthen (2001, 183-184) seems to hint at a similar interpretation by explaining rain in winter as an instance of 'instrumental teleology'.
[174] For art imitates nature: agriculture or the growth of crops takes place in winter because it rains in winter, not the other way around.
[175] This is rightly pointed out by Johnson (2005, 153-154).
[176] Pace Sedley (1991), 189. The passage Sedley uses as evidence to support his anthropocentric reading is *Ph.*II.2, 194a34-35 discussed above. Sedley argues that the construction of *hôs* plus the participle of

primary final cause of water elements realizing their own nature (rain, let alone winter-rain, does not have a nature, only water does).[177] Aristotle thus endorses a teleological view of winter-rain to the extent that he believes that winter-rain, which comes to be regularly due to material necessity, has the potentials for making plants grow – potentials which can be used by human beings (through the application of the art of agriculture) to make crops grow. The growth of crops is a secondary function or use of winter-rain, which can only be realized regularly and systematically through the goal-directed actions of human beings (mimicking those of formal natures); the use to which winter-rain is put, is not intrinsic to winter-rain (or to the water that returns to its natural place during the winter-season) but is imposed on it in accordance with the material potentials rainfall has.[178]

It is in this way in particular that winter-rain and teeth are analogous: their regular beneficial outcomes or functions (and not so much the occurrence of the phenomena themselves) require overarching goal-directed actions, either in the form of human beings performing some kind of art, or of formal natures acting like a craftsman adding purpose to things that are present of material necessity. Under this interpretation, we can attribute a teleological view of winter-rain to Aristotle, which is indirect and secondary to the coming to be of winter-rain and which is anthropocentric, but not in a significant way.[179]

Granted that the rainfall-example does not necessarily have to be read in an essentially anthropocentric way, one might still argue (as Sedley does) that other

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*huparcheô* should be read as 'on the ground that they exist' rather than as 'as if they exist'; however, according to Rijksbaron et.al. (2000; 100), constructions like these indicate a subjective reason, for which the narrator does not want to be held responsible (cf. Xenoph.*An.*IV.2.5). It is thus more likely that Aristotle makes a concession to a popular thought in claiming that we are *in some sense* (*pôs* should indeed be read in a conciliatory way) an end, too.

[177] Cf. Wardy (1993, 25) with regard to Aristotle's notion of the *polis*: the *polis* is *phusei*, but being by nature does not entail that it *has* a *phusis* in its own right. See also Judson (2005, 348), who argues that Aristotle's natural teleology applies "only to the generation, functioning, and parts of natural substances" and therefore not to the case of rain.

[178] In this respect, the example of the winter-rain is comparable to the example of the light shining through a lantern in *APo.*II.11, 94b27-37: the light shines the lantern by material necessity, but the lantern (being created for exactly this purpose by human art) also serves the purpose of helping people to avoid stumbling. This 'use' of the light is anthropological and secondary (because incidental) to the passing of light through the larger pores of the lantern. Cf. Byrne (2002), 43.

[179] Pace Sedley (1991), 196. Secondary functions of things – and especially of things that do not have a nature may be imposed externally, whereas primary functions may not; humans benefit from the growth of crops is external and supervening upon plants 'benefiting' from the realizing of their own nature, while water 'benefits' intrinsically from the realization of its nature by returning to its natural place.

passages in the Aristotelian corpus support the anthropocentric interpretation, and hence conclude that in the light of all this evidence Aristotle's teleology must still be qualified as being essentially anthropocentric.

A crucial and notorious passage in this context is Aristotle's description of how nature provides food for all living beings as part of an attempt to establish the naturalness of the art of acquisition and warfare in *Pol.*I.8, 1256b7-22:[180]

> ἡ μὲν οὖν τοιαύτη κτῆσις ὑπ' αὐτῆς φαίνεται τῆς φύσεως διδομένη πᾶσιν, ὥσπερ κατὰ τὴν πρώτην γένεσιν εὐθύς, οὕτω καὶ τελειωθεῖσιν. καὶ γὰρ κατὰ τὴν ἐξ ἀρχῆς γένεσιν τὰ μὲν συνεκτίκτει τῶν ζώων τοσαύτην τροφὴν ὥσθ' ἱκανὴν εἶναι μέχρις οὗ ἂν δύνηται αὐτὸ αὑτῷ πορίζειν τὸ γεννηθέν, οἷον ὅσα σκωληκοτοκεῖ ἢ ᾠοτοκεῖ· ὅσα δὲ ζῳοτοκεῖ, τοῖς γεννωμένοις ἔχει τροφὴν ἐν αὑτοῖς μέχρι τινός, τὴν τοῦ καλουμένου γάλακτος φύσιν. ὥστε ὁμοίως δῆλον ὅτι καὶ γενομένοις οἰητέον τά τε φυτὰ τῶν ζώων ἕνεκεν εἶναι καὶ τὰ ἄλλα ζῷα τῶν ἀνθρώπων χάριν, τὰ μὲν ἥμερα καὶ διὰ τὴν χρῆσιν καὶ διὰ τὴν τροφήν, τῶν δ' ἀγρίων, εἰ μὴ πάντα, ἀλλὰ τά γε πλεῖστα τῆς τροφῆς καὶ ἄλλης βοηθείας ἕνεκεν, ἵνα καὶ ἐσθὴς καὶ ἄλλα ὄργανα γίνηται ἐξ αὐτῶν. εἰ οὖν ἡ φύσις μηθὲν μήτε ἀτελὲς ποιεῖ μήτε μάτην, ἀναγκαῖον τῶν ἀνθρώπων ἕνεκεν αὐτὰ πάντα πεποιηκέναι τὴν φύσιν.
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> "Such property, seems to be given by nature herself to all, both when they are first born, and when they are grown up. For some animals generate at the moment of childbirth at the same time also sufficient nutriment to last until the offspring can supply itself – for example all the animals which produce larvae or lay eggs. And those which bear live young have up to a certain time nutriment within themselves for their offspring, namely the substance called milk. Hence it is equally clear that we should also suppose that, after they have come to be, plants exist for the sake of animals, and the other animals for the sake of men – domesticated animals *for both use and food*, and most if not all wild animals *for food and for other assistance*, as *a source of clothing and other utilities*. If, then, nature makes nothing incomplete or pointless, it is necessary that nature has made them all for the sake of men."

The conclusion of this passage concerning the teleological hierarchy between plants, animals, and human beings supposedly shows that Aristotle endorses the anthropocentric view that everything ultimately exists for the sake of human beings. Certainly Aristotle argues here for an instrumental relation between different kinds of living beings in which the lower are used by and are in that sense for the sake of

[180] Miller (1995), 317-319.

the higher; at the end of the chain of users stands mankind. The teleology Aristotle defends here is unmistakably anthropocentric.[181] However, the stress on the use of beings as food and of their general usability by others points out that the teleology Aristotle is discussing here is not direct teleology, but secondary teleology. The crux of the argument is the claim that nature provides food to all living beings, and does so often in the form of other living beings. The analogy drawn in *Pol.*I.10, 1258a21-38 is telling:

> ὥσπερ γὰρ καὶ ἀνθρώπους οὐ ποιεῖ ἡ πολιτικὴ, ἀλλὰ λαβοῦσα παρὰ τῆς φύσεως χρῆται αὐτοῖς, οὕτω καὶ <πρὸς> τροφὴν τὴν φύσιν δεῖ παραδοῦναι γῆν ἢ θάλατταν ἢ ἄλλο τι, (…) φύσεως γάρ ἐστιν ἔργον τροφὴν τῷ γεννηθέντι παρέχειν · παντὶ γάρ, ἐξ οὗ γίνεται, τροφὴ τὸ λειπόμενόν ἐστι. διὸ κατὰ φύσιν ἐστὶν ἡ χρηματιστικὴ πᾶσιν ἀπὸ τῶν καρπῶν καὶ τῶν ζῴων.
>
> "For as political science does not make men, but takes them from nature and uses them, so too nature provides earth or sea or the like as a source of food. (…) For it is a task of nature to provide food to that which is born, and for each, that what remains over of that from which it comes to be is its food. That is why the art of getting wealth out of crops and animals is natural for all people."[182]

Just as nature produces human beings so that politics can make use of them, so too nature produces and provides nourishment – also in the form of living beings – for other living beings to use.[183] The primary and intrinsic end of living beings is the realization of their own form, but they also have the potential to serve as food for other living beings that are in the process of realizing or maintaining their own form *from the perspective of those living beings*.[184] This propensity or usability is incidental and secondary to their coming to be, but is of vital importance to other beings: the food-chain imposes a hierarchy of conditional necessary relations between members of

[181] Sedley (1991, 181) discusses various strategies adopted by those who would like to downplay the importance and anthropocentric focus of this passage, and points out rightly that Aristotle does not just assert the anthropocentric teleology, but argues for it, and that as part of a serious argument ultimately concerning the naturalness of the city. I agree with him that any interpretation of this passage needs to account for the anthropocentric teleology, rather than to reason it away.
[182] See also *GA*.II.6, 744b17-25 where nature is compared to a good housekeeper providing nourishment to everyone for the sake of their growth.
[183] Cf. Lloyd (1996), 191-192.
[184] Cf. Judson (2005, 356-357), who argues that the 'for the sake of'-relations argued for in this text only hold from a certain viewpoint or perspective.

the present animal diversity, according to which the existence of the one is conditionally necessary for the coming to be and existence of the other.[185]

Note, however, that in Aristotle's view, the animal that comes to be is 'made' in such a way by the formal nature of that animal so that it is able to use and digest the food that is available in the specific habitat to which the animal belongs, and not the other way around: a camel has the kind of tongue and the amount of stomachs it has to be able to digest the thorny bushes that are available in its habitat as a potential source of food. There are no examples of plants or animals in Aristotle that are claimed to be the way they are for the sake of being the nourishment of some other being: the thorny bushes are not the way they are (that is, bristly, woody, and fibrous) because there are camels in their neighborhood who can only eat such food.[186] Just as in the case of winter-rain, plants and animals only have a potentiality for a secondary function *from a certain perspective* or *relative to* other beings higher up[187] in the food-chain: the art of agriculture and the goal-directed actions of human beings are necessary to turn a regular natural phenomena such as rain into a phenomena with regular beneficial outcomes *for them*, and in a similar way, the goal-directed actions of the formal nature of plants and animals are necessary to 'adapt' these plants and animals in such a way that they are able to benefit from the other living beings in their habitat as a source of food. Animals are adapted to their environments and to the available food in that environment; however, nature does not adapt them to serve themselves as food for others in their environment[188] – this is a use that is imposed on them from the perspective of other animals and their respective formal natures. Aristotelian teleology thus primarily takes the perspective of the individual living being in the form of the best possible realization of their internal structure and their overall well-being, and only secondary from other beings to whom these realizations of form might be usable and thus beneficial in some way.

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[185] Cf. Simpson (1998), 49.

[186] This point and the example are well brought out by Pellegrin (2002), 312. On the camel, see *PA*.III.14, 674a28-674b18.

[187] And perhaps also to beings lower down in the food-chain; see *PA*.IV.13, 696b25-35, which will be discussed below.

[188] The presence of parts that Aristotle identifies as being for the sake of defense rather points to the opposite: the formal nature of each animal produces, if possible and the required material is available, parts that help the animal escape from its possible predators.

What it means for human beings to be on the top of this hierarchy is that they are proclaimed to be most successful in making use of what nature provides to all living beings *because of their having mastered a wide diversity of arts*, and thus of being able to imitate the indirect or secondary teleology of nature really well. In principle, all natural products are available to all living beings as a source of food; for instance, there is no intrinsic reason why camels could not eat fresh grass or fish; it is because there are no such things available in their particular habitat that nature has not sufficiently equipped them to be able to eat and digest other foodstuffs. Only humans move freely through different habitats and invent various devices to increase their success in using things for their own advantage. Nothing in Aristotle's other treatises suggests, however, that this hierarchy is ordained by nature for the sake of man's benefit.[189] The order of causation works rather the other way around: nature has produced things, and the goal-directed actions of human beings are necessary to turn those things into something usable or beneficial for them (of course, while following the material potentials the natural products have).

The closing sentence of the above cited passage, which invokes the principle that nature does nothing in vain and that therefore it must have made all other living beings for the sake of human beings, is thus not an argument for anthropocentric teleology without qualification, but for an indirect or secondary anthropocentric teleology. Nature has made the other living beings for sake of human beings to use them, eat them, or benefit from them, but, I submit, this is a secondary purpose of animals and plants (and which is thus not part of their own nature), and one that is imposed by human beings through the application of some kind of art.

Relevant to this discussion of the hierarchy in the food-chain, and also more in general to the question of the scope of Aristotelian teleology, is the following text from *PA*.IV.13, 696b25-34:

> Τὰ μὲν γὰρ κατ' ἀντικρὺ ἔχει τὸ στόμα καὶ εἰς τὸ πρόσθεν, τὰ δ' ἐν τοῖς ὑπτίοις, οἷον οἵ τε δελφῖνες καὶ τὰ σελαχώδη· καὶ ὕπτια στρεφόμενα λαμβάνει τὴν τροφήν. Φαίνεται δ' ἡ φύσις οὐ μόνον σωτηρίας ἕνεκεν ποιῆσαι τοῦτο τῶν ἄλλων ζώων (ἐν γὰρ τῇ στρέψει σώζεται τἆλλα βραδυνόντων· πάντα γὰρ τὰ τοιαῦτα ζωοφάγα ἐστίν), ἀλλὰ καὶ πρὸς τὸ μὴ ἀκολουθεῖν τῇ λαιμαργίᾳ τῇ περὶ τὴν τροφήν· ῥᾷον γὰρ λαμβάνοντα

[189] Cf. Hankinson (1998), 147.

> διεφθείρετ' ἂν διὰ τὴν πλήρωσιν ταχέως. Πρὸς δὲ τούτοις περιφερῆ καὶ λεπτὴν ἔχοντα τὴν τοῦ ῥύγχους φύσιν οὐχ οἷόν τ' εὐδιαίρετον ἔχειν.
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> "In some [fish] the mouth is placed straight across, and towards the front, but in others on the underside, e.g. in the dolphins and selachians; and they turn belly up to seize their nourishment. And nature *appears* to do this *not only* for the sake of the preservation of the other animals (for during the turn the other animals escape, because of the delay; for all such creatures are carnivorous), *but also* in order that they do not follow their gluttonous ways regarding nourishment; for if they could grasp it easily, they would be destroyed owing to being quickly sated. And *in addition* to these reasons, the nature of the snout, being curved and narrow, is unable to open widely."

Here Aristotle attributes a function to the placement of a part that actually serves other beings than the animal itself: the placement of the mouth helps potential victims escape from being turned into food. This, however, must again be taken as a secondary use of a part seen from the perspective of the formal natures of animals living in the habitat of dolphins and selachians. The primary causes (intrinsic to the dolphins and selachians itself) are stated next: the fact that dolphins and selachians are not able to eat much at a time is both for the sake of the best of those animals themselves (if not prevented by the specific location of the mouth, these animals would eat themselves to death), and results of necessity (the shape of the snout makes it impossible to open it widely).[190] The hierarchy pertaining to the food-chain that was pointed out in the above mentioned text from the *Politics* is reversed in this case: 'lower' animals benefit from the location of the mouth in 'higher' animals. This points to the relativity of the hierarchy in that the enforcement of secondary uses to plants and animals is not restricted to higher organisms on lower ones, or to human beings on all other organisms. There is no absolute subordination of the good of one living being to that of another.[191]

Some have taken this text as evidence, not for an anthropocentric interpretation of Aristotelian teleology, but for a *cosmic* teleology: the suggestion is that there is a tendency towards regularity and goodness in the cosmos as a whole (over and above the one inherent in the individual natures of living beings) which

[190] See also Lennox's commentary on this passage; Lennox (2001b), 341.
[191] There is thus no reason to suppose that mention of the secondary function of saving other animals is a 'sarcastic expression', or 'a polite correction of popular teleology' as Balme thinks; Balme (1987b), 279; (1980), 9.

ensures the preservation of the cosmos as it is. Under this interpretation, the harmony and interaction between individual natural entities is derived from an overall nature, i.e. the cosmos, which has its own form. Admittedly, Aristotle sometimes does seem to think of nature or cosmos as a larger whole in which beings contribute to the existence and well-being of other beings.[192] However, the evidence for a cosmic interpretation of teleology in Aristotle is not very strong, and scanty in comparison to the evidence we have for a 'what is best for each substantial being'-based teleology.[193]

The key passage quoted in support of the cosmic reading is *Met.*XII.10, 1075a11-25:[194]

> Ἐπισκεπτέον δὲ καὶ ποτέρως ἔχει ἡ τοῦ ὅλου φύσις τὸ ἀγαθὸν καὶ τὸ ἄριστον, πότερον κεχωρισμένον τι καὶ αὐτὸ καθ' αὑτό, ἢ τὴν τάξιν. ἢ ἀμφοτέρως ὥσπερ στράτευμα; καὶ γὰρ ἐν τῇ τάξει τὸ εὖ καὶ ὁ στρατηγός, καὶ μᾶλλον οὗτος· οὐ γὰρ οὗτος διὰ τὴν τάξιν ἀλλ' ἐκείνη διὰ τοῦτόν ἐστιν. πάντα δὲ συντέτακταί πως, ἀλλ' οὐχ ὁμοίως, καὶ πλωτὰ καὶ πτηνὰ καὶ φυτά· καὶ οὐχ οὕτως ἔχει ὥστε μὴ εἶναι θατέρῳ πρὸς θάτερον μηδέν, ἀλλ' ἔστι τι. πρὸς μὲν γὰρ ἓν ἅπαντα συντέτακται, ἀλλ' ὥσπερ ἐν οἰκίᾳ τοῖς ἐλευθέροις ἥκιστα ἔξεστιν ὅ τι ἔτυχε ποιεῖν, ἀλλὰ πάντα ἢ τὰ πλεῖστα τέτακται, τοῖς δὲ ἀνδραπόδοις καὶ τοῖς θηρίοις μικρὸν τὸ εἰς τὸ κοινόν, τὸ δὲ πολὺ ὅ τι ἔτυχεν· τοιαύτη γὰρ ἑκάστου ἀρχὴ αὐτῶν ἡ φύσις ἐστίν. λέγω δ' οἷον εἴς γε τὸ διακριθῆναι ἀνάγκη ἅπασιν ἐλθεῖν, καὶ ἄλλα οὕτως ἔστιν ὧν κοινωνεῖ ἅπαντα εἰς τὸ ὅλον.
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> "We must also consider in which way the nature of the whole (*hê tou holou phusis*) contains the good and the best; whether as something separated and by itself, or as its arrangement [of its parts]. Or in both ways, as an army does; for the good [of an army] is partly in the order, and is also the general; but it is mostly the latter: for he is not due to the order but the order is due to him. All things are ordered together in some way, but not fish and birds and plants all in the same way; and [the order] is not such that there is no relation between one thing and another, there is one. For all things are ordered together towards one, but it is like a household, where the free persons have the least liberty to act at random, but all or most [of their actions] are arranged, while the slaves and animals can do little towards what is communal, but act as they chance: for that is the kind of principle that nature is of each of them. I mean, for example, that it is necessary that everything comes to be

[192] Furley (2004), 83; Hankinson (1998), 147; Matthen (2007), 15.
[193] Cf. Lennox (2001a), 201n.5.
[194] Cf. also Matthen (2001), who argues for the existence of a cosmic nature on the basis of *DC.*I; however, I believe Bodnár (2005), 10-17 offers convincing arguments that undermine such a reading.

> dissolved, and similarly there are other respects in which everything participates in the whole."

This passage forms the opening of a chapter in which Aristotle discusses the place of the good in 'the whole'; first he gives his own view and then goes on to discuss and criticize a couple of views of his predecessors. What exactly Aristotle's opinion is, is difficult to say, as the language he uses is full of metaphor and analogy. What is clear is that Aristotle likens the unmoved mover to the general of an army: just as the order (and the goodness) of the members of an army depends upon the general, so the natural order (and the goodness) of the whole (that is, of the heavenly bodies) depends upon the unmoved mover. Next, this order of the whole is likened to a household, in order to stress what seems to be the necessity involved in the movement of the stars and planets on the one hand, and the passing or deconstruction of bodies in the sublunary world on the other hand.[195] It is also clear that the 'the one' towards which everything else is ordered, is the unmoved mover – he is the cause (the final cause) of the order of the whole. This explains the regularity of the motions of the heavenly bodies and the existence of motion in the sublunary world, but – although this ordering must certainly be teleological in some sense – it is not clear in what teleological sense exactly. The language is not overtly teleological and the whole-part causal relationships involved are not particularly well-known from other passages in the Aristotelian corpus (usually whole-part relationships do not extend beyond organic substances).[196] It is also unclear to what extent this passage in fact establishes a notion of a global nature (the interpretation of the expression 'the nature of the whole' in *Met*.XII.10, 1075a11 is highly problematic),[197] or a 'nature of the entire ecosystem',[198] which is supposedly responsible for the subservience of lower living beings to higher ones. For, as opponents of this cosmic interpretation have argued,[199] Aristotle's natural philosophy cannot give any substantial content to such a notion; only substances have a nature, and the whole cosmos cannot be qualified as such a substance – at least not without doing away

[195] Cf. Balme (1987b), 278.
[196] Johnson (2005), 277.
[197] On the problems related to the interpretation of this notion, see Bodnár (2005), 18-21; he ultimately proposes to read the expression in the traditional way, as periphrastic for 'the whole'.
[198] As Sedley (1991), 192 and Cooper (1982), 213 interpret the expression.
[199] Especially by Bodnár (2005), 17-28, Broadie (1990), 394-396 and Wardy (1993), 23-26.

with the ontological independence of 'ordinary natural substances.[200] On the other hand, in virtue of the reference to the presence of the unmoved mover as a ordering and regulating principle towards which all natural substances are oriented, it might not even be necessary to introduce such a global nature.

All in all, due to the many interpretational difficulties involved in this passage, it cannot offer strong support for (and definitely does not prove)[201] a cosmic interpretation of Aristotelian teleology. As this cosmic teleology is absent in virtually all other Aristotelian writings, and the anthropocentric perspective only obtains on a secondary level of teleology, the scope of Aristotle's primary teleology is most certainly limited to the actions and structures of individual substantial beings.

## 1.4 Conclusion

In our discussion of the theory of causal explanation of the *Physica*, it has become clear that Aristotle's theory of the four causes is essentially a theory about four types of causal explanations, in which causes are picked out under their causally appropriate description. Since according to Aristotle natural beings possess in themselves all the four causal factors needed to bring about their own realization, explanations in the philosophy of nature will pick out natures as either one of these four causes.

This holds also for teleological explanations: these are explanations that pick out an item as the end for the sake of which something else is present or came to be. Unlike his predecessors, Aristotle attributes a specific causal role to ends, mostly in conjunction with the three other types of causes he distinguishes. Although Aristotle never offers a conceptual analysis of the 'that for the sake of which' or 'end', it turns out that the final causes picked out in explanations vary in kinds. There are three types of final causes: actual natural substances or artifacts; functions; and objects of desire. The first type figures in explanations of the coming to be of processes of generation; the second type figures in explanations of the presence and the material constitution of natural or artificial tools; and the third type figures in explanations of deliberative action. This third type is not very important

[200] Broadie (1990), 395-396.
[201] Here I strongly agree with the conclusions of Wardy (1993), 24.

for Aristotle's theory of natural teleology, because the teleology involved in agency is intentional in nature. It is my contention that the theory of natural teleology is primarily developed for the explanation of processes of generation. The key to the understanding of Aristotle's teleology lies in the reproduction of form that is constitutive of both natural and artificial generation: the form that is realized and that in its full actuality constitutes the final cause already exists in potentiality and is transmitted by something that possess this form in actuality. Final causality thus involves no backwards causation, since it is this form that determines the outcome of the process of generation. The crucial difference between art and nature is that while in nature the formal, final, and efficient causes coincide, they are separate in art.

My analysis of the three models of teleology showed that there are in fact three different causal patterns involved. The patterns are most similar in the case of natural generation and artistic production: the efficient and final causes are in both cases complementary to each other, while intentional states or deliberation play no role in either of these cases. These similarities form the basis of Aristotle frequently used analogy between art and nature. However, while the efficient cause actualizes form from the inside out in natural things, in artistic production it imposes form externally in the object in which the end is being realized. This gives evidence for the ontological priority of the goal-directedness of nature over that in art: art imitates nature, and is goal-directed because nature is.

The model of deliberate action entails a goal-directedness which is modestly appealing for didactic purposes, but is not much like the unintentional goal-directedness exhibited by nature. Certainly, in both cases there is a causal relationship of one thing being for the sake of the other, but the efficient and final cause in the case of deliberative action are not as tightly bound to each other as is the case in natural generation (or artistic production, for that matter) – in the realm of actions, there are many ways to achieve ends. This gap between the two causes makes as it were room for luck to operate as an 'incidental cause': Aristotle says that something comes to be by luck in the case of things that could have come to be for the sake of something, but did not in this case, and the actual cause is

indeterminable, or when the action that was undertaken for the sake of something resulted in something else. In this sense, luck is among the things that are for the sake of something, although it is not itself a teleological cause; the same holds for spontaneity, which operates in the realm of nature where there is no deliberation or choice.

In sum, because the causal patterns in the three models are different (although less so for the models of natural generation and artistic production), the explanations and kinds of ends invoked in those explanations will be different, too. The account of the *Physica* thus offers a general framework for three types of teleological explanations, which will be specified in the other treatises on natural philosophy.

Aristotle devotes a major part of *Ph.*II to the defense of his theory of natural teleology. The difficulties in Aristotle's argumentation in this part have induced (at least) three important problems in recent scholarship pertaining to the relation between teleology and necessity, the proper explanation of winter-rain, and, intimately related with this latter issue, the scope of natural teleology.

Although a lot more will have to be said on the issue of the relation of teleology and necessity in the next chapters, for now I have argued that for Aristotle his theory of teleology is not meant as an alternative to explanation by reference to material necessity, and hence the issue should not be interpreted as being about whether or not final causation can be reduced to material/efficient causation. Rather, it is proposed as a theory that accounts for natural beings and functional natural wholes by reference to intrinsic causes, rather than doing away with them as being merely coincidental conglomeration of elements as the materialists did.

Phenomena such as winter-rain, the coming to be of teeth, and the coming to be of well-functioning whole organisms need to be understood, and hence to be explained, in terms of an overarching final cause. Just as the materialist, Aristotle refers to material necessity in the explanation of the coming to be of winter-rain and teeth; but their functions (and in particular the fact that they have these functions regularly) – whether they are anthropocentric or natural – can only be explained through the hypothesis of the existence of efficient causes that act goal directedly. In

the case of natural (and primary) functions, this is the formal nature or the soul of the living being which acts as the *internal* efficient cause directed at the realization of the form inherent in those natures. In the case of anthropocentric (and secondary) functions, this is a human being who imposes from the *outside* a specific use on something, while following the material potentials this thing has, through the application of art.

The distinction between primary teleology (where final causes account both for the coming into being and the presence of things) and secondary teleology (where something that is already present is used for the sake of something good, even though it did not come to be for this purpose) allows us – and Aristotle – to attribute an anthropocentric purpose to winter-rain (i.e. the growth of crops), without having to qualify his whole theory of natural teleology as anthropocentric. The notion of secondary teleology also helps us to gain understanding of those passages that suggest the workings of a global nature. I argue that instead of positing the existence of a global nature in Aristotle, we should interpret these references to 'nature' as picking out the individual natures of substantial beings, who impose their own goals on other beings – beings for whom the achievement of these goals is only secondary and in some sense accidental to the achievement of their own goals. There is no convincing evidence for the interpretation of Aristotle's teleology as being essentially cosmic. For all we can tell, the paradigm examples of Aristotle's teleology are restricted to individual natures; surely the relation between parts and wholes is teleological too, but when those wholes do not have a nature of their own (like rain and the cosmos), their features cannot be explained in terms of their functionally defined form or natural function. These restrictions will subsequently limit the explanatory force of teleological explanations; whatever phenomenon extends beyond the individual nature or substance, will not be fully explainable through reference to final causes. Aristotle's teleology will prove to be most successful with regard to individual natures, whose features, principles, and causes Aristotle has described in the *Physica*.

## CHAPTER TWO:

## ARISTOTLE'S BIO-FUNCTIONAL ACCOUNT OF THE SOUL ESTABLISHING THE STARTING POINTS OF TELEOLOGICAL EXPLANATIONS IN *DE ANIMA*

### 2.0 Introduction

Aristotle introduces his investigation of the soul (τὴν περὶ τῆς ψυχῆς ἱστορίαν) in *De Anima* (*DA*) as being among the primary kinds of knowledge, both on account of its accuracy, and of its dealing with better and more wonderful things (*DA*.I.1, 402a1-5). This praise of the study of the soul should come as no surprise, for Aristotle's prime interest in natural philosophy is in *living* nature.[1] For living nature represents Aristotle's concept of nature in the fullest sense, and it is the primary candidate for substantial being. In addition, the soul is "as it were,[2] the principle of living beings" (*DA*.I.1, 402a8: ἔστι γὰρ οἷον ἀρχὴ τῶν ζώων). Moreover, it is *because* the soul is the principle of living beings that the investigation of the soul makes a great contribution to "in particular [the truth] about nature" (*DA*.I.1, 402a6-7: μάλιστα δὲ πρὸς τὴν φύσιν; cf. *DA*.I.1, 403a27-28).

This conception of the soul as "that what makes a natural body alive" is common throughout antiquity,[3] but the connection Aristotle makes with his philosophy of nature shows that his 'biological' view of the soul is more specific, in the sense that it makes the soul primarily part of the domain of the student of living nature (as opposed to, for instance, of metaphysics).[4] From a didactic point of view, it puts the investigation of the soul at the very beginning of the study of living

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[1] Lennox (2005), 2.

[2] Aristotle's qualification here of the soul being 'as it were' a principle of living beings might indicate that it remains to be seen in what sense the soul is a principle, i.e. that there are some senses in which the soul is a principle of living beings (i.e. in the sense of formal, efficient, and final cause), but that in others it is not (i.e. not in the sense of material cause); cf. *DA*.II.4, 415b8-10; Ross (1961), 176. Lennox (2006, 308) thinks that the qualification foreshadows Aristotle's thesis that the soul is also a principle of *plant* life, a view that is perhaps not immediately shared with his contemporary readership.

[3] Hankinson (1998), 12-13.

[4] I believe that for Aristotle the study of the soul is predominantly, but not exclusively part of biology, in the sense that *De Anima* studies the principle of life (i.e. soul) and living beings under the aspect of being ensouled. See Cohen (1992), 58; Sorabji (1993), 164-5; cf. Van der Eijk (1997), 231-232 on the 'biological status' of *DA*.

beings.[5] Hence *DA* is "among the primary things" (*DA*.I.1, 402a4: ἂν ἐν πρώτοις τιθείημεν) also in the sense of a preliminary to the completion of Aristotle's general undertaking of the investigation of nature.[6]

The issues Aristotle sets out to address in *DA* are "its nature and substantial being, and further attributes" (*DA*.I.1, 402a8-9: τήν τε φύσιν αὐτῆς καὶ τὴν οὐσίαν, εἶθ' ὅσα συμβέβηκε περὶ αὐτήν), where the attributes are specified as being the "proper affections of the soul" (*DA*.I.1, 402a10-11: ὧν τὰ μὲν ἴδια πάθη τῆς ψυχῆς εἶναι δοκεῖ) and "the affections that belong to the living beings also on account of the soul" (*DA*.I.1, 402a11: τὰ δὲ δι'ἐκείνην καὶ τοῖς ζώοις ὑπάρχειν). This leads Aristotle initially – after having discussed various methodological problems that relate to the study of the soul – into an analysis of his predecessors' views of the soul, but soon also into investigations of the ontological status of the soul and specifically that of the intellect (i.e. the thinking soul), and into analyses of the various affections, activities, functions and capacities of the soul, of their relations to the body (i.e. of the question whether all psychological states are also bodily states), and of the causal conditions of movement. This brief overview of topics makes clear that the scope of *DA* is far wider than encompassing the investigation of the soul as a non-aggregative unity[7] of teleologically organized functions that make the natural body in which they are realized alive, but it this with this bio-functional analysis[8] of the soul within *DA* that the present chapter will be mostly concerned.[9]

This chapter analyzes the structure, function, and explanatory force of the teleological explanations Aristotle employs in his account of the nature of the soul as a principle of life in general (in section 2.1), and in particular of the capacities of the

[5] According to the cross-references within the different treatises – which may or may not be authentic – Aristotle's biological investigation starts with *DA*, and continues with the so called *Parva Naturalia* (in the known order: *Sens*., *Mem*., *Somn*., *Insomn*., *DS*, *Long*., *Juv*. and finally *Resp*. with which "the discussion of life and death and kindred topics is practically complete"; *Resp*.480b20-21), and completes with *HA*, *PA*, *IA*, *MA*, and finally *GA*. For the cross-references, see Bonitz (1955), 95b-105a (the most telling passages are *Sens*.436a1-6, *Sens*.436b10-11, *Mem*.449b30-31, *Somn*.458a25-32, *DS*.464b17-18, *Long*.464b32-465a2, *Resp*.480b20-30, *IA*.704a4-9, *MA*.698a1-11, and *GA*.715a1-18).

[6] For an outline of Aristotle's philosophy of nature, see *Mete*.I.1, 338a20-339a10.

[7] It is not entirely clear how Aristotle conceives of the unity of the soul as a whole; for relevant passages, see *DA*.II.3, 414b28-32 and *DA*.III.9, 432a22-b6.

[8] Rorty (1992, 7) calls this Aristotle's 'philosophical bio-psychology'.

[9] The problems relating to Aristotle's notion of *nous* and to the workings of the capacity of thinking fall outside the scope of this chapter, as for Aristotle these aspects of the soul seem not themselves to involve capacities realized in bodily parts or physiological processes giving rise to functions (although they cannot operate without at least some parts being present or without some physiological processes taking place). Because I have limited my discussion to Aristotle's biological investigation of soul (cf. *PA*.I.1, 641a33-641b9 and *Met*.VI.1, 1026a4-6), this 'metaphysical' aspect of the soul will not be further discussed.

soul, which are the life-functions of the natural body in which they are realized (in section 2.2).

Concerning Aristotle's account of the nature of the soul, I will first show (in section 2.1.1) how Aristotle from the outset connects soul to teleological notions such as function and final cause, and analyzes the relation between soul and body in terms of conditional necessity. Aristotle's further attempts to define the soul and to analyze its interaction with the natural body through the analogy between nature and art are set out to strengthen these preconceptions in a theoretical way. Next (in 2.1.2), I will pick up on an issue raised by contemporary interpreters of Aristotle's 'philosophy of mind', concerning the relation between body and soul. This is the issue of whether or not Aristotle can be read as a modern functionalist, who endorses the view that the matter in which the soul-functions are being realized is compositionally plastic (i.e. is not essentially connected to the function for the sake of which it is present). Although this discussion may be somewhat outdated,[10] I still think it is worth discussing (and refuting it!), because it will help to clarify some problematic aspects in Aristotle's account of the relation between soul and body, and also highlights some important features of Aristotle's explanatory project concerning living nature.

Concerning the capacities of the soul, I will first (in 2.2.1) discuss how Aristotle connects different combinations of the capacities of the soul with different kinds of living beings. Next, I will determine the extent to which the relations of interdependency that exist between these capacities establish a teleological hierarchy. In addition, I will analyze the teleological explanations Aristotle offers to explain why the various kinds of living beings possess the kind of capacities or life-functions they possess, discussing both examples of necessary functions and of non-necessary functions. This will show that Aristotle believes that the fact that living beings have the life-functions they have is itself firmly grounded in the teleology of nature. Special attention will be devoted to Aristotle's teleological model of animal

[10] Although the functionalist interpretation has somewhat lost popularity in recent years, the debate over related issues such as multiply realizability and supervernience theory has not been settled yet; see Caston (2006), 320-322 (cf. also 320n.13 for an overview of the literature published in the last fifteen years on these issues).

locomotion and to the relation between teleology and the notions of self-motion and intentionality (in 2.2.2).

The main purpose of the chapter will be to show, that in establishing such a bio-functional conception of the soul, Aristotle is laying the foundations for his biology.[11] Note that I am not claiming that this is the main purpose of *DA* as a whole, which is more broadly concerned with determining to what extent the functions of the soul can be realized without a material substrate and with what ensouled beings have in common. My claim is rather that the results of the investigation of the soul and the accounts it gives of the various life-functions that for the most part need to be realized in natural bodies present the starting points for explanations in the biological works. For, if the soul is the first actuality and final cause of a natural body that potentially has life, then the various parts and features living beings have will be explainable in terms of the kind of soul (or capacities for the performance of life-functions) they possess.[12] Soul is not only the principle of every natural body having life in an ontological sense, it is also the explanatory principle of all the features and parts living bodies have in an epistemological sense.

## 2.1 Teleology in the analysis of the nature of the soul

### *2.1.1 Soul, functions, and ends*

One of the main aims of *De Anima* is to give a characterization of the nature of the soul as something that *all* living beings possess. As I will show below, Aristotle's

[11] The biological dimension is visible most notably in the explanations of why certain animals do or do not possess certain capacities, which are similar to explanations found in the biological works in pointing out correlations between parts, functions, and lifestyle of animals (for instance the explanation of why fish do not have voice in *DA*.II.8, 421a3-6: "It is clear, too, why fish have no voice; for they have no throat. They do not have this part because they do not take in air or breathe in.") or in the use of teleological principles in *DA*.III.9-13 (for instance in the explanation of why the perceptive capacity cannot be responsible for the locomotive capacity in *DA*.III.9, 432b22-26: "If nature does nothing in vain and never leaves out any of the necessary [parts], except in those beings that are maimed and incomplete, while such living beings are complete and not maimed (…) – then they too would have instruments for locomotion."). The connection with biology is also very clear in *DA*.III.12-13, where Aristotle explains the presence of the of the various soul-functions in those living beings that have it in terms of their necessity for or contribution to their preservation of life and reproduction; the language here is similar to that in, for instance, *PA* (Ross (1961), 573).

[12] Cf. Lloyd (1992), 149: "Do his particular psychological theories influence his zoological explanations, and if so how? Part of the answer to the first question is straightforward enough. Obviously, whenever he is dealing with an instrumental part that is directly concerned with one of the major faculties of the soul identified in *De Anima*, Aristotle cannot fail to bear in mind precisely that *that* is the function that the part serves, and he will indeed see the activities in question as the final causes of the parts."

attempts to achieve this aim build – implicitly or explicitly – upon teleological preconceptions that permeate all of Aristotle's natural investigations.[13]

These preconceptions are, first, that efficient, formal, and final causes often 'run together' (cf. *Ph.*II.7, 198a24-7), which is reflected in *DA* in the conception of the soul as not only as a source of movement and as a principle of organization of living beings, but also teleologically as some kind of unity of life-functions in virtue of which a natural body is to be called alive. Secondly, the idea that naturally organized wholes come to be through material-efficient processes that take place for the sake of realizing that whole and only on the condition that that whole is to be realized is reflected in *DA* in the conception of the relation between soul and living body as one that is established through conditional necessity. Finally, since it is the task of natural philosopher to study natural composites, the soul conceived as a form specifying the defining capacities for the performance of various life-functions that are realized in living bodies also belongs to the scientific domain of the natural philosopher.

In this section, I will analyze the extent to which these preconceptions play a role in Aristotle's preliminary account of the soul in *DA*.I.1, and are subsequently reflected and substantiated in his attempts to provide a 'rough' definition of soul in *DA*.II.1 and his characterization of the soul as the final cause of the living body in *DA*.II.4.

*2.1.1.a Teleological notions in the preliminary characterizations of the soul in DA.I.1*

Modern interpreters of Aristotle's *DA* often disregard the first book of the treatise on the assumption that it is mainly a review of past theories on the soul and that it does not contain much original thought of Aristotle on the subject.[14] Although this is largely true, I think that a close reading of at least the first chapter of book I, which is more methodological than historical in nature compared to the other chapters of the first book, might provide us with some preliminary indications on

[13] Pace Code & Moravscik (1992), 134-5, who deny that teleological notions play any important (explanatory) role in Aristotle's account of what it is to be alive in order to argue against a functionalist interpretation.

[14] Cf. Witt (1992), 169: "The fact that *DA* is frequently read and taught omitting book I suggests a widespread acceptance of the idea that it has nothing important to tell us about Aristotle's views on the soul."

Aristotle's conception of the soul and how this conception is related to teleological notions. Moreover, many remarks are of programmatic interest,[15] as they either open up the traditional conception of soul for Aristotle's own view, or point forward to fuller discussions on the issue later on in *DA*. This holds, too, for Aristotle's treatment of the three main preconceptions[16] concerning the soul current among his predecessors in *DA*.I.2-5. These are the preconception of the soul being the source of movement, that of its being the cause of perception or cognition, and that of its supposed incorporeality and immortality. The dialectic discussion of these preconceptions "shape and direct the inquiry that follows."[17]

One of the most important remarks concerning the nature of the soul in the opening chapter of *DA* is that it is, "as it were, a principle of living beings" (*DA*.I.1, 402a8: ἔστι γὰρ οἷον ἀρχὴ τῶν ζῴων). As I said in the introduction, this makes Aristotle's conception of the soul predominantly a biological one: the soul is that in virtue of which a natural body is alive. This preliminary definition of the soul, which is taken as a starting point without any further clarification (presumably because it was uncontroversial among Aristotle's readership), has important implications for the way in which Aristotle further develops his view of the soul. In some sense, this biological conception of the soul already predetermines the outcomes of the methodological questions that follow about what kind of thing the soul is (*DA*.I.1, 402a24-402b8).[18] For instance, it leads Aristotle to the conclusion that the notion of soul applies to living beings other than human beings, too. By making the soul a principle of *all* life, Aristotle makes the being-alive of all the different kinds of life-forms (e.g. those of plants and of animals) explainable by reference to the soul, and the differences in their life styles (e.g. perceiving and locomoting) explainable by reference to differences in the soul (*DA*.II.2, 413b32-414a1):

> ἔτι δ' ἐνίοις μὲν τῶν ζῴων ἅπανθ' ὑπάρχει ταῦτα, τισὶ δὲ τινὰ τούτων, ἑτέροις δὲ ἓν μόνον - τοῦτο δὲ ποιεῖ διαφορὰν τῶν ζῴων ·

[15] Menn (2002), 102-103. Cf. Rorty (1992, 7-8), who reads the chapter as setting the agenda of *DA*.
[16] *DA*.I.2, 405b12-31.
[17] See Witt (1992), 169.
[18] The questions are: (i.) the genus of soul (is the soul a *tode ti* and *ousia* or one of the categories); (ii.) the ontological status of the soul (is it in potentiality or is it rather a kind of actuality); (iii.) the structure of the soul (does the soul have parts or not; is every soul *homoeidês* or not; if it is *homeidês*, is the difference one of genus or species); (iv.) the definition of the soul (is there one definition only, or is there a definition for the soul of each separate kind of ensouled being).

> "Moreover, some animals have all of these [functions of the soul], others have only some of them, and still others have only one – this causes a differentiation between living beings."

Different kinds of living are for Aristotle thus coextensive with different kinds of soul.[19] For this reason, Aristotle includes the souls of all living beings, of human beings, animals, and even plants, into the present inquiry.

In addition, this biological conception of the soul entails a biological orientation of the investigation of the whole of *DA*.[20] Because life is analyzed in terms of the performance of the various vital and essential life-functions and affections of the ensouled being in question, much of the discussion on the soul will be devoted to the various functions and affections of the different species of living beings.[21] In some sense, the soul just *is* the capacities for these functions and affections (with the understanding that these functions and affections ultimately *belong* to the composite of soul and body). This bio-functional[22] conception of the soul is already visible in the methodological part of the first chapter of *DA*, where Aristotle discusses the question in which order the parts of the soul need to be studied (*DA*.I.1, 402b9-14).[23] This question already presupposes a functional partitioning of the soul, because Aristotle exemplifies the different parts as different faculties or capacities for the performance of different functions of the soul: that which thinks (τὸν νοῦν) performs the function of thinking (τὸ νοεῖν), that which perceives (τὸ αἰσθητικόν) performs the function of perceiving (τὸ αἰσθάνεσθαι), etc. The soul is presented as a unity of capacities for the performance of functions, in virtue of the possession of which a natural body can be said to be alive. This conception is teleological, for the soul is defined in terms of the different 'works' (τὰ ἔργα) or life-functions the natural body to which it belongs will be able to perform. It does so in a strong sense: these *erga* are not merely the activities the possession of

[19] Cf. Everson (1997), 3-4; Sorabji (1993), 163-165.
[20] Lloyd (1992), 148.
[21] Aristotle names different life-functions in different places of *DA*, but usually he mentions at least a few of the following: self-nutrition, growth and decay, reproduction, appetite (or desire), sensation or perception, touch, self-motion, and thinking. Aristotle gives a wide range of examples of affections, such as being angry, being courageous, loving and hating, and other emotions, but also pleasure and pain, and other forms of the soul being affected. In the first book of *DA* it seems that Aristotle uses the term *pathê* rather loosely to refer to any of the soul's forms of being affected, including functions (see e.g. *DA*.I.5, 409b14-19). Cf. Hamlyn (2001), 79.
[22] Cf. Charlton (1993), 98-99.
[23] The question is whether we should study the parts (*ta moria*) first, or the soul as a whole; the parts first, or their functions (*ta erga*); the functions first, or the objects (*ta antikeimena*) of the functions.

soul regularly and in a non-accidental way gives rise to; the capacities for the performance of *erga* are what the soul essentially is.[24] In short, the soul simply *is* the whole of capacities for the performance of such life-functions.

The most important references to teleology in Aristotle's preliminary sketch of the soul can be found in Aristotle's discussion of a final problem concerning the affections of the soul (*DA*.I.1, 403a3-b19): are they all common also to that which has it, or is there also something particular to the soul itself? In resolving this problem concerning the relation between soul and living body, I take Aristotle to be emphasizing two important points deriving to some extent from his teleological conception of nature.

First, Aristotle argues that the affections and functions of the soul involve the body, because both soul and body are affected. Although conceding that the question is hard to settle, and that perhaps the function of thinking could be particular to the soul itself (depending on the extent to which thinking needs to be seen as a form of imagination that involves the body) and therefore separable from the body, Aristotle thinks that there is clear empirical evidence for the conclusion that all the affections and most of the functions of the soul are always 'with body', and are therefore inseparable from the body (*DA*.I.1, 403a3-26; *DA*.I.1, 403a19: μηνύει; *DA*.I.1, 403a22-23: ἔτι δὲ μᾶλλον τοῦτο φανερόν). From this conclusion Aristotle then derives a preliminary characterization of the affections of the soul: they are 'enmattered structures'[25] (*DA*.I.1, 403a25): δῆλον ὅτι τὰ πάθη λόγοι ἔνυλοί εἰσιν. This 'definition' could be taken as reflecting Aristotle's theory of hylomorphism,[26] according to which he analyzes artificial and natural compounds in terms of the matter and form from which they are constituted.[27] However, it seems to me that the point Aristotle is making here is not just that the affections are forms

[24] Cf. *Mete*.IV.12, 390a10-12: "everything is defined in respect of its function; for when something is capable to perform its function, it is truly that thing; an eye, for example, when it is able to see; but the one that is not capable [to perform its function] is homonymously [that thing]".
[25] Caston (2006), 318.
[26] The core texts in which scholars see evidence for Aristotle's supposed hylomorphic theory of the soul are *DA*.II.1-4 and *DA*.II.12; the idea is that Aristotle developed this hylomorphic theory in order to refute not only Plato's dualistic account of the soul, but also his own earlier instrumentalist views (described in *Parva Naturalia*, *De Somno*, and *Physics* VIII), in which the natural body is characterized as the instrument of the soul. The two views are not mutually exclusive, and I indeed believe that both theories are at play in *DA*. On these issues, see Menn (1992), esp. 89-90.
[27] So Shields (1988) and (1993), passim.

that are realized in matter (note that Aristotle writes '*logos*' here, not '*eidos*'),[28] but that the affections of the soul are also, at the same time, affections of the body, and that they are so in a strong sense: affections take place in matter and therefore *require* the presence of a living body. Underlying this expression is, I believe, Aristotle's notion of conditional necessity,[29] which is the notion of particular materials having to be present first if a particular end is to be realized.[30]

That for Aristotle the affections of the soul are not just realized in matter, but that matter is also constitutive and required for the being of the affections, becomes clear from the definition of anger that he offers immediately after giving this very general characterization of affections (*DA*.I.1, 403a26-27):

> τὸ ὀργίζεσθαι κίνησίς τις τοῦ τοιουδὶ σώματος ἢ μέρους ἢ δυνάμεως ὑπὸ τοῦδε ἕνεκα τοῦδε.
>
> "For example, being angry is a certain kind of change of a *particular kind* of body or part or faculty due to such a cause for the sake of that."

The idea is that because (*DA*.I.1, 403a26: ὥστε) affections are *logoi enhuloi*, their definition, such as that of anger, must include references to all four causes: anger is a certain kind of change, belonging to a particular kind of material substrate, due to some efficient cause, taking place for the sake of some final cause. Affections take place for the sake of something, and if this end is to be achieved, they have to take place in the appropriate kind of matter. Affections are therefore not just psychological states that have bodily concomitants, but the two states are functionally connected through conditional necessity: anger can only be realized in the right kind of material.

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[28] Although Ross (1961), 7 translates '*logoi*' with "forms or notions"; Hamlyn (2001, 79) takes '*logos*' to suggest the reading of 'form' (or *eidos*). The question is, of course, whether Aristotle is claiming that that the *definitions* of the affections need to include matter or whether these *affections* themselves need to be enmattered; I opt for the latter interpretation. On this issue, see Everson (1997), 234-236.

[29] It has been acknowledged that there is almost no technical vocabulary to be found in *DA* (see e.g. Hamlyn (2001), xvi), but I believe that there are clear resemblances between the language used in this treatise and the semi-technical language Aristotle uses elsewhere to explain the notion of conditional necessity.

[30] E.g. *Ph*.II.9, 200a10-15: "Thus on account of what is a saw like this? That this may be, and for this. It is impossible, however, that this thing which it is for should come to be, unless it is made of iron. It is necessary, then, that it should be made of iron, if there is to be a saw, and its work to be done. The necessary, then, is necessary on some condition, and not as an end: the necessary is in the matter, the 'that for the sake of which' in the account."; see also *PA*.I.1, 639b20-30; *PA*.I.1, 640a1-9; *PA*.I.1, 640a33-b3; *PA*.I.1, 642a1-13; *PA*.I.1, 642a32-642b2.

The second point that Aristotle stresses in this chapter is that the study of the soul belongs to the tasks of the natural philosopher. Aristotle remarks that the fact that the affections of the soul involve body, immediately (ἤδη) makes the study of the soul (which is "either each soul or this kind of soul" – the latter being the soul that involves body), belong to the field of the natural philosopher (*DA*.I.1, 403a27-28: διὰ ταῦτα ἤδη φυσικοῦ τὸ θεωρῆσαι περὶ ψυχῆς, ἢ πάσης ἢ τῆς τοιαύτης). That is, because the affections of the soul are affections of the body as well, they belong to the domain of the natural philosopher. Aristotle then sets out to describe the task of the natural philosopher (*DA*.I.1, 403a27-403b16). First Aristotle clarifies in what respect the definition of the natural philosopher[31] will differ from that of the dialectician through the use of an example (*DA*.I.1, 403a29-b2):

> διαφερόντως δ' ἂν ὁρίσαιντο ὁ φυσικὸς [τε] καὶ ὁ διαλεκτικὸς ἕκαστον αὐτῶν, οἷον ὀργὴ τί ἐστιν· ὁ μὲν γὰρ ὄρεξιν ἀντιλυπήσεως ἤ τι τοιοῦτον, ὁ δὲ ζέσιν τοῦ περὶ καρδίαν αἵματος καὶ θερμοῦ. τούτων δὲ ὁ μὲν τὴν ὕλην ἀποδίδωσιν, ὁ δὲ τὸ εἶδος καὶ τὸν λόγον.
>
> "The natural philosopher and the dialectician would define each of these differently, for instance: what is anger? The one [i.e. the dialectician] will say that it is a 'craving for revenge' or something of that sort, while the other [i.e. the natural philosopher] will say it is 'a boiling of blood and heat around the heart'. Of those, the one gives an account of the matter, the other of the form and the structure."

The account of the dialectician thus gives merely a formal account of what anger *is*, while the account of the natural philosopher states from what kind of matter the emotion is constituted (namely blood that is boiling) and the efficient cause of the emotion (namely heat). Aristotle is willing to concede that 'a craving for revenge' is the *logos* of the thing called anger, but he adds the following consideration (*DA*.I.1, 403b3):

> ἀνάγκη δ' εἶναι τοῦτον ἐν ὕλῃ τοιᾳδί, εἰ ἔσται·
>
> "It is necessary for that [i.e. anger] to be in a particular kind of material, if it is to be."

Apparently, for the account of what anger is to be complete, one should add the kind of material in which anger is realized as well. The being-in-a-particular-kind-of-

[31] Presumably, in this line 'natural philosopher' is understood in a somewhat narrower sense, as for Aristotle, ultimately, the natural philosopher will have to provide accounts in terms of all four causes for natural phenomena; cf. Ross (1961), 201.

matter is again, and this time more explicitly, characterized as a necessary condition for the existence of the affections of the soul: the affections cannot exist without a body, nor can they exist with a body with the wrong material constitution. The natural philosopher thus deals with properties of a body that are strictly speaking not separable from the matter,[32] because it makes no sense according to Aristotle to speak about the affections and functions of the soul in a purely formal way, nor to speak in a purely material way about bodily structures in isolation of the functions for the performance of which they have come to be and are present.

Note that the importance of this functional connection between the soul and the living body is reinforced in the concluding statement of chapter I.3 (*DA*.I.3, 407b23-26):

> δοκεῖ γὰρ ἕκαστον ἴδιον ἔχειν εἶδος καὶ μορφήν, παραπλήσιον δὲ λέγουσιν ὥσπερ εἴ τις φαίη τὴν τεκτονικὴν εἰς αὐλοὺς ἐνδύεσθαι· δεῖ γὰρ τὴν μὲν τέχνην χρῆσθαι τοῖς ὀργάνοις, τὴν δὲ ψυχὴν τῷ σώματι.
>
> "For while each body seems to have its own *proper* shape and form, they talk as if one were to say that *carpentry is to be clothed in flutes*; but the art has to use tools and the soul has to use the body."

Aristotle here criticizes those predecessors who hold that the soul is set inside the body for not having further specified (*prosdiorizousi*) the body which receives the soul (*DA*.I.3, 407b20-23):

> οἱ δὲ μόνον ἐπιχειροῦσι λέγειν ποῖόν τι ἡ ψυχή, περὶ δὲ τοῦ δεξομένου σώματος οὐθὲν ἔτι προσδιορίζουσιν, ὥσπερ ἐνδεχόμενον κατὰ τοὺς Πυθαγορικοὺς μύθους τὴν τυχοῦσαν ψυχὴν εἰς τὸ τυχὸν ἐνδύεσθαι σῶμα.
>
> "But people put their effort into saying what sort of thing the soul is, while they determine nothing further about the body that receives it, just as though, in the manner of the Pythagorean myths, any random soul were to be clothed *in any random body*."

The meaning of the concluding statement is that just as each art needs its *own proper and befitting* instruments, so the soul needs its *own proper and befitting* body – proper and befitting, that is, for the functions it is to perform.[33]

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[32] Hamlyn (2001), 80; Ross (1961), 200.

[33] This is also how Hett (1936), 43 reads these lines. Aristotle makes a similar point in *DA*.II.2, 414a22-25: "For it [i.e. the soul] is not a body, but something which belongs to a body, and for this reason exists in a body, and in a body of such and such a kind. Not as our predecessors supposed, when they fitted it to a body without any further determination (*prosdiorizontes*) of what body and of what kind, although it is clear

To return to *DA*.I.1, there Aristotle's illustration of the necessity of a thing's being in appropriate matter if it is to be at all adds to this picture (*DA*.I.1, 403b3-7):

> ὥσπερ οἰκίας ὁ μὲν λόγος τοιοῦτος, ὅτι σκέπασμα κωλυτικὸν φθορᾶς ὑπ' ἀνέμων καὶ ὄμβρων καὶ καυμάτων, ὁ δὲ φήσει λίθους καὶ πλίνθους καὶ ξύλα, ἕτερος δ' ἐν τούτοις τὸ εἶδος <οὗ> ἕνεκα τωνδί.
>
> "such is the account of a house: that it is a shelter that protects against destruction by wind, rain and heat; but another will say that it is stones, bricks, and timber; and another again will say that it is the form in those things [i.e. stones, bricks, and timber] for the sake of these other things [i.e. shelter]."

Elsewhere Aristotle uses the relation between the materials of the house and the function the house serves as the stock example to illustrate his notion of conditional necessity.[34] Here it is used to illustrate that the explanation of things such as the presence of a house includes both references to constitutive materials and to functions, and preferably in combination with each other. It is through this example that Aristotle brings home his second point. The natural philosopher, Aristotle makes clear, is the one who is concerned not just with the matter (this would be a craftsman according to Aristotle; cf. *Ph*.II.2, 194b1-5 where a *technê poiêtikê* is being distinguished from a *technê chrômenê* in that the first is concerned with matter, while latter deals with form), or just with forms in abstraction (this would be the mathematician), or with separable forms (this would be the first philosopher), but with the product of *both matter and form*, where form is functionally defined (e.g. the form of anger is a 'craving for revenge') and not just shape. The natural philosopher's concern is with all the functions and affections of a particular kind of body realized in a particular kind of matter. Aristotle thus stresses that it is crucial for a natural philosopher to have a complete causal understanding of a phenomenon. For this reason the affections and functions of the soul need to be accounted for by the natural philosopher in terms of the *four* causes.

At the end of the chapter, Aristotle returns to his original question concerning the separability of the affections of the soul from the body, and concludes (*DA*.I.1, 403b16-19):

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that one chance thing does not receive another." In *DA*.II.2, 414a27 Aristotle refers to the notion of the proper matter (*hê oikeia hulê*) for the actualization of a potentiality.

[34] E.g. *PA*.I.1, 639b22-31 and *Ph*.II.9, 200a5-15.

> ἐλέγομεν δὴ ὅτι τὰ πάθη τῆς ψυχῆς οὕτως ἀχώριστα τῆς φυσικῆς ὕλης τῶν ζῴων, ᾗ γε τοιαῦθ' ὑπάρχει <οἷα> θυμὸς καὶ φόβος, καὶ οὐχ ὥσπερ γραμμὴ καὶ ἐπίπεδον.
>
> "We said that the affections of the soul are inseparable from the natural matter of the living beings in which they occur, such as anger and fear, and they are not like the line or plane."

That is, although the form and matter of the affections of the soul are separable in a conceptual way, they are not separable ontologically and in definition because the 'natural matter' of the living being is part of what the being essentially is. Anger and fear differ in this respect from mathematical figures, which although they always occur in matter, are not essentially connected to the matter in which they are realized (i.e. a line will still be a line, whether it is drawn in sand or on a piece of paper; anger, on the other hand, will only be anger if realized in boiling blood – otherwise it will not be anger). Because of this, form and matter are also not separable in the explanation of the affections of the soul: the connection between the two in nature is one of (conditional) necessity, where the matter is necessary in order to facilitate the realization of functions. What is more, the specific matter in which the form is realized plays an important role in the explanation of the variations and distributions of functions among different types of living beings.[35] The understanding of a functioning natural whole thus implies knowledge of the specific material in which these soul-functions are realized.

In sum, it is thus my contention that in this chapter it is not Aristotle's main purpose to merely stress the being *in matter* of the formal structure of some living being, but rather to show the intrinsic functional connection between the affections and functions of soul and the living body in which they are realized, thus building upon his teleological notion of conditional necessity. Aristotle's theoretical discussions of the soul in the remainder of *DA* should be read as attempts to further solidify and flesh out this teleological picture of the soul.[36]

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[35] Van der Eijk (1997), 233; see also chapter 3.2.

[36] If Aristotle analyzes the relation between the soul and the living body in terms of conditional necessity, then it poses serious restrictions on the possibility of a functionalist interpretation of Aristotle's conception of the soul. I will discuss this issue of a functionalist interpretation of Aristotle more fully in the section dealing with Aristotelian teleology and modern functionalism (see below in 2.1.2), but for now it suffices to say that according to a functionalist reading of Aristotle's conception of the soul, Aristotle leaves open the possibility that the functions of the soul can be realized in different kinds of material. On this interpretation, the affections and functions of the soul are for Aristotle compositionally plastic. It seems to me, however, that the conditionally necessary relation between form and function on the one

*2.1.1.b Function in Aristotle's account of the soul of a natural body in DA.II.1*

At the beginning of book II, Aristotle ends his dialectical discussion of the views of his predecessors and starts his own investigation (*DA*.II.1, 412a1-6). Aristotle describes his project as follows (*DA*.II.1, 412a3-6):

> πάλιν δ' ὥσπερ ἐξ ὑπαρχῆς ἐπανίωμεν, πειρώμενοι διορίσαι τί ἐστι ψυχὴ καὶ τίς ἂν εἴη κοινότατος λόγος αὐτῆς.
>
> "But let us go back and, as though from the beginning, try to distinguish what the soul is and what would be its most comprehensive definition."

In this subsection, I will concentrate on Aristotle's analysis of the soul as a final cause of a natural body, first in his attempt to find the most comprehensive definition of the soul, and second in the analogies he draws to exemplify his definition of the soul; my argument will closely follow the order of Aristotle's exposition in *DA* II.1. As indicated above, I believe that both these attempts should be interpreted in the light of Aristotle's larger project to consolidate his bio-functional conception of the soul.

Aristotle's definition of the soul progresses in different stages. Aristotle offers two intermediate definitions before stating – cautiously – his final (but still rudimentary) definition stating that the soul is the first actuality of a natural body that is *organikon*[37] (*DA*.II.1, 412b4-6). After having given this general definition of what soul is, Aristotle adds some clarifying remarks, which I have included in my discussion as well. As will become clear, the notion of function is the primary and most basic explanatory concept in Aristotle defining account of the soul.

Aristotle works towards his first definition of soul mainly through an analysis of the genus of substantial being (*DA*.II.1, 412a6-21). First Aristotle distinguishes between three different kinds of substantial being: there is the category of matter that is potentiality; the category of shape and form that is actuality (in two ways); and, thirdly, the compound of the two (τὸ ἐκ τούτων). Next, Aristotle moves to a discussion of substantial being itself: people usually consider bodies to be among the substantial beings, and in particular natural bodies. Those natural bodies

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hand, and matter on the other, which suggests that forms need to be (and in fact are) enmattered in specific kinds of matter, renders this interpretation unlikely from the outset.

[37] The interpretation of this term is controversial; I will return to this issue in my discussion of Aristotle's final definition.

that have life, i.e. that possess the capacities of self-nourishment, growth, and decay, are substantial beings of the compound type (*DA*.II.1, 412a11-16). Finally, by method of elimination, Aristotle is 'forced' to the following conclusion (*DA*.II.1, 412a19-21):

> ἀναγκαῖον ἄρα τὴν ψυχὴν οὐσίαν εἶναι ὡς εἶδος σώματος φυσικοῦ δυνάμει ζωὴν ἔχοντος.
>
> "Hence the soul must be a substantial being in the sense of the form of a natural body which potentially has life."

At this stage, the soul is presented as that which brings life to a natural body: it provides a natural body with the internal efficient cause of the basic vital functions of self-nourishing, growing, and decaying. So while soul is understood in terms of life, life itself is understood in terms of the ability to perform certain functions. Ultimately, the soul is identified with the functions the natural body has in virtue of which we call a natural body alive; the soul is thus a special kind of combination of life-functions.

The second definition is arrived at through two specifications of elements within the first definition (*DA*.II.1, 412a22-28). First, it is explained that substantial being in the first definition offered is actuality (*entelecheia*), which means that the soul must be the *actuality* of the natural body that has life potentially. Next, Aristotle points out that the soul is actuality in the sense of the actuality that corresponds to the possession of knowledge, which is a *hexis* or disposition (i.e. first actuality). The soul is not an actuality in the sense of the actuality that corresponds to the exercise of knowledge, which is an *energeia* or activity (i.e. second actuality). The distinction is one between possessing certain capacities, and exercising them: Aristotle's claim is that a natural body does not need to exercise its capacities at all times in order to be called alive – it just needs to have them. Moreover, the possession of capacities is chronologically prior to the exercise of those capacities, and in that sense, too, soul is like a *hexis* or disposition. Aristotle's comparison, however, between the *hexis* and the condition of sleep points out that the only time a natural body approximates the state of having life *purely* potentially or in first actuality is during sleep when most

functions are not being exercised; life in the fullest sense consists in the performance of the various life-functions.[38]

Specified in this way, the second definition of the soul becomes the following (*DA*.II.1, 412a27-28):

> διὸ ἡ ψυχὴ ἐστιν ἐντελέχεια ἡ πρώτη σώματος φυσικοῦ δυνάμει ζωὴν ἔχοντος.
>
> "That is why the soul is the first actuality of a natural body which has life potentially."

The term actuality or *entelecheia*, coined by Aristotle,[39] which is introduced into the definition of the soul here, is a teleological notion designating the completed state resulting from an internal movement towards this state.[40] For a natural body to have soul, or, in other words, for a natural body to possess life in a completed way, it needs to possess all the relevant life-functions by way of a disposition, such that they can be exercised or activated at any given time. At the same time, by characterizing the soul as the first actuality of a natural body, Aristotle characterizes the soul as the end of this body. So, although it is not so much the concept of function that is at stake here (although *entelecheia* seems to be associated with *energeia* and therefore with functioning),[41] in the background teleology still plays a role.

Finally, Aristotle clarifies what he means by a natural body that has life potentially' (*DA*.II.1, 412a28-b1):

> τοιοῦτον δὲ ὃ ἂν ᾖ ὀργανικόν.
>
> "This will be any [body] in so far as it is instrumental."

As indicated above, this specification of the natural body as being *organikon* to the soul is controversial. The traditional reading of *organikon* of "having organs"[42] or "being composed of organs" is unsatisfactory, as several scholars[43] have pointed out that elsewhere in the Aristotelian corpus *organikon* (a term coined by Aristotle)[44] always means 'instrumental', and that it is philologically unacceptable to propose a different reading exclusively for this definition of the soul. Reading *organikon* as instrumental, it means that Aristotle qualifies the natural body that has life

[38] On these issues, see Freeland (1987), 404-406.
[39] Ritter (1932; 1934).
[40] Johnson (2005), 88-90.
[41] Johnson (2005), 90.
[42] For the traditional interpretation, see Ross (1961), 51 and 313; Hamlyn (2001), 85.
[43] Most notably by Bos (2001), 187; 190-192; (2003), passim; see also Everson (1997), 64-65; Kosman (1987), 376-7; 381-382; and Menn (2002), 108-117.
[44] Byl (1971), 132.

potentially as the instrument of the soul,[45] presumably in the sense that the whole body is instrumental for life.[46] It is not until in the biological context, that Aristotle fleshes out the instrumentality of the natural body for the soul into the instrumentality of the various parts of living beings for the performance of the various functions of the soul. Hence, part of the explanatory program of the biological treatises will be to demonstrate teleologically how the parts living beings have are instrumental for its user.[47] In Aristotle's attempt here in *DA* to give a comprehensive definition of the soul, the focus is on the instrumental – that is, teleological – relation between natural bodies that potentially have life and the souls, constituting their defining capacity.[48]

In the next few lines, Aristotle exemplifies both how broad his conception of life is and what being 'instrumental' in practice boils down to (*DA*.II.1, 412b1-4):

> ὄργανα δὲ καὶ τὰ τῶν φυτῶν μέρη, ἀλλὰ παντελῶς ἁπλᾶ, οἷον τὸ φύλλον περικαρπίου σκέπασμα, τὸ δὲ περικάρπιον καρποῦ· αἱ δὲ ῥίζαι τῷ στόματι ἀνάλογον· ἄμφω γὰρ ἕλκει τὴν τροφήν.
>
> "Instrumental are also the parts of plants, even if they are extremely simple, such as for example the leaf is a cover of the pod, and the pod of the fruit. And the roots are analogous to the mouth, for both take in nourishment."

Just as the natural body is instrumental to the soul, so too are the parts of the natural body instrumental to the functions of the soul: the parts are instrumental in virtue of the functions they perform. Through these clarifications Aristotle then arrives at the most common definition of soul he can possibly (or is willing to) give (*DA*.II.1, 412b4-6):

> εἰ δή τι κοινὸν ἐπὶ πάσης ψυχῆς δεῖ λέγειν, εἴη ἂν ἐντελέχεια ἡ πρώτη σώματος φυσικοῦ ὀργανικοῦ.

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[45] Cf. *PA*.I.1, 642a11-13: "So too, since the body is an instrument (ἐπεὶ τὸ σῶμα ὄργανον) – for each of the parts is for the sake of something, and likewise also the whole – it is therefore a necessity that it be of such a character and constituted from such things, if that is to be." On this passage, see Lennox (2001b), 149-150. See also *DA*.I.3, 407b25-26, quoted above in 2.1.1.a.

[46] This is how Kosman (1987; 376) and Lennox (2001b; 142) interpret it. However, this is not the only possible interpretation: Bos (2001, 188-190), argues that 'the natural body that potentially has life' and that is 'instrumental to the soul' must be one of the elemental bodies, namely pneuma (for animals and human beings; the instrumental body for plants is vital heat); Everson (1997; 63-69) argues that the natural body to which Aristotle refers is not the whole animal body, but rather a part of it, so that the animal would not have one soul, but as many souls as it has instrumental parts; this latter view is strongly criticized by Barnes (1999), 121.

[47] Cf. Menn (2002), 113.

[48] Cf. Everson (1997), 64.

> "If it is necessary to state something common (cf. *DA*.II.1, 412b10: *katholou*) with regard to every soul, it will be the first actuality of a natural body that is instrumental."

Note, however, that according to Aristotle this definition, too, is nothing more than a "rough definition and a sketch" (*DA*.II.1, 413a9-10: τύπῳ μὲν οὖν ταύτῃ διωρίσθω καὶ ὑπογεγράφθω περὶ ψυχῆς). The definition necessarily remains vague, since it is supposed to cover every case of soul, and more specific definitions (including the characteristic activities of living beings) can only be offered at the specific level of the various kinds of living beings; what Aristotle adds to this rudimentary definition in the chapters to follow is mainly a specification of the types of activities the soul can be a capacity for and what its objects are. The final definition provided in *DA*.II.1 characterizes the soul emphatically in teleological terms: the soul is what completes a natural body so as to render it capable of performing its defining activities, while the natural body itself is for the sake of the performance of those defining activities; the natural body can only be completed by the soul by becoming its instrument. Ultimately, a living being not only possesses but also *exercises* its life (in the sense of second actuality) in virtue of having both soul and a natural body that is instrumental to the soul.

After having indicated that this definition of the soul as the *actuality* of a natural body takes away the need to ask whether the soul and the body are one (*DA*.II.1, 412b6-9), Aristotle offers some further specifications of the concepts used in this general definition of soul (*DA*.II.1, 412b10-11):

> οὐσία γὰρ ἡ κατὰ τὸν λόγον. τοῦτο δὲ τὸ τί ἦν εἶναι τῷ τοιῳδὶ σώματι (...).
> "For it [i.e. the soul] is a substantial being according to the definition. And that is what it is to be for such a body (…)."

At a first glance, Aristotle seems to switch here from the bio-functional language to talk about essences, but, as it turns out, essences and functions are closely related concepts for Aristotle. The functions that make a natural body a living body, also make that body the body it actually is: natural bodies are what they are in virtue of their abilities to perform their natural and non-accidental functions.[49] Natural bodies or parts that are not able to perform their defining functions are no longer what they are, except homonymously (cf. *PA*.I.1, 640b35-641a4 and the discussion of

[49] Cf. Lennox (2001b), 138; Wilkes (1992), 113.

homonymy below). Hence, the basic unity of self-nutrition, growth and decay, and touch, for example, make the natural body to be the plant it is. Further distinctions in functions make the plant to be the specific kind of plant it is. The unity of functions that constitutes the soul does not only make the natural body alive, it also specifies the essence of that living organism. Functions are as it were subsumed under the essences of living beings, and it is in this way that the soul is also the form of a living being. In short, Aristotle carefully weaves in the teleological notion of function into his definition of the soul.

Aristotle then explains this specification of the soul as that what it is to be for a natural body to be what it is through the use of an analogy (*DA*.II.1, 412b12-17):

> Καθάπερ εἴ τι τῶν ὀργάνων φυσικὸν ἦν σῶμα, οἷον πέλεκυς· ἦν μὲν γὰρ ἂν τὸ πελέκει εἶναι ἡ οὐσία αὐτοῦ, καὶ ἡ ψυχὴ τοῦτο· χωρισθείσης δὲ ταύτης οὐκ ἂν ἔτι πέλεκυς ἦν, ἀλλ' ἢ ὁμωνύμως, νῦν δ' ἔστι πέλεκυς. οὐ γὰρ τοιούτου σώματος τὸ τί ἦν εἶναι καὶ ὁ λόγος ἡ ψυχή, ἀλλὰ φυσικοῦ τοιουδί, ἔχοντος ἀρχὴν κινήσεως καὶ στάσεως ἐν ἑαυτῷ.
>
> "It would be as if one of the instruments, for example an axe, were a natural body: for its substantial being would be its being an axe, and that would be its soul. If this were separated off from it, it would no longer be an axe, except in name, but now it is an axe. For the soul is not what it is for it to be what it is and an account of such a body, but of a particular kind of natural body, which has a principle of movement and rest within itself."

This analogy between an instrument from the arts and a natural body instrumental to the soul takes the form of a thought-experiment in which we are to take away the soul or what corresponds to the soul in case of the axe (*DA*.II.1, 412b13-15). The soul of the axe would be its substantial being or that what it is for an axe to be what it is: presumably, this would be its capacity to cut.[50] Take away the axe's capacity to cut, and what is left is only an axe homonymously. Thus the category of artistic instruments presents the most clear-cut cases of things of which the essences are identical with their functions, and Aristotle's choice of an axe as an example to parallel natural bodies is therefore very significant.[51] The implication is that in the case of natural bodies, too, their essences coincide with their 'function' (or, better,

[50] Ross (1961), 316.
[51] See also Hamlyn (2001), 86: "Aristotle's selection of a tool, an axe, to provide an analogy with the ensouled body reveals how close to the surface in this discussion is the notion of *function*.".

with multiple life-functions; cf. *NE*.I.7, 1097b22-1098a17), which is their soul. If one takes away a natural body's soul, you take away its essence and thereby its capacity to perform its defining functions or activities, and it will no longer be a particular kind of body, except in name.

The analogy does not hold in every aspect, however, as Aristotle points out in the next few lines (*DA*.II.1, 412b15-17): the axe is just an axe, and not a natural body, and souls belong only to bodies that are natural and that therefore have in themselves a principle of movement and rest. What is defective in the notion of the soul as a function of non-natural tools is that these tools require an external source of movement in order to be able to perform their functions. In a strict sense, axes possess the capacity to cut as a first actuality, but can only realize that capacity in virtue of an external source in the form of a craftsman, who intends to use the axe in its proper way. That is, the movement from the first to the second actuality in tools requires an external source, unlike natural bodies that possess this source within themselves and are thus capable of actualizing their own capacities. The difference between tools and natural bodies is thus that the latter can actualize the functions for which they possess the capacity on their own.

Next, Aristotle proposes to apply this theory to the *parts* of living bodies, and draws another analogy (*DA*.II.1, 412b17-22):

> θεωρεῖν δὲ καὶ ἐπὶ τῶν μερῶν δεῖ τὸ λεχθέν. εἰ γὰρ ἦν ὁ ὀφθαλμὸς ζῷον, ψυχὴ ἂν ἦν αὐτοῦ ἡ ὄψις· αὕτη γὰρ οὐσία ὀφθαλμοῦ ἡ κατὰ τὸν λόγον (ὁ δ' ὀφθαλμὸς ὕλη ὄψεως), ἧς ἀπολειπούσης οὐκέτ' ὀφθαλμός, πλὴν ὁμωνύμως, καθάπερ ὁ λίθινος καὶ ὁ γεγραμμένος.
>
> "It is necessary to investigate what we have said also with regard to the parts [of natural bodies]. For if the eye were a living being, then its soul would be sight. For that is the substantial being that is according to the definition of the eye (and the eye is the matter of sight), without which it would no longer be an eye, except in name, in the same way as one made from stone or painted."

The thought-experiment presented here encourages us to think of a part of a natural body that has life potentially as if it were a living being itself. In that case, its soul would be its defining function, and without the ability to perform this function, the part would be what it is in name only. In short, the eye is to the natural body as sight is to the soul. In this analogy, essence and function again coincide, and again the

implication is that the part (and, analogously, the living being) would no longer be what it is without this essence or function, except homonymously.

At this point Aristotle brings home the analogy. That which applies to the part also applies to the whole body of the living being (*DA*.II.1, 412b22-25):

> δεῖ δὴ λαβεῖν τὸ ἐπὶ μέρους ἐφ' ὅλου τοῦ ζῶντος σώματος· ἀνάλογον γὰρ ἔχει ὡς τὸ μέρος πρὸς τὸ μέρος, οὕτως ἡ ὅλη αἴσθησις πρὸς τὸ ὅλον σῶμα τὸ αἰσθητικόν, ᾗ τοιοῦτον.
>
> "It is necessary to take that which applies to the part to the whole body of a living being: for just as there is an analogy from part to part, in the same way [there is an analogy] from the whole [function of] perception to the whole perceptive body, to the extent that it is such [i.e. perceptive]."

This means that the function of perception is the soul of the living body insofar as this living body is a perceptive living body (perceiving is just one of the functions a body might have in addition to, for instance, self-nourishment, growth, and decay). As such, the living body is capable of perceiving by itself, because of its own internal efficient cause of motion and rest that is its soul. Here Aristotle stresses again that is the having of a soul that makes a natural body alive potentially (*DA*.II.1, 412b26-29).

The conclusion Aristotle draws from these analogies at the end of this chapter (*DA*.II.1, 412b27-413a4) is set up emphatically in terms of both his notions of actuality and potentiality, and function and essence. The sense in which the soul is actuality is not that in which cutting and seeing are actual (i.e. as second actuality or as the performance of functions), but in the sense in which sight and the capacity of the artistic instrument are (i.e. as first actuality or as the capacity for the performance of functions). The body is in each case that which is something in potentiality:

> ἀλλ' ὥσπερ ὀφθαλμὸς ἡ κόρη καὶ ἡ ὄψις, κἀκεῖ ἡ ψυχὴ καὶ τὸ σῶμα ζῷον.
>
> "[Not as such], but in the way in which an eye is the pupil and sight, so here, too, is the living being the soul and the body."

Function and functional body are thus intrinsically connected to each other: together they constitute the substantial beings. As Aristotle pointed out earlier, the question of whether soul and body are separable thus makes no sense to the extent that the soul is the actuality of a body or a body part; the question only obtains if there are parts of the soul that are not the actuality of a body part (*DA*.II.1, 412a4-6). The soul is separable from the body only if the soul were the actuality of the body in the

sense that the sailor is the actuality of the boat (*DA*.II.1, 413a8-9); but this issue has not been settled yet and will have to be picked up in a later chapter.

In sum, Aristotle analyzes soul his definition of the soul as the first actuality of a natural body that has organs in terms of the essence of beings, and essences in terms of function: an animal is what it is when it possess capacities for its characteristic functions, an internal principle through which it can actualize those functions (and be alive in second actuality), and a natural body with which it can perform those functions. The complete living beings will thus be explainable in terms of all its life-functions.

### *2.1.1.c Aristotle's conception of the soul as a final cause of natural bodies*

In section 1.1.1.a, we saw that Aristotle defines knowledge as knowledge of all four causes or types of explanations, and since *DA* sets out to gain knowledge about the soul, Aristotle also analyzes the soul in terms of the four causes. In this section, I will focus on Aristotle's attempt to establish the soul as the final cause of natural bodies in *DA*.II.4. I will argue that in doing so Aristotle turns the soul into the starting point of explanation of natural bodies having life.

In the middle of discussing the nutritive and generative faculty of the soul in the second book of *DA* (*DA*.II.4, 415b11-29), Aristotle returns to his qualification of the soul as the cause and first principle of the living body. Subsequently, he analyzes the soul in terms of three of his four causes, the formal, the efficient and the final cause. The conception of the soul as the final cause, or, in Aristotle's own terms, as a *telos* and *hou heneka*, is explained through an analogy with the crafts-model[52] (*DA*.II.4, 415b15-21):

> φανερὸν δ' ὡς καὶ οὗ ἕνεκεν ἡ ψυχὴ αἰτία· ὥσπερ γὰρ ὁ νοῦς ἕνεκά του ποιεῖ, τὸν αὐτὸν τρόπον καὶ ἡ φύσις, καὶ τοῦτ' ἔστιν αὐτῆς τέλος. τοιοῦτον δ' ἐν τοῖς ζῴοις ἡ ψυχὴ κατὰ φύσιν· πάντα γὰρ τὰ φυσικὰ σώματα τῆς ψυχῆς ὄργανα, καθάπερ τὰ τῶν ζῴων, οὕτω καὶ τὰ τῶν φυτῶν, ὡς ἕνεκα τῆς ψυχῆς ὄντα· διττῶς δὲ τὸ οὗ ἕνεκα, τό τε οὗ καὶ τὸ ᾧ.
>
> "It is clear that the soul is a cause also as that for the sake of which. For just as the intellect acts for the sake of something, in the same way, too, does nature, and that

[52] There are numerous other passages throughout the Aristotelian corpus where Aristotle makes the same analogy. See, for example, *Ph*.II.8 (passim), *GA*.I.22, 730b9-23. For the relation between the craft analogy and Aristotle's teleology, see Broadie (1990) and Matthen (2006); cf. also chapter 1.2.

> is her end. That thing is among living beings the soul according to nature: for all natural bodies are instruments of the soul, just as the bodies of living beings, so too also the bodies of plants, because they are for the sake of soul. And that for the sake of which is double, there is the 'of which' and the 'for which'."

The instrumentality of the nature of the natural body that potentially for the soul is here turned into a teleological relationship in which the natural body is for the sake of the soul: the soul is its final cause. This means that the soul could not do what it needs to do (for instance, perceive or locomote), if it were not realized in a natural body, but also that the natural bodies are the conditionally necessary prerequisites for a fully-functioning soul.[53] Before discussing the wider ramifications of this account of the soul as the final cause of the natural body to which it belongs, let me first say a little more about Aristotle final remark about the doubleness of that for the sake of which (*DA*.II.4, 415b20-21).

Some scholars ignore these lines as a mere parenthetic remark,[54] but since the expression appears twice in this chapter (see also *DA*.II.4, 415b3), I believe it deserves at least some comments.[55] There are two questions that need to be answered here, first, the interpretation of the doubleness itself, and second, its application to the soul as an end (i.e. if and in what sense the soul is an end in a double sense).

One possible line of interpretation is offered by Johnson, for whom this distinction between the two senses of *to hou heneka* is central to resolving 'the problems of Aristotelian teleology.' He characterizes the distinction as "a difference between the aim of something and the beneficiary of the achievement of that aim," using for the latter the formula 'for the sake of which for which beneficiary.'[56] He takes *to hou heneka – hou* to refer to the end proper, while *to hou heneka – hôi* is taken to refer to the beneficiary of the (realization of the) end. Applying this distinction to the characterization of the soul as a final cause, Johnson explains that "The body

[53] As the example of the mole makes clear, it is possible in some sense to have the organ of sight without having the actual capacity of sight, but it is absolutely impossible to have the capacity of sight without having the proper parts; *DA*.I.5, 411b24.
[54] See e.g. Hamlyn (2001), 95.
[55] Johnson (2005), 75.
[56] Johnson (2005), 65-67.

exists for the aim of the soul's functioning, and the soul's functioning exists for the benefit of the individual organism that lives through the soul and with the body."[57]

Despite the interesting parallels Johnson offers to illustrate his reading of *to hou heneka hôi*,[58] I am not convinced that this is the most natural reading of the expression. The Greek seems to suggest that the ambiguity – that which is *ditton* or *dittôs* – lies in the kind of end picked out. Subsequently, the '*to men, to de*'-construction offers two possible readings of the kind of end referred to, or two ways in which to read '*to hou heneka*', which are 'that for the sake of which' or the final cause, and 'the for which' or 'the beneficiary of which'.[59] The question is then whether or not Aristotle intends to qualify the soul as both a final cause and the beneficiary of the natural body.[60] It seems to me, however, that Aristotle only points to the ambiguity in order to separate off the technical sense in which the soul is a 'that for the sake of which' of a natural body, namely in the sense of being an end for the sake of which the natural body has come to be and is present.[61] The function of the statement is thus to *limit* the interpretation of the soul as a final cause, rather than to extend it.

In identifying the soul with the formal, efficient, and final cause of the natural body that has life potentially, Aristotle conceives of the soul not only as the ontological principle of living beings (in the sense of its essence, internal origin of movement and rest, and internal orientation towards its complete realization through the 'use' of the natural body), but also as the epistemological principle facilitating an explanation of life. The soul as final cause seems to have explanatory priority, though, since it is in terms of its functioning that the essence of living beings is

[57] In this interpretation Johnson (2005, 75n.22) follows Menn (2002), claiming that "the body is for the sake of the soul as *to hôi*, the to-benefit-whom, as an *organon* is for the sake of the art or the artisan." However, Menn's analogy misrepresents Aristotle's analogy (that is, the analogy compares the following two domains: nous :: nature; axe :: natural bodies; cutting :: soul), in putting the soul at the same level as the artisan. Under this interpretation, the analogy should rather be construed as: 'as the soul benefits from the body, so too does the cutting benefit from the axe.' It is not clear how either the soul or the cutting could 'benefit' from their instruments, except in the sense that they cannot exist or operate without them (cf. *DA*.II.2, 414a19-21).

[58] Johnson (2005), 67n.8.

[59] This is also the way Kullman interprets the expression (1985), 172; cf. Judson (2005), 358. See also *Ph*.II.2, 194a34-b1: when Aristotle states that "we also are in a sense an end" he means that we are an end in the sense of the beneficiary, not in the sense of a final cause in a technical sense.

[60] Johnson (2005, 69), holds that both senses of 'the for the sake of which' are simultaneously operative and refers to the interpretations of Themistius, Simplicius, and Philoponus in favor of this interpretation; this does not settle the question for Aristotle though.

[61] This interpretation is suggested by Gotthelf (1987), 210.

determined and it is this defining function that explains why the natural body is present and is as it is (because it is conditionally necessitated that way). In the biology, this notion of soul as the final cause thus provides the starting point of teleological explanations of why animals have the instrumental bodies they have, since the bodies and their parts are *present* for the sake of the soul, i.e. for the sake of the realization of form of the body and next for the actualization of the capacities.

The conception of the soul as the final cause of the natural body is also crucial for Aristotle to demonstrate that what a natural body for the most part *does* – its *ergon* in the non-technical sense of its characteristic activity – is in fact that body's *function*, the *ergon* or *telos* in technical sense, which is the exercise of the animal's capacities. These activities are the living beings' proper functions in virtue of the kind of soul it has: natural bodies come to be exactly to perform such soul-functions.[62]

Code and Moravcsik point out that Aristotle's account of the soul in *DA* as a whole and in this section in particular does not amount to a teleological definition of the soul, or "much less [does it] define it in 'functional terms'".[63] Indeed, the soul itself is not defined teleologically (its nature is not explained as being for the sake of something, nor is its presence demonstrated through the use of teleological principles), but rather it is posited as the starting point in virtue of which teleological explanations pertaining to living nature will be possible. The reference to the natural body and to parts of living beings as being the 'instruments of the soul', on the other hand, picks out the soul as a functional complex to which the natural body 'contributes'. This surely *resembles* a functional description of the *compound* of the body and soul in Cummins' theory of function.[64] According to Cummins, a function is the contribution that an aspect or a portion of a system makes towards the capacities of the larger system of which it is a part.[65] Contrary to Code and Moravcsik, I do not see any problems of constructing a functionalist account for

[62] In this regard, Aristotle's notion of function differs significantly from the notion of function applied in etiological accounts in modern philosophy of biology. For Aristotle, function is predominantly a teleological notion (the function is the cause of the presence of the part which is for the sake of it), while for etiologists like Millikan (1999) and Neander (1999) function is generally a historical-pragmatic notion (the function of a part is that activity for which it was adapted or selected for over multiple generations – in other words, the function is what a part does and what it was selected for to do).
[63] Code & Moravcsik (1992), 134-135.
[64] Pace Klein (2002), 17, who thinks that Aristotle commits himself to Cummins functionalism.
[65] Cummins (1999), 57-83.

Aristotle if we follow Cummins, such that bodily parts are defined in terms of their contribution to the organism to which they belong. For instance, a Cummins account of the heart couched in Aristotelian terms would run like this. The heart is what heats the body, where heating is a usual effect of hearts incorporated in organisms, and organisms incorporating a heating heart in the usual way exhibit warmth; therefore, the organism exhibits warmth. Warmth sustains or increases the organism's capacity of preserving itself and of reproducing its species. The soul is what on this account is constituted by the total of the capacities of the organism. The problem is, however, that for Cummins, this definition does not entail that the heart is present for the sake of warming the organism. Cummins' concept of function is not teleological; in fact, it is emphatically designed *against* teleological accounts of function. For Aristotle, on the other hand, the fact that parts can be defined by reference to their contribution to the larger whole follows emphatically from his teleological worldview: it is *because* parts are for the sake of the whole that parts can be defined in terms of their contribution to the whole. So, although, again, Aristotle is not a functionalist in a modern sense, this does not preclude any role for teleology in his account of the soul. It is therefore not necessary to downplay the role of teleological elements in Aristotle's account in order to disentangle him from modern functionalist accounts.[66]

Aristotle's conception of the soul as a final cause of the natural body provides the basis for teleological explanations of the natural body and its parts living beings actually have in the biological works. In this way, *DA* provides the theoretical framework for Aristotle's explanatory project of the biology, which will be the subject of the next chapter.

### *2.1.2 Aristotelian teleology versus modern functionalism*

#### *2.1.2.a The problem of the unity of body and soul and modern functionalism*

In *DA*.II.1, 412b6-9 Aristotle makes clear that for him the third definition of the soul – that the soul is the first actuality of a natural body that is instrumental –

[66] This seems to be the main strategy of Code & Moravscik (1992); see especially 132; 135; 138.

should suffice as an answer to the question of the relation between body and soul (*DA*.II.1, 412b6-9):

> διὸ καὶ οὐ δεῖ ζητεῖν εἰ ἓν ἡ ψυχὴ καὶ τὸ σῶμα, ὥσπερ οὐδὲ τὸν κηρὸν καὶ τὸ σχῆμα, οὐδ' ὅλως τὴν ἑκάστου ὕλην καὶ τὸ οὗ ἡ ὕλη· τὸ γὰρ ἓν καὶ τὸ εἶναι ἐπεὶ πλεοναχῶς λέγεται, τὸ κυρίως ἡ ἐντελέχειά ἐστιν.
>
> "For that reason there is also no need to ask whether the soul and body are one, in the same way [as there is no need to ask whether] the wax and the impression [are one], or in general [whether] the matter of each and that of which it is the matter [are one]. For 'unity' and 'being' – despite the fact that they are spoken of in many ways – are [said] most properly of actuality."

In arguing that the unity that obtains between the soul and the natural body in which the soul is realized is like the compound of wax and the impression, Aristotle possibly draws from his theory of hylomorphism,[67] but the reference to actuality as that what unites the two also suggests a teleological link indicating the (first) state of completion of the living being and its direction towards activity.[68] From this passage it becomes clear that the Aristotle believes the soul and natural body to be intimately connected to each other and indeed to be inseparable (that is, in so far as the soul is the actuality of parts of the body; in so far as the soul is not the actuality of a bodily part, the soul might be separable; *DA*.II.1, 413a4-8). This account, however, does not make clear how *exactly* body and soul are related to each other, and what the status of the natural body is. The analogies between the soul and functions of instruments discussed earlier suggest that the matter or body in which form or soul is realized is at least to some degree contingent.[69] As Aristotle states repeatedly, axes can be made of different kinds of materials, such as bronze or iron, as long as the materials used have the right kind of material potentials.[70] Are we to conclude that there is no essential relation between a particular type of body and a particular soul-function, too?

According to functionalist interpreters of Aristotle this is indeed the conclusion we should draw. Functionalists acknowledge that for Aristotle soul-functions must be realized in some kind of functionally appropriate material, but

[67] This is, for instance, how Caston (2006, 318) and Ross (1961, 314) interpret this passage.
[68] Menn (2002), 105.
[69] Cf. Cohen (1992), 58.
[70] See Burnyeat (1992a), 17.

claim that the *particular* functionally appropriate material in which soul-functions are enmattered is irrelevant. For instance, the question of whether perception is realized in hard eye-jelly, or in fluid eye-jelly, or even in perceptive sensors is irrelevant as long as the eyes are functionally equivalent. In claiming this, interpreters of Aristotle adopt the compositional plasticity thesis[71] central to modern functionalism, which holds that mental states may be realized in completely different kinds of materials governed by heterogeneous laws of physics, because the particular material realization of a given function is not part of its essence.[72] Although modern functionalists reserve this thesis exclusively for mind-body relations, interpreters of Aristotle (mainly Nussbaum, Putnam,[73] and Cohen)[74] have applied it freely to all the functions of the soul and their bodily realizations in animals and humans alike. By attributing the compositional plasticity thesis to Aristotle it is claimed that Aristotle's conception of the soul can be read as a prototype of contemporary functionalism, as opposed to being a specimen of Platonic dualism or reductive materialism. Setting aside the issue of whether or not this application of a modern mind-body problem to Aristotle's general psychology is legitimate, I will argue below that the functionalist reading of Aristotle is mistaken.[75]

In the following subsections, I will show that the evidence that has been put forward in favor of the functionalist interpretation demonstrates that in theory Aristotle allows for some weak form of compositional plasticity even in natural substances, but that this 'theoretical possibility' has no meaning in Aristotle because

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[71] A concomitant to this thesis is the theory that every function or activity of the soul has to involve *a* bodily change – that is, that psychological events entail physiological processes. At least for the kind of functionalism Putnam is arguing for, it is not necessary to specify the material factors that are either necessary or sufficient for the occurrence of psychological events; all that is needed is there to be *some* physiological change that correlates with the occurrence of psychological events. For the scope of this dissertation, it will suffice to say that this latter view seems to be in accordance with Aristotle's claims that the functions of the soul are realized in matter and that the body is affected *in some sense*.

[72] This definition is based on Cohen's (1992, 58): "functionalism is the theory that mental states are defined in terms of their relations to causal inputs, behavioral outputs, and other mental states. It holds that the same mental state may be realized in several different physical states or processes [i.e. different in the sense of being governed by heterogeneous laws of physics; this is in fact what prevents psychological events to be reduced fully to physiological processes; for this addition, see Klein (2002), 3]. Mental states cannot, therefore, be reduced to physical states. They are, rather, functional states of the physical systems that realize them."

[73] Nussbaum & Putnam (1992), 27-56.

[74] Cohen (1992), 57-73.

[75] See also Burnyeat (1992a, 15-26), Charles (1983), 227-234 and (1988), 41-42, and Everson (1997), 252-258 for different lines of approach against functionalist interpreters of Aristotle.

in reality it never obtains.[76] Moreover, I will argue that matter is relevant to Aristotle *not* only insofar as it enables a part to perform its proper function. For, although different materials might be functional equivalent, there are other factors, too, which are often connected to the essence of the being in question, that co-determine the kind of material used to realize a particular function in a particular kind of living being. By using the example of the realization of perception in eyes, it will be shown that the functionalist interpretation misrepresents both Aristotle's notion of matter, and his goal in the teleological explanation of living beings as is set out in *DA* and the biological works. My main contention is that the functionalist reading of Aristotle stops at too general a level of analysis: Aristotle has no interest in functions in abstraction, but in the identification of the eternal and unchanging kinds of animals actually found in nature, with their own particular material realizations of their own characteristic functions. The supposition that these animals could have been realized differently contradicts Aristotle's concept of the fixity of animal kinds and of the teleology of nature.[77] Instead, I propose that the unity between body and soul should be explained teleologically.

#### *2.1.2.b Does matter matter? Functions and definitions*

Let me start by discussing the question of to what extent matter matters for Aristotle through an analysis of the 'evidence' that has been put forward by functionalist readers of Aristotle to show that Aristotle holds that (i.) functions of the soul are realized in matter; (ii.) functions of the soul must be realized in some suitable matter, but the particular matter in which the functions of the soul are realized is contingent and logically unrestricted (this is the strong compositional plasticity thesis).

One argument that has been put forward by functionalist interpreters of Aristotle is that essences are functionally defined in Aristotle, and that matter is not a

[76] With regard to artifacts, Aristotle obviously allows for compositional plasticity, but part of the point will be that artifacts and living beings are fundamentally different such that the compositional plasticity in the domain of the artifacts cannot be transferred to the domain of living beings.

[77] In this context Aristotle's concept of natural possibilities is important, for it puts constraints on the possible realizations of functions in animals that share to a certain extent the same form. On the notion of natural possibility, cf. *Met.*V.22, 1022b21-23: "We speak of privation if something has not one of the attributes which a thing might naturally have, even if this thing itself would not naturally have it, e.g. a plant is said to be deprived of eyes." On the teleological principle making use of this notion of natural possibilities, see 3.3.1.c.

part of the definition of what a thing is.[78] Because the material constitution of something is not part of its essence, it follows that matter is thus contingent. In favor of this view, functionalist interpreters cite a passage from the *Metaphysics* (*Met.*VII.11, 1036a26-b32). In this chapter Aristotle is held to deny that matter is part of a definition, and to argue in favor of the compositional plasticity thesis.

The central aporia of *Met.*VII.11 concerns what sort of things can be part of the form or essence, and what things cannot be part of it according to Aristotle. Underlying this discussion seems to be an ambiguity about definition and essence itself.[79] Usually, Aristotle identifies essences with the purely formal properties of something (such as soul; *Met.*VII.11, 1037a27-33) and holds that definitions should only pick out those universal, formal properties. At other times, Aristotle identifies essences with the concrete, composite natural being, and in that case he holds that the definition of that thing needs to pick out both the formal and the material properties in which the form – given the way the world is – is realized. As Aristotle makes clear in both in this chapter (*Met.*VII.11, 1037a12-17) and in *DA*, the latter type of definition seems to be the one that is especially appropriate in natural philosophy (*DA*.I.1, 403b7-8):[80]

> τίς οὖν ὁ φυσικὸς τούτων; πότερον ὁ περὶ τὴν ὕλην, τὸν δὲ λόγον ἀγνοῶν, ἢ ὁ περὶ τὸν λόγον μόνον; ἢ μᾶλλον ὁ ἐξ ἀμφοῖν;
>
> "Which then of these [people giving definitions] is the natural philosopher? Is it the one who [states the definition] concerning to the matter, while ignoring the form, or the one who [states the definition] only concerning the form? It must rather be the one who [states the definition concerning] the compound of the two."

Contrary to the functionalist interpreters it thus seems to me that in natural philosophy, of which the investigation of the soul is part, definitions need to take matter into account, because the matter is part of the essence of living beings. Below I will discuss the key passages in *Met.*VII.11 to show that the functionalist interpretation is untenable.

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[78] Cohen (1992), 59-60; 72-73; Nussbaum & Putnam (1992), 45-46; Shields (1990), 22-23.
[79] Cf. Lloyd (1992), 159; Charles (2000), 277-278.
[80] On different types of definitions in Aristotle, see Bayer (1998), Bolton (2002) and Deslauriers (1990 and 2007).

Aristotle introduces the aporia concerning the parts of a definition as follows (*Met.*VII.11, 1036a26-31):

> Ἀπορεῖται δὲ εἰκότως καὶ ποῖα τοῦ εἴδους μέρη καὶ ποῖα οὔ, ἀλλὰ τοῦ συνειλημμένου. καίτοι τούτου μὴ δήλου ὄντος οὐκ ἔστιν ὁρίσασθαι ἕκαστον· τοῦ γὰρ καθόλου καὶ τοῦ εἴδους ὁ ὁρισμός· ποῖα οὖν ἐστὶ τῶν μερῶν ὡς ὕλη καὶ ποῖα οὔ, ἐὰν μὴ ᾖ φανερά, οὐδὲ ὁ λόγος ἔσται φανερὸς ὁ τοῦ πράγματος.
>
> "Naturally one might also be confused about what kinds of things are parts of the form, and what kinds are not, but are parts of the composite. And still without clarity about that it is not possible to give definitions of each thing separately. For the definition is of the universal and of the form. As long as it is not clear what kind of parts are like matter and what kinds are not, there will not be a clear definition of the states of affairs."

In setting out this aporia, Aristotle distinguishes form from matter, and claims that forms are part of the definition, while matter (being part of the composite, but not of the form) is not. Aristotle then discusses two types of beings. First, there are things like mathematical figures, which "are obviously brought into being in different kinds of material" (*Met.*VII.11, 1036a31-32: ὅσα μὲν οὖν φαίνεται ἐπιγιγνόμενα ἐφ' ἑτέρων τῷ εἴδει), such as the circle. For Aristotle it is clear that for mathematical figures the matter is not part of the essence, because the essence is separated from the matter (*Met.*VII.11, 1036a34: διὰ τὸ χωρίζεσθαι αὐτῶν). Second, there are things like natural, living beings such as man that are not observed to be separated from matter: what prevents these cases from being different from mathematical figures? The analogy Aristotle applies is this: even if circles always came to be in the same kind of material, say bronze, it would still not be the case that the bronze is part of the form of circles – even though "it would be difficult to subtract it in one's thinking" (*Met.*VII.11, 1036a37-38: χαλεπὸν δὲ ἀφελεῖν τοῦτον τῇ διανοίᾳ). Similarly, even if "the form of a man always appears in flesh and bones and parts of that sort" (*Met.*VII.11, 1036a3-4: οἷον τὸ τοῦ ἀνθρώπου εἶδος ἀεὶ ἐν σαρξὶ φαίνεται καὶ ὀστοῖς καὶ τοῖς τοιούτοις μέρεσιν), we do not have to conclude that they are also parts of a man's definition. Rather, they are matter, and it is only because we always find man to come into being in such matter, that it is hard to separate the flesh and the bones from the form man in our minds.

Here Aristotle clearly endorses the view that definitions *of the universal and the form* – even of living beings – do not include matter. The interpretative crux seems to lie in the sentence connecting the cases of mathematical figures and living beings (*Met.*VII.11, 1036a35-b1):

> οὐδὲν μὲν κωλύει ὁμοίως ἔχειν τούτοις.
>
> "Nothing prevents them [things like man] from being similar to the others [i.e. things like circle]."

The functionalist interpreters interpret 'similar' as entailing not only a similarity in respect of definition between the two domains (the definitions of living beings, just as those of things like circles, do not include matter), but also a similarity in respect of compositional plasticity: just as the matter in the case of circles is compositionally plastic, so too in the case of man (even if he has never been seen to come to be in matter other than flesh and bones). I think this interpretation is wrong, not in the least because it presses the meaning of 'similar' too much. The point Aristotle makes here is exactly that both when the form can be seen to be realized in different kinds of matter and when the form cannot be seen to be realized in different kinds of matter, the definition of the universal does not include the matter. Aristotle thus mentions human beings as an example of things that are *not* compositionally plastic, but are always realized in flesh and bones, and still have definitions of the universal without inclusion of the matter.

In addition, the functionalist interpretation is in conflict with a later passage (*Met.*VII.11, 1036b21-32):[81]

> Ὅτι μὲν οὖν ἔχει τινὰ ἀπορίαν τὰ περὶ τοὺς ὁρισμούς, καὶ διὰ τίν' αἰτίαν, εἴρηται· διὸ καὶ τὸ πάντα ἀνάγειν οὕτω καὶ ἀφαιρεῖν τὴν ὕλην περίεργον· ἔνια γὰρ ἴσως τόδ' ἐν τῷδ' ἐστὶν ἢ ὠδὶ ταδὶ ἔχοντα. καὶ ἡ παραβολὴ ἡ ἐπὶ τοῦ ζῴου, ἣν εἰώθει λέγειν Σωκράτης ὁ νεώτερος, οὐ καλῶς ἔχει· ἀπάγει γὰρ ἀπὸ τοῦ ἀληθοῦς, καὶ ποιεῖ ὑπολαμβάνειν ὡς ἐνδεχόμενον εἶναι τὸν ἄνθρωπον ἄνευ τῶν μερῶν, ὥσπερ ἄνευ τοῦ χαλκοῦ τὸν κύκλον. τὸ δ' οὐχ ὅμοιον· αἰσθητὸν[82] γάρ τι τὸ ζῷον, καὶ ἄνευ κινήσεως οὐκ ἔστιν ὁρίσασθαι,

[81] Code & Moravcsik (1992), 134, argue against the compositional plasticity thesis as well, but from a wholly different angle: they take this passage not to be voicing Aristotle's own view, since the passage is stated in the form of an *aporia* - therefore we cannot with certainty attribute to Aristotle the compositional plasticity thesis for the case of living beings.

[82] Here I follow the textual tradition (instead of the emendation made by Frede & Patzig (1988; 210-211), who read *aisthêtikon* for *aitsthêton* at *Met.*VII.11, 1036b28): Animals are perceptible things and therefore only realizable in perceptible matter, which is changeable, as opposed to the intelligible matter in which geometrical figures are embodied; on this issue, see Granger (2000), 415-423.

> διὸ οὐδ' ἄνευ τῶν μερῶν ἐχόντων πώς. οὐ γὰρ πάντως τοῦ ἀνθρώπου μέρος ἡ χείρ, ἀλλ' ἡ δυναμένη τὸ ἔργον ἀποτελεῖν, ὥστε ἔμψυχος οὖσα · μὴ ἔμψυχος δὲ οὐ μέρος.
>
> "That there is some problem concerning the definitions, and because of what reason, has been said. For that reason it is also futile to trace back everything in that way and to take away all the matter. For some things are perhaps such and such in such a thing or such things in such a state. And the comparison with regard to an animal, the one Socrates the Younger used to say, is not good: for it leads away from the truth, and it makes one assume that it is possible to be a human being without parts, in the same way the circle can be without bronze. But it is not the same: for a living being is something perceptible and something that cannot be defined without motion, and for that reason it cannot be without parts that are disposed in a particular way. For the hand is not in any state a part of a human being, but only the one that is capable of accomplishing its work, such that it is ensouled: what is not ensouled is not a part of it."

In this passage, Aristotle discusses definitions *of the composite*, and criticizes both the method of some of his (Pythagorean) predecessors who traced everything back to the form and took away the matter, as well as the analogy Socrates the Younger drew between human beings and circles. Here Aristotle argues that composite natural beings cannot be defined without taking their own principle of movement into account, and stresses that composite natural beings cannot be without their material parts being disposed in a particular way. The example of the hand shows that the material in which the function of the hand is realized is quite specific: it is not a hand of any sort (*Met.*VII.11, 1036b30: πάντως) that is part of a human being, but only the one that is *ensouled*[83] – only in that way it is capable of performing its function.[84] This is not an argument for compositional plasticity,[85] but for the importance of taking the matter in which forms are realized (and not just any

[83] Cf. Lennox (2005), 10: "It would be wrong to think that the connection between soul and body in a plant or animal is similar to that between circularity and (say) bronze. Once you say that to be an animal is to be capable of perception, you are at once saying that it is a being with instrumental parts capable of undergoing certain changes and performing certain functions. To be ensouled is to be a body capable of such functions."

[84] Cohen (1992, 73) adopts a functionalist reading based on this passage. Cf. also Nussbaum & Putnam (1992), 32: "any account that properly gives the what-is-it of such a being must make mention of the presence of material composition – and, as our Z11 passage suggests, of the presence of a material composition that is in some way *suitable* or *in the right state*." (the italics are in the original, the underlining is mine). However, it is not entirely clear whether Aristotle means a particular kind of material or a functionally suitable kind of material when he speaks about "parts that are disposed in a certain way (*Met.*VII.11, 1036b30: ἐχόντων πώς)."

[85] Cf. Bostock (1994), 164-165.

suitable matter) into account, also when giving definitions of composite beings. At the end of this chapter, Aristotle alludes to the distinction between definitions of the universal and definitions of the composite, while leaving open the possibility that the definition of the *composite* does include the matter in which the form is realized (*Met.*VII.11, 1037a21-b1; 1037a24-7):

> καὶ ὅτι ἐν μὲν τῷ τῆς οὐσίας λόγῳ τὰ οὕτω μόρια ὡς ὕλη οὐκ ἐνέσται—οὐδὲ γὰρ ἔστιν ἐκείνης μόρια τῆς οὐσίας ἀλλὰ τῆς συνόλου, ταύτης δέ γ' ἔστι πως λόγος καὶ οὐκ ἔστιν·
>
> "And that the parts in the sense of material are not in the definition of the substantial being – for they are parts not of that substantial being, but of the composite, and of the latter there is in a sense a definition and there is not."

The upshot of this chapter is that in the type of definition that is relevant in natural philosophy, namely the type of definition that is concerned with composites the matter in which the form is realized is part of the definition.

The reason why the natural philosopher should state definitions that include the matter has to do with the kind of knowledge that he needs to provide (*Met.*XI.7, 1064a19-28):[86]

> ἐπεὶ δὲ τὸ τί ἐστιν ἀναγκαῖον ἑκάστῃ πως τῶν ἐπιστημῶν εἰδέναι καὶ τούτῳ χρῆσθαι ἀρχῇ, δεῖ μὴ λανθάνειν πῶς ὁριστέον τῷ φυσικῷ καὶ πῶς ὁ τῆς οὐσίας λόγος ληπτέος, πότερον ὡς τὸ σιμὸν ἢ μᾶλλον ὡς τὸ κοῖλον. τούτων γὰρ ὁ μὲν τοῦ σιμοῦ λόγος μετὰ τῆς ὕλης λέγεται τῆς τοῦ πράγματος, ὁ δὲ τοῦ κοίλου χωρὶς τῆς ὕλης· ἡ γὰρ σιμότης ἐν ῥινὶ γίγνεται, διὸ καὶ ὁ λόγος αὐτῆς μετὰ ταύτης θεωρεῖται· τὸ σιμὸν γάρ ἐστι ῥὶς κοίλη. φανερὸν οὖν ὅτι καὶ σαρκὸς καὶ ὀφθαλμοῦ καὶ τῶν λοιπῶν μορίων μετὰ τῆς ὕλης ἀεὶ τὸν λόγον ἀποδοτέον.
>
> "Since it is necessary for each of the branches of knowledge to know in some way what something is and to use that as a starting point, it is necessary to not let it go unnoticed in what way one who studies nature should define and how he should get hold of the definition of the substantial being, whether it is like the snub or more like the concave. For among these the definition of the snub is said with the matter that belongs to that thing, and the one of the concave is said without the matter.

[86] Cf. Aristotle's discussion of the kind of knowledge that pertains to nature and the kinds of things that belong to this branch of study (*Met.*VI.1, 1025b30-1026a6): "There are among the things that are defined and among things that are essences some that are like the snub, and some that are like the concave. And these are different, because the snub is something that is grasped with its material (for the snub is a concave nose), while the concavity is without perceptible matter. If all natural things are said in the same way as the snub is, such as for instance nose, eye, face, flesh, bone, the whole animal, leaf, root, bark, the whole plant (for the definition of none of them is without motion, but always includes matter), then it is clear how it is necessary to search and define the essence in natural things, and also why it is also the task of the student of nature to investigate some parts of the soul, in so far as they are not without matter."

> For snubness comes about in a nose, and therefore also the definition of it is studied along with it [i.e. the matter], for the snub is a concave nose. Thus it is clear that also the definition of flesh and of eye and of the other parts always needs to be stated with the matter."

Again, Aristotle argues that the definition of the composite should include both the form and the matter in which the form is realized. What is at stake here is knowledge of natural beings: definitions that are supposed to yield knowledge of natural beings have to include the matter, because it is part of what it is for them to be what they are.[87]

In sum, it seems that in the *Metaphysica* passages discussed above, Aristotle consistently argues for the inclusion of matter in the definition of composites, which is precisely the kind of definition the natural philosopher should state in order to attain knowledge of natural beings. If these passages give an accurate representation of Aristotle's position, then the material constitution of living beings is part of their essence, and not just relevant to the extent in which it makes the realization of the psychological functions possible.

Additional evidence can be found in the biological work, where Aristotle occasionally refers to definitions of the substantial being of an animal that include features that are not primarily functional, such as being blooded or bloodless (which is a material factor concerning matter of the natural body),[88] being partitioned into separate segments (which is the formal organization of insects), or having a certain size, length or thinness (which are the formal dimensions of living beings).[89] Interestingly, Gotthelf suggests that Aristotle might have thought that the 'elemental blend' of an animal is part of the definition of the substantial being of that animal as well. This suggestion is made on account of the animal's preference for a certain

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[87] Aristotle is interested in this 'causal' type of definition of the composite also in *DA; see DA*.II.3, 413a13-16): "For it is necessary that the defining account not only brings out the 'what it is', as most definitions do, but also includes and displays the explanation."

[88] The example of being blooded or being bloodless as included in the definition of the substantial being of some being suggests most clearly that in the practice of natural investigations Aristotle uses definitions that include references to both form and matter; Lloyd (1996), 59.

[89] For references to properties included in the definition of the substantial beings see, e.g., *PA*.IV.5, 678a26-34; *PA*.IV.12, 693b2-13; *PA*.IV.13, 695b17-25 (cf. *PA*.II.2, 648a20); *PA*.IV.6, 682b27-29; *PA*.IV.9, 685b12-15. On this issue, see also Gotthelf (1987), 190-192 and section 3.2.2 below.

kind of food, which Aristotle explains in terms of the elemental blend of an animal (where the elemental blend is used as a given feature of that animal).[90]

All this evidence indicates that at least at the level of his actual biological explanations as part of his investigations of nature, Aristotle considers – in any number of cases – matter to be explanatorily basic[91] and part of the explanatory definition of living being. In the explanation of living beings, matter matters for the natural philosopher.

### *2.1.2.c The principle of homonymy*

In the analysis of soul above, I argued that Aristotle analyzes essences in terms of functions: a thing is what it is by virtue of what it non-accidentally, but intrinsically does and is for.[92] The aforementioned analogy of the natural body with a tool such as an axe offers a good example: the essence of an axe is its capacity to cut in a particular way, and similarly, natural beings are defined by their particular soul-functions. Functionalists derive from examples such as these the thesis that matter is relevant to Aristotle *only* insofar as it enables functions to be realized. A saw made of wool or wood will not work, but a saw made of bronze is just as much a saw as one made of iron, and the same will apply to the realization of natural beings. I will show that this thesis is wrong, first by looking at Aristotle's use of the principle of homonymy and next, in the following subsection, by discussing his notion of conditional necessity.

Aristotle's homonymy principle holds that when you take away the essence or capacity for the performance of a certain function (i.e. if you 'separate it off') of something, then what is left is that thing only in name. The principle is thus a linguistic principle, referring to an inappropriate use of terms for things that are no longer what they essentially are. For instance, to use the term 'body' for what is no

[90] Gotthelf (1987), 192. Cf. Lennox (2005), 12.
[91] I will provide more evidence for this in the next chapter (3.2.3).
[92] For a functional notion of essence, cf. *GA*.V.1, 778a29-35: "For whenever things are not the product of nature in general nor yet characteristic of each separate kind, then none of these things is such as it is or is so developed for the sake of anything. The eye for instance exists for a final cause, but it is not blue for a final cause unless this condition be characteristic of the kind of anima. In fact, in some case this condition has no connection with the definition of the substantial being of an animal (…). See also Lennox (2001a), 112.

longer alive is inappropriate, for a dead body is a body in name only – the term does no longer capture the essence of its referent, because the latter has lots its defining capacities for function. The reason why this principle is important for the understanding of Aristotle's philosophy of nature is that it reveals the intimate connection between the essence of a thing, its function, and its constitutive material, such as for example in the following passage from the *Meteorologica* (*Mete.*IV.12, 390a10-13):

> ἅπαντα δ' ἐστὶν ὡρισμένα τῷ ἔργῳ· τὰ μὲν γὰρ δυνάμενα ποιεῖν τὸ αὑτῶν ἔργον ἀληθῶς ἐστιν ἕκαστον, οἷον ὀφθαλμὸς εἰ ὁρᾷ, τὸ δὲ μὴ δυνάμενον ὁμωνύμως, οἷον ὁ τεθνεὼς ἢ ὁ λίθινος· οὐδὲ γὰρ πρίων ὁ ξύλινος, ἀλλ' ἢ ὡς εἰκών.
>
> "All things that are, are defined by their function: each thing is truly itself when it can perform its function; an eye, for instance, when it can see. When a thing is not capable of that, [it is that thing only] homonymously, like a dead [eye] or one made of stone: for a wooden saw is not a [saw], except in the same way as one in a picture is."

In this passage Aristotle gives two examples of ways in which a thing may not be able to perform its proper function (any longer) and thereby causes it to loose its essence: first, when a thing is dead, that is, when it is no longer ensouled,[93] and second, when a thing is constituted of the wrong kind of material. Interestingly, in other passages where Aristotle refers to the homonymy principle, he explains the first case by analogy to the second. For example, flesh losing its soul is *just like* being constituted from the wrong kind of material (e.g. *Mete.*IV.12, 389b28-390a2; *GA.*II.1, 734b24-25: οὐ γὰρ ἐστι πρόσωπον μὴ ἔχον ψυχὴν οὐδὲ σάρξ, ἀλλὰ φθαρέντα ὁμωνύμως λεχθήσεται...). The suggestion is that by loosing the soul, the body and its parts undergo some kind of (possibly material)[94] change that makes them no longer 'fit' to perform their functions, because they have lost their vital heat. A dead human body is therefore no longer a human body (to the extent that it cannot even be regarded as a dead human body), except homonymously, for they have nothing definitionally in common.[95]

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[93] Whiting (1992), 77.

[94] Cf. Lennox (2001b), 138: "That suggests that a corpse is not simply *functionally* unlike its former living self, but that it has also undergone a disabling *material* change, making it akin to a statue of a human." (Italics are by Lennox.)

[95] On this use of the principle of homonymy, see Shields (1999), 131-154.

The importance of the matter being appropriate for the performance of the function of something is also something that is often stressed in the context of the application of the homonymy principle. In the following passage, for example, Aristotle criticizes Democritus and others who thought that a thing is what it is by virtue of its configuration or color, without taking matter into account (*PA*.I.1, 640b33-641a5):

> Καίτοι καὶ ὁ τεθνεὼς ἔχει τὴν αὐτὴν τοῦ σχήματος μορφήν, ἀλλ' ὅμως οὐκ ἔστιν ἄνθρωπος. Ἔτι δ' ἀδύνατον εἶναι χεῖρα ὁπωσοῦν διακειμένην, οἷον χαλκῆν ἢ ξυλίνην, πλὴν ὁμωνύμως, ὥσπερ τὸν γεγραμμένον ἰατρόν. Οὐ γὰρ δυνήσεται ποιεῖν τὸ ἑαυτῆς ἔργον, ὥσπερ οὐδ' αὐλοὶ λίθινοι τὸ ἑαυτῶν ἔργον, οὐδ' ὁ γεγραμμένος ἰατρός. Ὁμοίως δὲ τούτοις οὐδὲ τῶν τοῦ τεθνηκότος μορίων οὐδὲν ἔτι τῶν τοιούτων ἐστί, λέγω δ'οἷον ὀφθαλμός, χείρ.
>
> "And yet, also a dead [man] has the same shape or configuration, but still he is not a man. In addition, it is impossible that a hand is in just any disposition whatsoever, for example of bronze or wood, except homonymously, like the painted physician. For it will not be capable of performing its proper function, just as neither stone flutes, nor the painted physician, can perform their proper function either."

Natural and artificial compounds alike have to be constituted of matter that is in a certain disposition, if it is to perform its proper function. The idea is here that if we want to understand what something is, it is necessary to take the constitutive matter into account – precisely because matter is what enables functions to come about.

Being constituted from the wrong kind of material thus means the following: in case of artifacts and natural bodies alike the wrong kind of material is that material that is not appropriate with regard to the function the thing has to perform – i.e. it does not have the right material potentials to enable it to perform its function or at any rate to perform it well. In case of natural bodies a second criterion needs to be met in order for the material to be appropriate for the function: the matter has to be alive – soul-functions can only be realized in bodies that are ensouled.[96] Aristotle's use of the homonymy-principle thus indicates a rather strong connection between soul-functions and the natural bodies in which they are realized.[97]

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[96] Cf. Code & Moravscik (1992), 134.

[97] Shields (1999, 150-151) argues in favor of a functionalist interpretation of Aristotle that Aristotle is not committed to the view that the natural body that is instrumental is the only potential basis for the

Here we touch upon an important difference between the material constituents of artifacts and of natural bodies. Surely, the body cannot be the matter of a living being in the same way as, say, the bronze is the matter of a statue: the distinction lies in the fact that the bronze persists when being turned into a statue, while there is no such analogue for a living being (a living being comes to be out of catamenia, eggs, or seeds, which do not persist as the matter of mature living beings). The living being thus is not made of the body as the statue is made of the bronze, but rather the living being *is* the body – it is *constituted by* the body.[98] In addition, the material constituents of artifacts usually are what they are and have the characteristics they have no matter what artifact they constitute, also when they are not incorporated in some whole. This, however, is not true of the material constituents of living beings – these do not preserve their essence outside a living being or inside a being without soul,[99] and what is more, sometimes only receive their specific material potentials when they are actually part of a living being.[100] Again, we can see no analogue for a body lying around in an indeterminate, unorganized pile, in the way that bronze can (the pieces of a statue are just pieces of bronze, while there are no 'body pieces' outside the body, except in name). The upshot is that while the bricks of a house will still be bricks also after the house has been broken down, an eye will no longer be an eye anymore after the body of which it is part has died. As Furth argues, "this homonymy extends to the deepest of the underlying parts: the non-uniform organs are no longer organs, the intermediate bone(s) and vein(s), etc., no longer bone and vein, and the uniform blood and bile no longer blood or bile."[101]

Therefore, although the homonymy principle does not rule out the possibility of Aristotle allowing bodily parts to be realizable in different kinds of suitable material, it does rule out compositional plasticity *in a strong sense*. A hand made of iron will never be a real hand, even if it were constructed in a way that

realization of soul-functions, because "non-organic bodies are potentially organic; they cannot be identical with organic bodies, but this does not preclude their coming to constitute them." I believe this conclusion to be based on a false analogy between natural bodies and artifacts.

[98] Kosman (1987), 374; Freeland (1987), 392.

[99] Lloyd (1992), 165.

[100] Freeland (1987), 395.

[101] Furth (1987), 37.

would make it suitable for the function of grasping,[102] simply because an iron hand does not have life potentially.[103] Bodily parts are not just matter (*hulê*).

### *2.1.2.d The conditionally necessary relation of function and matter*

The connection between function and matter is not only brought out at a linguistic level through the application of the principle of homonymy. Aristotle's investigation of living beings in *DA* and the biological works shows that body and (soul-) functions are also intrinsically connected to each other in an ontological way: the teleological notion that underlies this ontological connection is that of conditional necessity.

The notion of conditional necessity is introduced by Aristotle to explain the causal and ontological relationship between the material constitution of a thing and its function: the material constitution is present and has come to be for the sake of the function and is necessitated by that function. Among natural generated things, necessity operates on a condition: if some natural thing is to come to be for the performance of a certain function, it is necessary that certain materials with certain material potentials come to be first and are constitutive of the thing coming to be. Aristotle illustrates this notion by analogy with artistic production (*PA*.I.1, 642a7-12):

> λέγομεν γὰρ τὴν τροφὴν ἀναγκαῖόν τι κατ' οὐδέτερον τούτων τῶν τρόπων, ἀλλ' ὅτι οὐχ οἷόν τ' ἄνευ ταύτης εἶναι. Τοῦτο δ' ἐστὶν ὥσπερ ἐξ ὑποθέσεως· ὥσπερ γὰρ ἐπεὶ δεῖ σχίζειν τῷ πελέκει, ἀνάγκη σκληρὸν εἶναι, εἰ δὲ σκληρόν, χαλκοῦν ἢ σιδηροῦν, οὕτως καὶ ἐπεὶ τὸ σῶμα ὄργανον (ἕνεκά τινος γὰρ ἕκαστον τῶν μορίων, ὁμοίως δὲ καὶ τὸ ὅλον), ἀνάγκη ἄρα τοιονδὶ εἶναι καὶ ἐκ τοιωνδί, εἰ ἐκεῖνο ἔσται.
>
> "For we say nourishment is something necessary according to neither of those two modes of necessity, but because it is not possible to be without it. And this is, as it were, conditionally necessary; for just as, since the axe must split, it is a necessity that it be hard, and if hard, then made of bronze or iron, so too since the body is an instrument (for each of the parts is for the sake of something, and likewise also the whole), it is therefore a necessity that it be of such a character and constituted from such things, if that is to be."

[102] Cf. *GA*.I.18, 722b33-723a1.
[103] Cf. Burnyeat (1992a), 26.

When a blacksmith wants to produce an axe, he first needs to buy the necessary and appropriate material; when nature produces natural bodies as instruments for the soul, she first has to produce the necessary and appropriate material with the right material potentials from which a properly functioning being arises. Soul and soul-functions are thus not just realized in functionally appropriate materials; rather they conditionally necessitate the coming to be of these materials in the developing organism. For natural, living beings, soul-functions and body cannot be contingent in a strong ontological sense, for the functions conditionally necessitate the coming to be of the particular kind of matter in which they are realized.

On a theoretical level, both the blacksmith and nature might have more than one kind of material available to them that has the right material potentials. A blacksmith can thus use either bronze or iron to produce an axe, because both these kinds of material have the right material potential for allowing the instrument to perform its proper function. Similarly, one could argue that nature could use either air or water to produce an eye, because both of these kinds of material have the right material potential (i.e. transparency) for sight. The function as such does not determine the specific type of material that is necessary for its performance, but rather the specific type of material *potentials*, like the primary contrary potentials of the elements such as hot and cold, moist and dry, or like the affections of the composite bodies such as heavy and light, rough and smooth, etc. In theory, this leaves some room for a weak form of compositional plasticity also in the case of living beings.

In reality, however, the actual material realizations of soul-functions in each kind of animal are not essentially contingent.[104] The reason for this is that the application of conditional necessity to generative processes works out differently for the works of nature as opposed to the works of art. For instance, in order for something to be a fully functioning axe, it has to meet the formal criterion of incorporating the axe-form in some material and the functional criterion of possessing the capacity to cut. This requires the artist to build the axe from a material that is hard enough to enable the blade to cut through materials such as

[104] Cf. Everson (1997), 257.

wood. Exactly because the axe is only determined by this *one* function of cutting, the axe-maker has some freedom in design and in choice of materials.

Organic body parts, and the natural body as a whole, on the other hand, are both materially and functionally interdependent. For instance, nature never produces an eye, but always an eye of a particular animal species. The integration of parts into the complete living being poses some significant limitations on the natural possibilities the formal nature of that animal has in generating the eye: the other parts an animal has, its *bios* (life-style and environment), and its activities all put extra requirements on the design of the part. This means that the more complex the soul of a particular kind of living beings is, the more restricted the constraints on the material constitution of the animal's body and parts will be.[105] In addition, parts may have to perform multiple functions, and require the presence of other parts or functions for their own functioning; all of this restricts the formal nature in realizing soul-functions in natural bodies. Moreover, while the artist may have a choice in using either iron or bronze, the formal nature usually does not have such unrestricted options: it is restricted by the material that is available within the elemental make-up of an animal and by whatever kinds and amounts of materials it can process from the incoming food.

The reason why conditional necessity works out more stringently for the products of nature than it does for the products of art is thus both that soul-functions themselves are highly complex, and that their realizations are interdependent and co-determined by many other factors.[106] In addition, Aristotle's teleological view of nature demands that the actual products of nature are the best among what is possible for each kind of animal: because only one kind of realization of a certain function will be best for this kind of animal, the possibility of compositional plasticity *within* individual animal kinds is thereby ruled out.[107]

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[105] Cf. Furth (1987), 27, 39; and Wilkes (1992), 112.

[106] Cf. Johansen (1998), 283: "This study, however, has given reasons for not taking variation in sense-organs as evidence of compositional plasticity of the sort that the functionalists have in mind. It is true that Aristotle showed considerable interest in the variation in sense-organs. However, the reason why different animals had different sense-organs was that perception as the sense-organ's goal was more complex than at first appeared."

[107] Moreover, nature always operates in an economical way: it will make not only make the best use possible of the available materials to realize the functions of the soul, but also the most economical use; this also constrains the ways in which those soul-functions are realized; on the economy of nature and its relation to teleology, see below in 3.3.1.b.

I will conclude this subsection by discussing the material realization of sight to further exemplify the limited extent to which soul-functions are compositionally plastic according to Aristotle.

Let me start with an account of the organ of sight. The function of sight is realized in the organ of the eye. As Aristotle points out in *De Sensu* both water and air share the right material potential, i.e. transparency, necessary for the eye being able to see (*Sens*.II, 438a12-16):[108]

> τὸ μὲν οὖν τὴν ὄψιν εἶναι ὕδατος ἀληθὲς μέν, οὐ μέντοι συμβαίνει τὸ ὁρᾶν ᾗ ὕδωρ ἀλλ' ᾗ διαφανές· ὃ καὶ ἐπὶ τοῦ ἀέρος κοινόν ἐστιν. ἀλλ' εὐφυλακτότερον καὶ εὐπιλητότερον τὸ ὕδωρ τοῦ ἀέρος· διόπερ ἡ κόρη καὶ τὸ ὄμμα ὕδατός ἐστιν.
>
> "That the organ of sight is composed of water is true, but it is not true that seeing occurs in so far as it is water, but in so far as it is transparent – and that is common also to air. But water is more easily contained and more easily condensed than air: and for that reason the pupil and the eye are composed of water."

At first sight, this may suggest that Aristotle argues for the compositional plasticity of the eye, but as it turns out, the eye cannot be realized in both water and air. For Aristotle immediately goes on to explain why water, rather than air, must be the matter of the eye in virtue of the *other* functional properties water has,[109] i.e. its being easy to contain and its density, both of which air lacks.[110] Hence, to say that an eye can be realized in different transparent materials because these materials are functionally equal (in this one particular respect) would commit Aristotle only to a weak version of functionalism. This description still does not capture the point of the abovementioned discussion, which is to argue for the claim that eyes can only be realized in water (in virtue of its transparency and other functional properties), and not just that they are only realized in transparent matter.

In another passage (*GA*.II.6, 744a5-29), Aristotle gives a description of the complex processes involved in the coming to be of the eye out of "purest part of the liquidity about the brain" (*GA*.II.6, 744a8-9: ἀλλ' ἀπὸ τῆς περὶ τὸν ἐγκέφαλον

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[108] This passage takes place in the middle of Aristotle's criticism of Democritus' theory of sight; on the significance of this debate for Aristotle's own theory of sight, see Johansen (1998), 44-51.
[109] See Lloyd (1992), 165n.79.
[110] Moreover, transparency is a nomologically homogeneous property, such that all realizations of sight – be it in water or air – would be governed by similar laws of physics, which would therefore rule out any strong form of compositional plasticity; see Klein (2002), 8n.7.

ὑγρότητος ἀποκρίνεται τὸ καθαρώτατον), which is drained off.[111] The matter of the eye is thus not 'just some transparent water', but the pure, fluid and cold water coming from the brain. This suggests that in case of the actual realization of eyes, all eyes will basically be constituted from a similar kind of matter (i.e. brain-water). This is also suggested in the section leading up to the discussion of the matter of the eye (*GA*.II.6, 743a21-26):

> αὕτη δὲ οὔτε ὅ τι ἔτυχε ποιεῖ σάρκα ἢ ὀστοῦν οὔθ' ὅπου ἔτυχεν οὔθ' ὁπότ' ἔτυχεν, ἀλλὰ τὸ πεφυκὸς καὶ οὗ πέφυκε καὶ ὅτε πέφυκεν. οὔτε γὰρ τὸ δυνάμει ὂν ὑπὸ τοῦ μὴ τὴν ἐνέργειαν ἔχοντος κινητικοῦ ἔσται, οὔτε τὸ τὴν ἐνέργειαν ἔχον ποιήσει ἐκ τοῦ τυχόντος, ὥσπερ οὔτε κιβωτὸν μὴ ἐκ ξύλου ὁ τέκτων ποιήσειεν ἄν, οὔτ' ἄνευ τούτου κιβωτὸς ἔσται ἐκ τῶν ξύλων.
>
> "But she [i.e. heat] does not make flesh or bone from whatever it runs into, or where it runs into it, or when it runs into it, but that which is by nature disposed for it, and where it is naturally fitted, when it is naturally fitted. For neither will that which exists potentially be made except by that moving agent which possesses the actuality, nor will that which possesses the actuality make anything out of anything whatever; just as the carpenter would not make a box except out of wood, and a box will not be made out of the wood without the carpenter."

Eyes are realized not in any random material, but in the naturally most fitting materials, which is the liquid from the brain.

Moving on to the level of bodies of particular animal kinds in which actual eyes are enmattered, the following requirements have to be met at the outset. To begin with, the animal in which the eye comes to be has to be alive, that is, has to be ensouled. There is only one kind of body in which soul-functions can be realized, and that is, as we have said before, the body that has life potentially because it has a soul.

Furthermore, the presence of other functions is presupposed. For example, the animal has to have the functions of growth and decline, of self-nutrition, and of touch: the function of sight is dependent on all of these 'lower' functions (that is, for the most part, you will not find animals that are able to see without being able to grow, feel, and reproduce). The possession of the capacity for self-nutrition is what distinguishes living beings from non-living beings, and it is a precondition for all the

[111] For the process of the formation of the eyes, see Johansen (1998), 76.

other functions that constitute the living being. Touch is what makes a living being an animal rather than a plant, and is therefore an essential function of every animal. All these functions together co-determine the material disposition of the animal in question. The animal body in which the function of sight is to be locally realized is thus already determined to a certain extent by the other vital and essential functions the animal has to perform. In addition, the material realization of sight is negotiated by all the other functions that are typical for the particular kind of animal.[112]

As we said, other factors play a role, too, such as the animal's need for acuity of vision, the basic elemental make-up of the animal, the kind of food it processes, and the animal's natural habitat. The particular material constitution in which the function of sight is realized may thus differ from species to species, but in each case the material differentiation is conditionally necessitated by the fine-tuning of the function of sight in the particular kind of animal.[113] As I will discuss in more detail in the next chapter (3.2.4), Aristotle usually explains the material differentiations of parts that perform the same type of function by reference to the better. The material differentiation of parts are thus for the sake of the improvement of the performance of that function in that particular kind of animal. This principle (see e.g. *PA*.II.2, 647b29-31) is illustrated by Aristotle with reference to differences in the material constitution of eyes (*PA*.II.2, 648a14-19):

> (...) ὑπολεπτέον ἔχειν τὴν διαφοράν, τὰ μὲν πρὸς τὸ βέλτιον ἢ χεῖρον, τὰ δὲ πρὸς τὰ ἔργα καὶ τὴν οὐσίαν ἑκάστῳ τῶν ζῴων, οἷον ἐχόντων ὀφθαλμοὺς ἀμφοτέρων τὰ μέν ἐστι σκληρόφθαλμα τὰ δ' ὑγρόφθαλμα, καὶ τὰ μὲν οὐκ ἔχει βλέφαρα τὰ δ' ἔχει πρὸς τὸ τὴν ὄψιν ἀκριβεστέραν εἶναι.
>
> "They [i.e. parts] should be assumed to possess a differentiation, in some cases relative to what is better or worse, in other cases relative to each animal's functions and substantial being. For instance, two animals may both have eyes. But in one these eyes are hard, while in the other they are of fluid consistency; and while the one does not have eyelids, the other has it – both are for the sake of a greater accuracy of vision."

[112] Cf. Lloyd (1992), 148 on the interdependence of soul and *body*.
[113] Cohen (1992), 59, might be right in claiming that "in general, there will be no essential connection between a psychological state and any particular material realization of it," but there will still be a conditional necessary relation between the psychological state and its particular material realization of it.

Whether animals have hard or fluid eyes is largely functionally determined by the principle that the material differentiation is for the better, and is therefore non-contingent for the animal in which sight is realized.

Another chapter of the *Parts of Animals* shows how the application of this principle works out in the material realizations of eyes (*PA*.II.13, 657a30-b4; 657b30-658a10; see figures one and two below). Here Aristotle discusses three types of realizations of eyes. First, there are animals with fluid eyes and eyelids; secondly, there are animals with hard eyes without eyelids but with mobility; and thirdly, there are animals with fluid eyes but without eyelids. The material realization of the eye and the (not) having of eyelids are causally correlated in the following way. Animals in need of clear vision such as man, birds, and quadrupeds, have fluid eyes, because the fluidity contributes to sight. Animals with fluid eyes need protection of those eyes, and eyelids are there for the sake of giving fluid eyes that protection. Animals such as insects and hard-skinned crustaceans – whose skin is too hard to form eyelids from – have hard eyes instead. These hard eyes blunt their vision of necessity. To make up for this lack of vision, nature endows these animals with mobility "so that, by turning to the light and receiving its beam, the eye may see more sharply (*PA*.II.13, 658a2-3: ὅπως ὀξύτερον βλέπῃ στρέφοντα πρὸς τὸ φῶς καὶ δεχόμενα τὴν αὐγήν)." Fish, which live in the water, also lack eyelids, but because the water contains less objects that could hit the eyes than air does, and because the water hinders sharp sight, they have eyes of fluid consistency. In the first group of animals with fluid eyes and eyelids, Aristotle makes a further distinction between the birds and the oviparous quadrupeds (*PA*.IV.11, 691a19-27). The latter have harder eyes than birds, because they do not really need much keen vision as they spent most of their lives in holes. Birds, on the other hand, need very sharp vision while flying through the air – sharpness of vision is more useful to their way of life. In these examples, both the material make-up of the animal and its *bios* fine-tune the animal's function of sight.

The differences in the material realization of eyes all come to be for the sake of an optimal functional performance of the eye within the particular animal species. The eye is realized in the best way possible within that animal species: the specific function the eye has to perform in a particular animal conditionally

necessitates the material constitution the eye has in that animal. In sum, while it may seem that among different kinds of animals, eyes can be found to be realized in somewhat different,[114] kinds of material and material structures, the eye of a particular kind of animal could not have been realized in any other way than the way it is now without functionally impairing the animal. Because nature always does what is best for the substantial being of each kind of animal, the material realizations of functions are in each case highly necessitated and determined.

*Figure 1: Three Differentiations in Material Realizations of Sight*

| Animal kind | (I.) Man, Birds, and Quadrupeds | (II.) Insects and hard-skinned Crustaceans | (III.) Fish |
|---|---|---|---|
| Material Realization | Fluid eyes + Eyelids | Hard eyes + mobility | Fluid eyes |
| Need of Vision | High (fluidity of eyes contributes to sight) | High (hardness of eyes prevents good vision, but their mobility makes up for this lack) | High (fluidity of eyes contributes to sight; living in water hinders clear vision) |
| Other Material requirements | Protection (fluidity of eyes makes them vulnerable; therefore nature gives them eyelids) | Protection (hardness of skin prevents nature from making eyelids; therefore nature produces hard eyes) | Not much protection (fish live in the water which contains fewer objects than air) |
| Material disposition | Soft skin | Hard skin | Soft skin |
| Habitat | Air | Air | Water |

*Figure 2: Further Differentiations in Material Realizations of Sight in Category I*

| Animal kind | Birds | Oviparous quadrupeds |
|---|---|---|
| Material Realization | Fluid – relatively soft eyes | Fluid – relatively hard eyes |
| Need of Vision | Relatively higher need for vision | Relatively lower need for vision |
| Habitat | Fly often through the air | Live in holes under the ground |

Because of this teleological dimension, I believe that Shields is wrong to conclude from Aristotle's remark in *DA*.I.4, 408b21-22 ("if an old man were to receive an eye of the right sort, he would see just as a young man"; εἰ γὰρ λάβοι ὁ πρεσβύτης ὄμμα τοιονδί, βλέποι ἂν ὥσπερ καὶ ὁ νέος), that Aristotle "allows in principle that one could gradually replace bodily parts at will with others of the right sort, viz. ones capable of performing the functional role assigned to those parts, and still end up with a

[114] Cf. *DA*.II.9, 421b26-422a4: "It seems that in man this sense-organ differs from that of the other animals, just as his eyes differ from those of the hard-eyed animals – for his eyes have eyelids, as a screen and sheath, as it were, and he cannot see without moving or raising them. But the hard-eyed animals have nothing of this sort, but see straightaway what takes place in the transparent."

functioning human being."[115] Aristotle's point here is that due to process of aging the material constitution of the eye deteriorates (just as in case of drunkenness or disease). Would the old man receive the eye of a young man, which is materially equivalent to the eye of the old man (this is what would constitute an eye of the right sort), except for the fact that it is in better shape (e.g. it is a little more moist), the old man would not merely be able to see, but be able to see *well*. Aristotle emphasizes here that the material constitution affects the quality of the functioning of a part, not that the material constitution is irrelevant to the realization of functions.

In order to stress the importance of the material constitution of the parts in which the function is realized, I would like to discuss briefly the case of the mole. The mole is an animal that we expect to have – like all other viviparous animals that have feet – all the five senses, but is in fact deprived of sight. The mole has eyes, but they are hidden away under a layer of thick skin. Aristotle meticulously describes (in *HA*.I.9, 491b26-36; *HA*.IV.8, 532b33-533a15) all the material constitutive parts of the eye of the mole, which match the parts of ordinary eyes in every way (the black part, the part inside it called the pupil, and the fatty part surrounding it). The only difference with normally functioning eyes is that the eyes of the mole are too small to serve the function of sight.[116] This is why Aristotle characterizes the mole as a mutilated or defective kind (*HA*.IV.8, 533a2: τι πεπήρωται γένος), which indicates the structural (as opposed to an accidental one) and therefore generic shortcoming of the mole. Accordingly, the blindness of the mole is described in terms of being "a deprivation according to itself (*Met*.V.22, 1022b24-26: Στέρησις (...) τὸ δὲ καθ' αὑτό)." It thus seems to be part of the nature of the mole to be deprived of sight. Strictly speaking, the eyes of the mole are not for the sake of something as they do not perform the function for the sake of which they have come to be, but the fact that Aristotle still refers to these parts as eyes (be it in a very careful way because of the homonymy principle) is important (*HA*.I.9, 491b29-30):

> Τοῦτον δὲ τρόπον μέν τιν' ἔχειν ἂν θείη τις, ὅλως δ' οὐκ ἔχειν.

[115] Shields (1990), 21.
[116] The reason why the mole has defective eyes is that the passing of fluid from the brain to the eyes through channels has been stunted; see Johansen (1998), 76.

> "In some sense one could posit that it has [eyes], but it does not have [eyes] in the full sense."[117]

The material and structural resemblances between the functioning eyes and the eyes of the mole are close enough for Aristotle to say that the mole *in some sense* has eyes.[118]

In sum, the goal of sight is not just to enable an animal to see without qualification, but to enable him to see given his elemental make-up, natural activities and habitat. Eyes are realized in the best and only way possible within each kind of animal. This means that functions are specified to the particular animal in which there are realized, and thus by conditional necessity, that the particular material potentials are specified as well. The material differentiation at the lowest level, say, between hard and fluid eye-jellies, is either necessary for the well-functioning of the particular animal kind, or the result of other basic explanatory factors such as the elemental make-up of the animal in question. In both cases the particular material realization matters, because it is typical for that kind of animal. In Aristotle's teleological biology, eyes could not have been realized differently for each particular animal without functionally impairing that animal or without turning it into a different kind of animal.

### *2.1.2.e Functional analogy*

This brings me to the final issue of what Aristotle calls the analogous parts. The existence of analogous parts has been brought in by functionalist readers of Aristotle as providing an example of functions that are structurally realized in different ways in different kinds of animals.[119] Aristotle's use of the term 'analogous parts' has thus been interpreted as an indication for his commitment to the compositional plasticity thesis, but, as I will argue, unrightfully so.

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[117] Cf. *DA*.III.1, 425a11-12.

[118] The suggestion seems to be that the eyes of a mole are more entitled to be called 'eyes' than the eyes of a dead human being. Both kinds of eyes are functionless (and thus lack their essence), but while the eye of a dead man might as well have been made of the wrong kind of material (as the eye undergoes some material change when the body dies and is no longer ensouled), the eyes of the mole at least meet some of the material requirements (such as being constituted of ensouled matter), unfinished and non-functional as they may be.

[119] Cohen (1992), 59; Nussbaum (1978), 83; and Shields (1990), 24.

Analogous parts are parts that belong to animals who do not share a common genus[120] and that perform the same function (e.g. 'protecting the body'), but are different both in form and in name (e.g. hairs, scales, and feathers).[121] The question is of what nature the proclaimed functional identity of these parts is. If it is an identity pertaining to the *type* of function, and if functions are what define the essence of a thing, why does Aristotle not refer to them by the same name?[122] The functionalist interpretation of Aristotle holds that whatever performs the function of the lung is a lung, but it seems that Aristotle rather prefers to distinguish the lung from its anonymous counterpart (the part is anonymous because of defaults of the natural language) which is functionally analogical to it but different in form (cf. *PA*.I.4, 644a12-22), and refrains from producing a new coinage (the situation is similar in the case of the blood and it anonymous counterpart). In the cases like that of the bones of men and fish-spines in fish Aristotle in fact uses different names to refer to analogous parts.[123] If the functions the analogous parts perform (e.g. 'protecting the body') are identical without qualification, then the widely varying material realizations of these parts among different kinds of animals (e.g. hairs in humans, scales in fish, and feathers in birds) demonstrate the compositional plasticity of soul-functions *among different kinds of animals*. However, by definition, the analogous parts are different in form and thus not identical without qualification. This means that, for instance, what it is for a body to be protected is different for different kinds of animals (e.g. 'protection against water' for fish, and 'protection against air' for birds); this limits the compositional plasticity of a soul-function to a particular kind of animal (e.g. 'protection against water' is perhaps realized differently for different kinds of fish, although they all have scales).

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[120] On this use of analogy, see Charles (2000), 242 and Lloyd (1996), 140-141.

[121] For a reference to analogous parts within *DA*, see *DA*.II.4, 416a5-6: "but as the heads are in animals, so are the roots in plants, if it is necessary to speak of organs as different or the same in virtue of their functions." Cf. also *PA*.I.4, 644a16-22: "For those animals that differ by degree and the more and the less have been brought together under one kind, while those that are analogous have been kept apart (…)."; *PA*.I.5, 645b6-10: "for instance, some groups have lungs, other have no lung, but an organ analogous to a lung in its place; some have blood, others have no blood, but a fluid analogous to blood, and with the same office."

[122] Cf. *DA*.II.4, 416b23-24: ἐπεὶ δὲ ἀπὸ τοῦ τέλους ἅπαντα προσαγορεύειν δίκαιον ("Since it is right to call all things after their end (…).")

[123] See e.g. *HA*.I.1, 486b19-21: "there are some animals whose parts are neither identical in form nor differing in the way of excess or defect; but they are the same only in the way of analogy, as, for instance, bone is only analogous to fish-bone, nail to hoof, and to claw, and scale to heather; for what the feather is in a bird, the scale is in a fish." and *PA*.644b11-12: "For their parts differ not by analogous likeness, as bone in mankind is related to fish-spine in fish (...)."

Aristotle offers a solution for how the concept of analogy should be used in biology in the *Posterior Analytics* (*APo.*II.14, 98a20-24):

> Ἔτι δ' ἄλλος τρόπος ἐστὶ κατὰ τὸ ἀνάλογον ἐκλέγειν. ἓν γὰρ λαβεῖν οὐκ ἔστι τὸ αὐτό, ὃ δεῖ καλέσαι σήπιον καὶ ἄκανθαν καὶ ὀστοῦν· ἔσται δ' ἑπόμενα καὶ τούτοις ὥσπερ μιᾶς τινος φύσεως τῆς τοιαύτης οὔσης
>
> "Again, another method is to select by analogy: you cannot take any one identical thing which pounce and spine and bone should be called; but there will be items which follow these features too, *as though there were some single nature of this sort*."

According to this passage, one is to think of analogous parts as performing some function that does not pick out any real 'nature', but from the assumption of which it will still be possible to identify the characteristics that follow from it. The common function performed by analogous parts is nothing but a formal description,[124] serving a heuristic function within the context of explanation and demonstration,[125] based on a mere abstraction from the different species of a function that are actually realized in different animals. This common function does not specify the material potentials necessary for the realization of it, because it only picks out an 'as if nature', and is not part of any real soul. This is in line with the way Aristotle generally speaks about soul-functions. Outside the context of *DA*, Aristotle never talks about 'the' function of sight being realized in 'an' eye, but rather about 'the function of sight being realized in this particular kind of animal'.[126] So although one could say that analogous parts such as hairs, scales and feathers are there for the sake of the performance of the 'same', common or general function, that is, to cover and protect the animal, the need to be covered is not the same, nor is the *eidos* of the function of covering in different kinds of animals. The problem Aristotle faces here is in fact how exactly analogous parts are connected if they do not share the same form.[127]

My contention is that Aristotle thinks about a common definition of 'the function of seeing' in the same way as he thinks about a common definition of soul:

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[124] Barnes (1993), 251.
[125] Lloyd (1996), 145-146.
[126] As Charlton (1993), 198, points out, soul is always the soul *of* some being; the same holds for the soul's functions or capacities – they are always the functions or capacities of some kind of living being. Cf. Aristotle's concluding remark at *DA*.II.3, 415a13-14: "it is thus clear that the account of each of these [capacities] is the most appropriate also with regard to the soul."
[127] On this problem, see Lloyd (1996), 145-57.

the common definitions are only marginally interesting, or even ridiculous (*DA*.II.3, 414b25: *geloion*), as they pertain to no particular living thing and to no real nature[128] (*DA*.II.3, 414b20-29; *DA*.II.3, 414b32-33):

> ὥστε καθ' ἕκαστον ζητητέον, τίς ἑκάστου ψυχή, οἷον τίς φυτοῦ καὶ τίς ἀνθρώπου ἢ θηρίου.
>
> "Therefore we must inquire in each separate case what the soul is of each, for instance, what of a plant, what of a human being, and what of a wild animal."

It is the particular functions of particular animals that Aristotle is interested in, and at this level there is no room for compositional plasticity.

In conclusion, it seems that for Aristotle most natural bodies and parts are non-multiply realizable. The hypothesis that "at some abstract level, the possibility [of compositional plasticity] is at least conceivable"[129] to Aristotle, is therefore not so much wrong, as that it misrepresents Aristotle's explanatory project. Aristotle's concern to explain and uncover the kinds of material constitutions and the potentials of the material underlying the realization of psychological functions at the level of particular animal kinds reveals that Aristotle does not hold a functionalist attitude at all. We may grant the functionalist interpreters of Aristotle that he indeed commits to a weak sense of compositional plasticity also for natural beings, since in Aristotle's view functions only determine (and conditionally necessitate) the suitable material potentials, and not the particular matter. I hope, however, to have shown that in reality the material constitution of a part is in fact highly determined and necessitated because of the (inter)dependency of functions and because of the other factors (such as *bios*) that specify the function within the animal kind; this is reflected in the practice of the actual explanations Aristotle gives of the realizations of psychological functions in particular animals. The different material realizations of soul-functions are the necessary result of the teleological procedure of nature: given all the other facts about an animal, the way a soul-function is realized, is the best and only way possible for that animal; Aristotelian functions are always optimal functions. Accordingly, soul-functions prove to be non-multiply realizable in the animal to

[128] Klein (2002), 12.
[129] Cohen (1992), 59. Modern functionalism only requires commitment to the epistemic conceivability of compositional plasticity (in contrast to actual, ontological compositional plasticity) for someone to qualify as a functionalist, but to call Aristotle a functionalist in this sense is an empty claim.

which they belong. A functionalist may say that this is a contingent fact of this world, and that Aristotle still – in theory – allows for compositional plasticity, but my reply would be that it is this world, and, in particular, the living beings that occupy this world, that Aristotle endeavors to explain.

Moreover, Aristotle's form of functionalism is not topic-neutral.[130] There are restrictions on the kinds of material that can perform bio-psychological functions: the material has to be natural or organic, which means that it has to have an internal source of motion and rest, and to be potentially alive, which means that it has to be endowed with soul. This implies, among other things, that according to Aristotle statues will never be able to experience the same psychological states as animals do, no matter how similar their internal organization will be to that of animals. On the other hand, Aristotle is not concerned with making computers think; he is concerned with the explanation of living beings that need specific material, or rather, bodily parts in order to perform their characteristic functions.[131] A functionalist reading of Aristotle does not represent Aristotle's own account of the relation of body to soul, nor his primary interests in the teleological explanation of life.

Aristotle uses functional concepts not as a result of his supposed functionalist conception of the soul, but as a result of his teleological conception of nature.

## 2.2 Teleology in the analysis of the capacities of the soul

### *2.2.1 Teleology and the general capacities of the soul*

In this section, I provide an analysis of the ways in which teleological notions play a role in Aristotle's discussion of the various general capacities of the soul. Since soul is coextensive with life, and since life is one of those things that are "spoken of in many ways," Aristotle sets out to distinguish the different ways or forms of life in

[130] On topic neutrality, see Caston (2006), 321-322 and Smart (1959), 141-156.

[131] I essentially agree with Rorty (1992), 9: "Any and every *psuchê* is a *logos enhulos* realized in a physical body of a certain kind, rather than in matter as it might be described by a theoretical physicist. (…) [W]hile there are general resemblances or analogies between the psychological functions of distinctive types of animals, *the full explanation of those functions essentially refers to the specific physiology of a certain type of animal*." (The italics are mine.)

*DA* by listing the functions that are in some way or another most characteristic of life.[132] In this section, I will first outline the organization of the different life functions Aristotle distinguishes (largely in *DA*.II.2-4), and show how the ontological hierarchy of the life-functions laid out in *DA* (in which higher life-functions do not occur without the lower ones being present too) gives rise to a more teleological colored hierarchy in the biology (in which the higher life-functions are present 'for the sake of' the lower ones). In the next subsection, I will analyze the teleological explanations Aristotle offers for the presence of various capacities of the soul.

### *2.2.1.a The hierarchy of the capacities of the soul*

In *DA*.II.2-4, Aristotle distinguishes the living from the non-living broadly in terms of the presence of at least one life-function (*DA*.II.2, 413a20-23):

> λέγομεν οὖν, ἀρχὴν λαβόντες τῆς σκέψεως, διωρίσθαι τὸ ἔμψυχον τοῦ ἀψύχου τῷ ζῆν. πλεοναχῶς δὲ τοῦ ζῆν λεγομένου, κἂν ἕν τι τούτων ἐνυπάρχῃ μόνον, ζῆν αὐτό φαμεν (...).
>
> "So we say, taking this as a starting point for the inquiry, that what is ensouled is distinguished from what is soulless by living. But living is said in more than one way, and if any one alone of the following is present in something, we say that it is alive (…)."[133]

The specific listings of life-functions often vary in different texts in *DA*, but on the whole they seem to include a selection from the following seven:

1) decay and growth (φθίσις τε καὶ αὔξησις);
2) movement with respect to nutrition (κίνησις ἡ κατὰ τροφὴν);
3) appetite (ὄρεξις);
4) imagination (φαντασία);

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[132] The terminology Aristotle uses in his discussions might need some brief clarification. Aristotle speaks of the *dunameis* of the soul (e.g. *DA*.II.2, 413a22), which I translate as the capacities (or faculties) of the soul. Sometimes Aristotle calls them *môria* (parts) of the soul, but this should not be taken too literally (perhaps 'aspects' would be a better translation). The *energeia* or *praxis* (activity) of these *dunameis* (a *dunamis* is a capacity or potentiality for an activity) is what Aristotle equates with the performance of *erga* (functions). The individual functions are usually indicated by the use of the substantive form of the infinitive (*to -ein*; e.g. *to noein*), or with an action-noun (*-sis*; e.g. *noêsis*), while the adjectivum verbale (*to –ikon*; e.g. *to noêtikon*) is used to indicate the capacities or faculties of the soul, but sometimes also that which has these capacities or faculties. The supinum (*to –on*; e.g. *to noêton*) is used to refer to the objects of the capacity.

[133] (Cf. *DA*.II.3, 414a29-32).

5) perception (αἴσθησις);
6) locomotion or movement with respect to place and rest (κίνησις καὶ στάσις ἡ κατὰ τόπον);
7) thinking (διανοία) or the possession of intellect (νοῦς).

In other passages, Aristotle states that it is the presence of one particular function that singles out the living from the non-living. This is the function of nutrition, involving both self-nutrition (τὸ θρεπτικὸν) and reproduction (γεννήσις).[134]

The two accounts Aristotle offers of what constitutes life do not contradict each other.[135] First of all, it is the having of soul which truly and primarily makes something alive, and only secondarily the having of a particular soul- or life-function (cf. *DA*.II.2, 413a21-22). Since all the capacities for life-functions are 'parts' of the soul, the presence of either one of these functions in a natural body will be sufficient for it to qualify as being alive. Secondly, among perishable living beings, the presence of any one of the life functions presupposes ultimately the presence of the capacity of nutrition (I will return to the issue of the interdependence of the life functions below). If some being possesses the nutritive capacity, it meets the most basic functional requirement for being called alive. Thirdly, although Aristotle focuses mainly on the perishable living beings and their life functions in *DA*, his broader account of life leaves open the possibility for there being a divine kind of living, which is constituted only by the function of thinking.

The series of life functions Aristotle puts forward is not organized randomly, but follows a strict ontological hierarchy in which the higher function can only exist if the lower one exists and is realized in the natural being, all the way down to the function of nutrition which the basic life-function.[136] The function of nutrition is the only function that for its presence does not rely on the presence of other functions (*DA*.II.2, 413a31-32):

> χωρίζεσθαι δὲ τοῦτο μὲν τῶν ἄλλων δυνατόν, τὰ δ' ἄλλα τούτου ἀδύνατον ἐν τοῖς θνητοῖς.
>
> "That one [i.e. the capacity of nutrition] can exist separately of the others, but the others cannot [exist separately] from that in mortal beings."

[134] See e.g. *DA*.II.2, 413b2-3 and *DA*.II.4, 415a22-25.
[135] Pace Matthews (1992), 185-193.
[136] Cf. Barnes (1971-72).

The fact that the capacity to absorb food, in virtue of which living beings have life, *can* exist separately or independently of the other capacities is clear in the case of plants: they have no other capacity of the soul except for the capacity of nutrition.[137] For this reason, the function of nutrition is both what makes something a living being in the most rudimentary form, and what constitutes the defining or essential function of plants, the lowest life-form.

For animals, the next life-form, the defining function is the perceptive function of touch (ἁφή; *DA*.II.2, 413b2; b5; cf. *DA*.II.3, 414b1-4). Aristotle uses the function of perception as a collective term encompassing a number of perceptive functions for which an animal may or may not have to capacity; touch is the first and most basic one among them. Just as the capacity of nutrition can exist independently of the other capacities, in the same way touch can exist independently of the other perceptive capacities (*DA*.II.2, 413b5-7: ὥσπερ δὲ τὸ θρεπτικὸν δύναται χωρίζεσθαι τῆς ἁφῆς καὶ πάσης αἰσθήσεως, οὕτως ἡ ἁφὴ τῶν ἄλλων αἰσθήσεων; *DA*.II.3, 415a4-5).

For human beings (and possibly for some other kind of being more honorable than humans), the highest life-forms, the essential function that marks their specific kind of living is thinking (*DA*.II.3, 414b18-19; 414b18: τὸ διανοητικόν τε καὶ νοῦς), which is the highest function.[138] This gives evidence for the idea that function and essence are intrinsically connected for Aristotle: for the essential differences between different types of living beings (i.e. plant, animal, human being, god) are determined by the kinds of capacities for the performance of certain functions they have.[139]

In describing the hierarchy among the different functions of the soul, Aristotle uses the verb *chôrizesthai*, indicating the independent existence of one psychic function from another in terms of its 'ontological separability'.[140] Aristotle explains this notion through an analogy between the capacities of the soul and complex rectilinear figures (*DA*.II.3, 414b28-32):

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[137] See *DA*.II.2, 413a33-b1; *DA*.II.3, 414a33-b1; *DA*.II.3, 415a2-3; and *DA*.II.4, 41523-26.
[138] In human beings, this function seems to be dependent on the capacity of imagination (*DA*.III.8, 432a8-9), but perhaps in divine beings it need not be.
[139] *DA*.II.2, 414a1; cf. the case for the perceptive capacities: *DA*.II.2, 414a2-4; *DA*.II.3, 414a29-31.
[140] Broadie (1996), 163-164.

> παραπλησίως δ' ἔχει τῷ περὶ τῶν σχημάτων καὶ τὰ κατὰ ψυχήν· ἀεὶ γὰρ ἐν τῷ ἐφεξῆς ὑπάρχει δυνάμει τὸ πρότερον ἐπί τε τῶν σχημάτων καὶ ἐπὶ τῶν ἐμψύχων, οἷον ἐν τετραγώνῳ μὲν τρίγωνον, ἐν αἰσθητικῷ δὲ τὸ θρεπτικόν.
>
> "What applies to the soul is almost the same as what applies to geometrical figures. For in both figures and things that are ensouled, that which is prior always exists potentially in that which follows in order, for instance, the triangle in the quadrilateral, and the nutritive capacity in the perceptive."

Just as more basic rectilinear figures are potentially contained in the ones that are next figure in order, in the same way the nutritive capacity of the soul is potentially contained in the next capacity in order, which is the perceptive capacity. The unity between the different capacities described here is one of order (*taxis*):[141] just as in a sequence of numbers the number one can be without number five, number five cannot be without number one, because number one exists potentially in number five. In the lines following this analogy, Aristotle explains the interdependency of functions in the soul in terms of the higher capacity not being able to exist without the lower capacity, while the lower capacity can exist independently of the other capacities (*DA*.II.3, 415a2-3):

> ἄνευ μὲν γὰρ τοῦ θρεπτικοῦ τὸ αἰσθητικὸν οὐκ ἔστιν· τοῦ δ' αἰσθητικοῦ χωρίζεται τὸ θρεπτικὸν ἐν τοῖς φυτοῖς. πάλιν δ' ἄνευ μὲν τοῦ ἁπτικοῦ τῶν ἄλλων αἰσθήσεων οὐδεμία ὑπάρχει, ἁφὴ δ' ἄνευ τῶν ἄλλων ὑπάρχει·
>
> "For without the nutritive capacity there is no perceptive capacity, but the nutritive capacity is present in separation of the perceptive capacity in plants. Again, without the sense of touch none of the other perceptive capacities are present, but touch is present without the others."

Here Aristotle contrasts the separability of the nutritive capacity (*chôrizetai*) and of the capacity of touch (*aneu huparchei*) with the not being able to exist of the perceptive capacity without the nutritive one (*aneu ouk esti*). The hierarchy thus sketched between the different capacities of the soul is a purely ontological one[142] but as Aristotle points out, this is not all that there is to it (*DA*.II.3, 414b33-415a1):

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[141] See *Met*.V.11, 1018b26-29.

[142] What the precise relations of ontologically independency and dependency are among the various capacities of the soul remains unclear in *DA*, especially with regard to the capacities associated with perception and desire: The capacity of perception seems to presuppose the presence of the faculties of imagination (*phantasia*) and appetite (*orexis*). Aristotle explains that where there is perception, there is also pain and pleasure: in *DA*.II.3, 414b4-6 Aristotle adds the pleasant (*hêdu*) and the painful (*lupêron*), and where there are pain and pleasure, there is also of necessity desire (*epithumia*; *DA*.II.2, 413b23-25).

διὰ τίνα δ' αἰτίαν τῷ ἐφεξῆς οὕτως ἔχουσι, σκεπτέον.

"For what reason they are in that state of arrangement, needs to be investigated."

This question will be answered teleologically at the end of *DA* (in particular in *DA*.III.12-13, discussed below). Based on the assumption that nature does nothing in vain, the ontological hierarchy is there interpreted as a 'taxonomical' hierarchy[143] in which the lower functions are seen as a precondition for the existence of the higher and where the higher functions are explained as contributory to the lower functions.

In the biological context, the focus is thus no longer on the ontological status of functions, but rather on the conditional and non-symmetrical relation between the function in question and the other functions that coexist within a living being.[144] The lower functions are explained as those functions that are of vital or essential necessity for the specific life-form: that is, without the realization of those functions, the animal would not be able to survive or to be the kind of animal it is supposed to be. The higher functions reflect an increasing complexity of the organism and its life-form, and their presence is usually explained as contributing to the goals pursued by the performance of the basic vital or essential functions (except for the function of thinking, which has a function of its own).[145] The notion underlying the hierarchy and the combinations of soul-functions to be found in living beings laid out in this way is teleological, if only in a loose sense: even though the higher functions are not conditionally necessitated by the lower ones, their

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Sometimes Aristotle offers a somewhat different account: if there is perception, then there is also desire. Desire on its turn is characterized as a sub-capacity of appetite (it is the appetite for the pleasant; *DA*.II.3, 414b6-7), where appetite consists of desire, passion (*thumos*), wishing (*boulêsis*) (*DA*.II.3, 414b2-3). Hunger (*peina*) and thirst (*dipsa*) are sub-capacities of desire (*DA*.II.3, 414b12-14). Tasting is a sub-capacity of the perceptive function of touch (*DA*.II.3, 414b7-12); in addition to the capacity of touch, the faculty of perception also encompasses the capacities of vision (*opsis*), hearing (*akoês*), and smell (*osmê*) (*DA*.II.3, 415a5-6). The cases of imagination (*DA*.II.3, 414b17-18) and of theoretical thinking (*theôrêtikon*) are less clear cut; the latter "seems to be a different kind (*genos*) of soul (cf. *DA*.II.3, 415a12-13: *peri de tou theôrêtikou nou heteros logos*), which alone allows of existing independently [of the other capacities], exactly in the way the eternal exists independently of the perishable (*DA*.II.2, 413b26-27)."

[143] Cf. Caston (1996, 184-186) on the conception of *chôristos* as 'taxonomical separability.

[144] On this notion of priority and posteriority, cf. *Met*.V.11, 1019a2-4: "Now some things are called prior and posterior in that way, but others in accordance with nature and substantial being, namely those things that are capable of being without other things (ὅσα ἐνδέχεται εἶναι ἄνευ ἄλλων), while those others are not capable of being without them, which is a distinction Plato used."

[145] Pace Johnson (2005), 9, who holds that the simpler functions exist for the sake of the more complex ones. The hierarchy rather works the other way around: the more complex functions are for the better and exist therefore to a certain extent for the sake of the simpler functions, because they increase the animal's ways of surviving and reproducing itself, which are the most basic and simple life-functions, but are also the most necessary ones.

presence would make no sense if the lower ones or some other related capacities were not present as well (e.g. the presence of the locomotive capacity would make no sense if the capacity for perception or for desire were not present too).[146]

In sum, the hierarchy reflects a purely ontological organization which is then reinterpreted in teleological terms,[147] thus providing the starting point for the explanation of the parts and features of living beings in the biological works.

### *2.2.1.b The teleology of the capacities of the soul*

In *DA,* Aristotle does not only discuss the hierarchical relation between the different capacities of the soul, he also provides teleological explanations of why living beings have the capacities for the performance of the particular functions they have. The capacities are themselves defined in terms of the goal-directed activity (i.e. the function) they are the capacity for, but note that the goal that will be achieved by the actualization of the capacity differs from the goal identified in the teleological account explaining why living beings have the capacities they have. The first goal will be an answer to the question of what the actuality of a particular capacity of the soul amounts to (the proper *ergon* or final cause of the process), such as getting or digesting food. The second goal will be an answer to the question of why that capacity of the soul does what it does (the ultimate goal that is served by a well-functioning part in the context of the living being to which it belongs), such as preserving life. I will first discuss the teleological explanations Aristotle offers for the necessary essential or vital functions, such as the nutritive function and the perceptive functions. Next, I will discuss an example Aristotle offers concerning a non-necessary function, namely voice.

As discussed above, the capacity of nutrition, being that in virtue of which something has life, is common to all living beings, and the basic capacity on which all other soul-capacities build (*DA*.II.4, 415a23-25):

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[146] Cf. Hankinson (1998), 154.

[147] Aristotle does so without taking any resource to value-terms; pace Ross (1961), 337. The *locus classicus* for Aristotle's concept of a value-laden *scala naturae* is *HA*.VIII.1, 588b4-22 (cf. *PA*.IV.5, 681a10-15; *PA*.II.10, 656a3-13), but even there, 'higher' seems to be functionally defined as 'having a higher amount of life and of living well', i.e. having more being in the form of having more life functions, and thus of having a greater organic complexity. Cf. Lennox (1999), 6-7 on *PA*.II.10, 656a3-13.

> ἡ γὰρ θρεπτικὴ ψυχὴ καὶ τοῖς ἄλλοις ὑπάρχει, καὶ πρώτη καὶ κοινοτάτη δύναμίς ἐστι ψυχῆς, καθ' ἣν ὑπάρχει τὸ ζῆν ἅπασιν.
>
> "For the nutritive soul belongs also to the others [i.e. living beings], and it is the first and most common capacity of the soul, by which life belongs to them all."

For this reason, Aristotle starts his investigation of the capacities of the soul in *DA*.II.4 with the discussion of what this capacity amounts to, i.e. its function and activity, and of why all living beings have this capacity. The function of the nutritive capacity is both to reproduce and to use food (*DA*.II.4, 415a25-26: ἧς ἐστὶν ἔργα γεννῆσαι καὶ τροφῇ χρῆσθαι), and these two functions are claimed to be the most natural functions among living beings (*DA*.II.4, 415a27: φυσικώτατον γὰρ τῶν ἔργων τοῖς ζῶσιν; cf. *Pol*.I.2, 1252a28-30). Aristotle explains reproduction as "the production of another like itself (*DA*.II.4, 415a28: τὸ ποιῆσαι ἕτερον οἷον αὐτό)", the goal of which (that is, the reason why all living beings need to be able to reproduce) is this (*DA*.II.4, 415a29-b7):

> ἵνα τοῦ ἀεὶ καὶ τοῦ θείου μετέχωσιν ᾗ δύνανται· πάντα γὰρ ἐκείνου ὀρέγεται, καὶ ἐκείνου ἕνεκα πράττει ὅσα πράττει κατὰ φύσιν (τὸ δ' οὗ ἕνεκα διττόν, τὸ μὲν οὗ, τὸ δὲ ᾧ). ἐπεὶ οὖν κοινωνεῖν ἀδυνατεῖ τοῦ ἀεὶ καὶ τοῦ θείου τῇ συνεχείᾳ, διὰ τὸ μηδὲν ἐνδέχεσθαι τῶν φθαρτῶν ταὐτὸ καὶ ἓν ἀριθμῷ διαμένειν, ᾗ δύναται μετέχειν ἕκαστον, κοινωνεῖ ταύτῃ, τὸ μὲν μᾶλλον τὸ δ' ἧττον, καὶ διαμένει οὐκ αὐτὸ ἀλλ' οἷον αὐτό, ἀριθμῷ μὲν οὐχ ἕν, εἴδει δ' ἕν.
>
> "To participate in the eternal and the divine for as far as they can. For everything desires this, and does everything it does in accordance with nature for the sake of this. (For 'that for the sake of which' is twofold: that of which and that for which.) Since, then, it is not possible to participate in the eternal and divine by continuous existence, because no perishable being is able to remain the same and one in number, each shares in it for as far as it can, it participates in it, the one more, the other less; and it remains not the same, but like itself, not one in number, but one in form."

By reproducing something like itself, that is, by reproducing something that has the same form as it has itself, and thereby preserving its particular kind of life-form, perishable beings can participate in the 'eternal and divine'.[148] This is, according to Aristotle, the ultimate goal for all action. The idea that generation is for the sake of sharing in the eternal and divine goes back to the principle that being is better than

[148] Lennox (2001a), 137.

not being, and living better than not living (*GA*.II.1, 731b24-732a1; *GC*.II.11, 338b6-19).[149] A perishable individual will by nature not be able to hold on to life eternally, but its kind is capable of being eternal, *if* it is passed on to the individual's offspring, and this will be its good. A man will reproduce himself and thereby preserve mankind *because* it is the only and best way possible for a man to participate in the eternal and the divine.[150] It is important to note that it is the individual's striving for participation in the eternal and the divine which is the true final cause of reproduction, not the preservation of the life-form as such. The individual does not reproduce itself for the sake of its form but for the sake of its own individual good from which the preservation of the life-form follows.[151] The ultimate final cause that 'everything desires to participate in the eternal and the divine' is taken as the self-evident starting-point of the explanation of generation. The preservation of life which follows from this desire presents the starting point for the teleological explanations of all other life functions: ultimately all functions, parts and features of a living being must be accounted for in terms of their contribution to the preservation of this particular kind of living being – of what will either be necessary or for the better for the preservation of this kind of substantial being. Generation for the sake of the self-preservation of a particular kind of life is the most basic teleological explanation Aristotle offers.[152]

So far, Aristotle has only provided a teleological explanation for the generative function of the nutritive soul.[153] Aristotle's account of the nutritive functions in the sense of the use of food starts with a consideration of the nature of food, following the necessary methodological order of studying capacities as laid out at the beginning of the chapter (*DA*.II.4, 415a14-23). Next, Aristotle distinguishes the nutritive function from the capability of producing growth; it is in this context that Aristotle states the reason why a living being needs the nutritive function. By way of nourishing itself, the living being "saves its substantial being, and exists as long as it also feeds itself" (*DA*.II.4, 416b14-15: σώζει γὰρ τὴν οὐσίαν, καὶ μέχρι

[149] Ultimately, the idea goes back to Pl.*Symp*.207c-208b.
[150] Cf. Lennox (2001a), 133-137.
[151] Balme (1987c, 279-280.
[152] Cf. Johnson (2005), 171-178.
[153] In fact, at the end of *DA*.II.4 Aristotle prefers to call the nutritive capacity the generative soul, apparently after its primary function (*DA*.II.4, 416b23-24).

τούτου ἔστιν ἕως ἂν τρέφηται). The nutritive function is the capacity that allows the animal to preserve itself, and that prepares the food for activity. Without food, a living being is not able to exist (*DA*.II.4, 416b17-20).

While the generative function is thus in one sense for the sake of the preservation of the animal-kind as a whole, the nutritive function is primarily for the sake of the preservation and the functioning of the individual animal (which is of course a prerequisite if the animal is to reach sexual maturity and to reproduce itself). It is also clear now why it is that the nutritive soul is explanatorily basic for all the other capacities: without food the higher capacities simply cannot exist. The nutritive function is thus the most vital function of the animal (*DA*.III.12, 434a22-26):

> Τὴν μὲν οὖν θρεπτικὴν ψυχὴν ἀνάγκη πᾶν ἔχειν ὅτι περ ἂν ζῇ καὶ ψυχὴν ἔχῃ, ἀπὸ γενέσεως καὶ μέχρι φθορᾶς· ἀνάγκη γὰρ τὸ γενόμενον αὔξησιν ἔχειν καὶ ἀκμὴν καὶ φθίσιν, ταῦτα δ' ἄνευ τροφῆς ἀδύνατον· ἀνάγκη ἄρα ἐνεῖναι τὴν θρεπτικὴν δύναμιν ἐν πᾶσι τοῖς φυομένοις καὶ φθίνουσιν·
>
> "Everything then that lives and has a soul must have the nutritive soul, from birth until death; for anything that has come to be must have growth, maturity, and decline, and these things are impossible without nourishment. The potentiality for nutrition must then be present in all things which grow and decline."[154]

The remark that the nutritive function is presupposed by the capacity of growth and decline shows how strong it is connected to the material processes going on in the living being's body. The most basic level of life is constituted by the regulation of the flow of matter, without which there is no life and which, more importantly, distinguishes it from the non-living; the soul as the form of a living being provides the matter for the body "by processing matter through itself by way of metabolism, growth, and reproduction."[155]

Aristotle does not provide any justification for why the nutritive and generative function are both functions of the same nutritive capacity, but maybe the similarity in the teleological explanations of the two functions offers somewhat of a justification. Both functions are for the sake of the preservation of the animal, the one qua individual to the life and well-being of which the individual itself can contribute by feeding itself, the other qua the animal belonging to a particular animal

[154] Cf. *PA*.II.10, 655b30-2: "it is not possible to be or to grow without food."
[155] Grene & Depew (2004), 31.

kind to the eternity of which the individual animal can contribute by reproducing itself. In sum, the nutritive capacity of the soul serves the preservation of life.

The perceptive capacity of touch is not only an essential or defining[156] capacity of animals, it is also vital for the animal. Unsurprisingly, the presence of this capacity is explained teleologically as being ultimately necessary for the sake of self-preservation (*DA*.III.12, 434b13-14): the body of the animal must have the capacity of touch – it is the one perceptive capacity an animal *must* have (*DA*.III.13, 435b19), if the animal is to survive. Touch is necessary for survival, because anything which touches something else without sensing or registering it (i.e. undergoing some kind of change by being affected by the object), will not be able to flee from some things (e.g. predators) or catch others (e.g. food); and "in that case, it will be impossible for the animal to survive" (*DA*.III.12, 434b16-18: εἰ δὲ τοῦτο, ἀδύνατον ἔσται σώζεσθαι τὸ ζῷον). By connecting touch to the appetitive capacities, Aristotle is able to explain the basic 'flee and chase'-behavior of animals.[157]

This ultimate function of the capacity of touch to preserve the animal through enabling it to seize (or to run from) things when they sense their presence also leads Aristotle to the conclusion that taste is a kind of touch (*DA*.III.12, 434b18: διὸ καὶ ἡ γεῦσίς ἐστιν ὥσπερ ἁφή τις). Taste is the touching – or the perceiving – of food, which is a tangible body, and without which the animal cannot be (*DA*.III.12, 434b22-24):

> αὗται μὲν οὖν ἀναγκαῖαι τῷ ζώῳ, καὶ φανερὸν ὅτι οὐχ οἷόν τε ἄνευ ἁφῆς εἶναι ζῷον.
> "So these [i.e. touch and taste] are necessary for an animal, and it is clear that without touch it is impossible for an animal to be."[158]

The capacity of touch, then, and its sub-capacity of taste, both presuppose and contribute to the nutritive capacity, and as such are present for the sake of the preservation of the animal.

The other perceptive capacities an animal has, Aristotle explains in the following way (*DA*.III.13, 435b20-25):

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[156] Cf. *DA*.III.13, 435b16-17.
[157] See Freeland (1992), 236-237; and 245: "This means that in the *DA* it is reasonable for Aristotle to attempt to explain animals' possession of the sense of touch teleologically, as sort of adaptation or purposive suitability to the worlds as it is, namely a tangible world."
[158] Cf. *DA*.III.13, 435b17-18.

> οὐ τοῦ εἶναι ἕνεκα ἀλλὰ τοῦ εὖ, οἷον ὄψιν, ἐπεὶ ἐν ἀέρι καὶ ὕδατι, ὅπως ὁρᾷ, ὅλως δ' ἐπεὶ ἐν διαφανεῖ, γεῦσιν δὲ διὰ τὸ ἡδὺ καὶ λυπηρόν, ἵνα αἰσθάνηται τὸ ἐν τροφῇ καὶ ἐπιθυμῇ καὶ κινῆται, ἀκοὴν δὲ ὅπως σημαίνηταί τι αὐτῷ [γλῶτταν δὲ ὅπως σημαίνῃ τι ἑτέρῳ].
>
> "[They] are not for the sake of its existence, but for its well-being, e.g. it has sight in order to see, because it lives in air and water, or, in general, because it lives in something transparent; and it has taste because of what is pleasant and painful, in order that it may perceive these in food and that it may feel desire and be set in motion; and hearing in order that something may be indicated to it [and a tongue in order that it may indicate something to another]."[159]

The teleological account of the perceptive capacities as we find it here is the result of the application of the teleological principle (common in the biological works) positing that all the parts an animal has are either necessary parts – that is, necessary for the performance of a necessary vital or essential function, or for the sake of improving the performance of a function that is already primarily performed by another part.

Strictly speaking, only the perceptive capacity of touch is both essentially and vitally necessary for animals, the other capacities mentioned in *DA*.III.12 'merely' contribute to this first and basic capacity and thereby contribute to the general well-being of the animal. Note that this division of capacities (into those that are necessary, and into those that are 'merely' subsidiary or luxury parts)[160] does not deny the fact that those latter parts significantly improve the functioning of the animal as a whole. It just means that because we can observe that not all animals have all the capacities listed, and are still able to preserve themselves and their animal-kind, these capacities cannot be necessary for animals in general.

In *DA*.III.12 Aristotle singles out the ways in which the other capacities contribute to the well-being of the animal, which on its turn accounts for their presence. For instance, the presence of the capacity of sight is explained as being for the well-being of the animal, and being realizable because animals live in something transparent. Air and water both provide the materially necessary medium for sight, which is to 'touch' upon objects at a distance. This is a teleological explanation not

[159] Cf. *DA*.III.12, 434b25: αἱ δὲ ἄλλαι τοῦ τε εὖ ἕνεκα.
[160] See Sorabji (1980), 157-158.

only of why locomotive animals have sight (it significantly improves their ways of preserving themselves), but implicitly also of why locomotive animals have the kind of perceptive organs they have: the organs are made to perceive effects or changes in the transparent.[161] The capacity of taste enables animals to be "perceptive of what is tangible and nutritive" (*DA*.III.12, 434b21-22: διὰ τὸ τοῦ ἁπτοῦ καὶ θρεπτικοῦ αἴσθησιν εἶναι), and hence to perceive the foods that it should chase after. The capacity of hearing enables animals to detect food or predators at a distance by perceiving significant sounds, while the tongue is here attributed a secondary function (in addition to being the organ of taste) of communication.[162] The presence of these perceptive capacities can ultimately be accounted for by reference to their contribution to the well-being of each kind of animal.

Aristotle makes a special case, however, for the perceptive capacities, and especially for the capacity of sight,[163] as being necessary for the survival of those animals that locomote, stating that (*DA*.III.12, 434b26-27):

> εἰ γὰρ μέλλει σώζεσθαι, οὐ μόνον δεῖ ἁπτόμενον αἰσθάνεσθαι ἀλλὰ καὶ ἄποθεν.
> "If it is to survive, it is not only necessary for it to perceive while touching, but also from a distance."

The whole teleological argument leading up to this conclusion (*DA*.III.12, 434a31-b8) is quite complicated. As often, Aristotle starts from the principle that nature does nothing in vain.

In the biological works, this principle is used mostly to explain the absence of parts in a teleological way, by arguing that if the part were present it would be in vain, and by showing that the function for the performance of which this part for the most part would be necessary is realized in another way (e.g. snakes move forward by bending themselves instead of being equipped with feet), or is not missed too much (e.g. having outer ears would have been better for birds, but it is not absolutely necessary for their ability to hear; for the use of this principle, see

[161] See Charles (2000), 122n.22.
[162] The presence of the tongue in this list and the absence of smell are somewhat remarkable; maybe the verb *semainein* makes Aristotle think of human beings more than of animals in general, and in humans the capacity of smell is poorly defined, while communication is one of its defining characteristics.
[163] Aristotle seems to have mainly sight in mind, as becomes clear from the concluding remarks in III.12, 435a6-10, in which he rejects a theory of vision in which something issues from the eye as well as from the object of vision.

3.2.4 and 3.3.1.c). Here Aristotle uses it to explain the presence of a capacity in a teleological way, also by using a counterfactual reasoning. However, whereas in the biological work one is usually to imagine the presence of the part that is found to be absent (and then to conclude that its presence would have been in vain), here one is to imagine the absence of a capacity (and the instruments in which it is realized) in order to draw the conclusion that its presence serves a function. That is, Aristotle proposes to imagine what would happen if locomotive animals lacked the capacity of perception; then we would immediately realize that they would be able to reach their natural goal, but would die. Hence, the capacity of perception must be for the sake of something (*DA*.III.12, 434a27-b1):

> αἴσθησιν δ' οὐκ ἀναγκαῖον ἐν ἅπασι τοῖς ζῶσιν (...) τὸ δὲ ζῷον ἀναγκαῖον αἴσθησιν ἔχειν, <οὐδὲ ἄνευ ταύτης οἷόν τε οὐθὲν εἶναι ζῷον,> εἰ μηθὲν μάτην ποιεῖ ἡ φύσις. ἕνεκά του γὰρ πάντα ὑπάρχει τὰ φύσει, ἢ συμπτώματα ἔσται τῶν ἕνεκά του. εἰ οὖν πᾶν σῶμα πορευτικόν, μὴ ἔχον αἴσθησιν, φθείροιτο ἂν καὶ πᾶν σῶμα πορευτικόν, μὴ ἔχον αἴσθησιν, φθείροιτο ἂν καὶ εἰς τέλος οὐκ ἂν ἔλθοι, ὅ ἐστι φύσεως ἔργον.
>
> "Sense-perception is not necessary in all living things (…), but an animal needs to have perception, and without this it is not possible to be an animal, if nature does nothing in vain. For all things that are there by nature, are for the sake of something, or will be coincidental to the things that are for the sake of something. And if any body were such as to locomote, but did not have perception, it would be destroyed and would not reach the end which is the function of its nature."

As said above, the basic assumption of this argument is that, of course, nature does nothing in vain, and that therefore perception is present for the sake of something in locomotive animals. That purpose is stated immediately following the argument, in the form of a rhetorical question: "For how could it be nourished?" (*DA*.III.12, 434b1-2: πῶς γὰρ θρέψεται). That perception is indeed necessary for the nourishment of locomotive animals is established first through an inverted analogy with stationary animals (*DA*.III.12, 434b2):

> τοῖς μὲν γὰρ μονίμοις ὑπάρχει τοῦτο ὅθεν πεφύκασιν.
>
> "For stationary living things have food from that out of which they have been born."

Instead of adding something like "but this is not the case for locomotive animals, and therefore they have to find their own food by first perceiving it at a distance and then moving towards it to grab it," Aristotle leaves the analogy unfinished. He

immediately switches to a reduction to the impossible, claiming that (*DA*.III.12, 434b3-5):

> οὐχ οἷόν τε δὲ σῶμα ἔχειν μὲν ψυχὴν καὶ νοῦν κριτικόν, αἴσθησιν δὲ μὴ ἔχειν, μὴ μόνιμον ὄν, γενητὸν δέ—ἀλλὰ μὴν οὐδὲ ἀγένητον· διὰ τί γὰρ οὐχ ἕξει;
>
> "It is not possible for a body to have a soul and an intellect that can distinguish things, but not have perception, if it is not stationary and has been generated – and even if it were not generated – for why would it not have it [i.e. perception]?"

Aristotle only allows for this possibility (of a body having soul and intellect, but not perception) on the condition that being without perception would be better for either the soul or the body.

In sum, Aristotle here inverts the more common use of the principle as we know it from the biological works. Usually the principle of something being 'for the better' is invoked to explain the presence of a part by showing its contribution to a necessary function that is performed primarily and properly by another part. Here it is used to explain the presence of a function – perception – by showing the implausibility of the body and soul being better off without this function, while at the same time being equipped with another function that presupposes the presence of the first. Apparently, the absence of a capacity is justified, if and only if the animal's well-being benefits from this absence. Since this is not the case, however, no natural bodies that are not stationary have a soul without the perceptive capacity. The presence of the capacity of perception is thus established through 'negative teleology': the teleological reasoning is that if it is not better for the animal not to have a particular function (and especially if it would die without it), then it must have this function. The general assumption seems to be that since observation shows that all living beings are able to live, reproduce, and – in various degrees – to live-well, they must all have the capacities necessary to do so.

On the whole, Aristotle tries to attribute as much 'necessity' to the perceptive capacities as possible: although they are not as necessary and basic as nutrition and reproduction, they nevertheless play a strongly supportive role without which animals would be far worse off. The presence of the perceptive capacities is thus ultimately explained by their contribution to the nutritive capacity, and thus to the preservation and survival of the animal, but also by their significant contribution to the well-being of the animal.

In addition to each perceptive capacity having its own proper function and ultimately contributing to the nutritive capacity, all five capacities also contribute to the perception of the common objects of perception (*DA*.III.1, 425b4-11):

> ζητήσειε δ' ἄν τις τίνος ἕνεκα πλείους ἔχομεν αἰσθήσεις, ἀλλ' οὐ μίαν μόνην. ἢ ὅπως ἧττον λανθάνῃ τὰ ἀκολουθοῦντα καὶ κοινά, οἷον κίνησις καὶ μέγεθος καὶ ἀριθμός; εἰ γὰρ ἦν ἡ ὄψις μόνη, καὶ αὕτη λευκοῦ, ἐλάνθανεν ἂν μᾶλλον κἂν ἐδόκει ταὐτὸν εἶναι πάντα διὰ τὸ ἀκολουθεῖν ἀλλήλοις ἅμα χρῶμα καὶ μέγεθος. νῦν δ' ἐπεὶ καὶ ἐν ἑτέρῳ αἰσθητῷ τὰ κοινὰ ὑπάρχει, δῆλον ποιεῖ ὅτι ἄλλο τι ἕκαστον αὐτῶν.
>
> "One might ask for the sake of what we have several senses and not one only. Is it perhaps in order that the common-objects which accompany [the special objects], e.g. movement, magnitude, and number, may less escape our notice? For if there were sight alone, and this was of white, they would be more likely to escape our notice and all things would seem to be the same because color and magnitude invariably accompany each other. But as things are, since the common-objects are present in the objects of another sense too, this makes it clear that each of them is distinct."

The teleological explanation on a secondary level of why (locomotive) animals have the five perceptive capacities they have instead of just one, is that they make it less likely that (the existence of) the common objects of perception escape our attention. If we were only able to see a white ball, it would be difficult to distinguish the whiteness in color from the magnitude in shape, because the two necessarily come together. Once we are also able to touch the ball, and feel a hard shape, we are able to recognize that the magnitude is something different from the color and from the hardness of the ball, and thereby get a clearer perception of its magnitude and of the nature of magnitude in general. The possession of five perceptive capacities is thus for the sake of perceiving the common objects.

Secondary functions are ultimately all accounted for through their contribution to the well-being of the living beings. In *DA*.II.8, Aristotle gives an elaborate teleological explanation of voice, describing both the material and physiological prerequisites necessary for the realization of voice, and the function which it ultimately serves (*DA*.II.8, 420b13-22):

> φωνὴ δ' ἐστὶ ζῴου ψόφος οὐ τῷ τυχόντι μορίῳ. ἀλλ' ἐπεὶ πᾶν ψοφεῖ τύπτοντός τινος καί τι καὶ ἔν τινι, τοῦτο δ' ἐστὶν ἀήρ, εὐλόγως ἂν φωνοίη ταῦτα μόνα ὅσα δέχεται τὸν ἀέρα.

> τῷ γὰρ ἤδη ἀναπνεομένῳ καταχρῆται ἡ φύσις ἐπὶ δύο ἔργα—καθάπερ τῇ γλώττῃ ἐπί τε τὴν γεῦσιν καὶ τὴν διάλεκτον, ὧν ἡ μὲν γεῦσις ἀναγκαῖον (διὸ καὶ πλείοσιν ὑπάρχει), ἡ δ' ἑρμηνεία ἕνεκα τοῦ εὖ, οὕτω καὶ τῷ πνεύματι πρός τε τὴν θερμότητα τὴν ἐντὸς ὡς ἀναγκαῖον <ὄν> (τὸ δ' αἴτιον ἐν ἑτέροις εἰρήσεται) καὶ πρὸς τὴν φωνὴν ὅπως ὑπάρχῃ τὸ εὖ.
>
> "Voice is sound made by an animal and not with any chance part of his body. But since everything which makes a sound does so because something strikes something else in something else again, and this last is air, it is reasonable that the only creatures to have voice should be those which take in air. For nature then uses the air breathed in for two functions; just as it uses the tongue for both tasting and articulation, and of these tasting is necessary (and so is found in a greater number [of living beings]), while expression is for the sake of well-being, so also nature uses breath both to maintain the inner warmth, as something necessary (the reason will be stated elsewhere), and also to produce voice so that there may be well-being."

The emphasis on the body of the animal being of the right kind is important here: although the animal must have (parts in) the right material condition, nature does not cause the coming into being of parts which have the right material constitution especially or only for the performance of secondary functions.[164] If the 'right body' is not present from the outset, then the animal will lack the subsidiary or luxury function. This is also the implication of the teleological explanation Aristotle sets out of why fish have no voice (*DA*.II.8, 421a3-6):

> φανερὸν δὲ καὶ διότι οἱ ἰχθύες ἄφωνοι· οὐ γὰρ ἔχουσι φάρυγγα. τοῦτο δὲ τὸ μόριον οὐκ ἔχουσιν ὅτι οὐ δέχονται τὸν ἀέρα οὐδ' ἀναπνέουσιν.
>
> "It is clear, too, why fish have no voice; for they have no throat. They do not have this part because they do not take in air or breathe in."

[164] In some cases, however, nature may produce a part to come to be in such a way that it is useful for the primary function, which turns out to be *at the same time* useful for a secondary function; e.g. *PA*.II.17, 660a17-22: "Mankind has the most detached, softest and broadest tongue, so that it may be useful for both its activities – the soft and broad tongue being useful both for the perception of flavors (for man is the most keenly perceptive of animals, and his tongue is soft, for it is most tactile, and taste is a sort of touch); and for the articulation of words and speech." Also, nature might "adapt" the part that has come to be in the way it has for the performance of a primary function to make it suitable for a secondary function (e.g. the case of human mammae in *PA*.IV.10, 688a19-25), but not always so (presumably because this is not always possible given the other facts about the animal), as becomes clear from the explanation Aristotle offers for the little amount of vocal articulation in the four-footed animals that are blooded and live-bearing (*PA*.II.17, 660a34-5): "This is because they have a tongue that is hard, undetached, and thick." The tongues of these animals do not have the right material potentials to be usable for articulation in addition to their primary function of taste.

The structure of this explanation reflects a common pattern of explanation that Aristotle uses in the biological works. In an earlier passage, Aristotle has already presented us with a teleological explanation of the correlation of throats and lungs: the throat is the organ for breathing, and it exists for the sake of the lung (*DA*.II.8, 420b21-24). Only animals that breathe air have throats. The primary function of throats is to contribute to the function of cooling which is primarily and properly performed by the lungs; the secondary function of the throat is communication. Now fish do not breath air (they cool themselves by water), and therefore do not have or need lungs; animals without lungs lack throats, and without a throat, the materially necessary condition for the production of voice is lacking, too. Fish lack the necessary physiological requirements to produce voice, because their primary essential and vital functions do not require the presence of those organs nature can use (and needs) for the realization of subsidiary, luxury functions.

The teleological explanation of voice is yet another instance of secondary teleology: the formal nature uses parts or things which are already present for the sake of the performance of necessary functions, such as the tongue (which is present for the sake of taste) or air (which is present in those animals that breathe air for the sake of cooling the body) also for the sake of the performance of a subsidiary function, such as voice or communication, which serves the well-being of the animal.

In *DA* II and III, Aristotle describes the different capacities more extensively as affecting their own particular set of objects in a particular way under the proper (physiological) circumstances, while indicating that the capacities are always being exercised for the sake of something. Ultimately, the necessary functions of living beings are there for the sake of the life and preservation of the animal (and thereby its kind), while the non-necessary functions are for the better and contribute to the well-being of the animal. The picture one gets of living beings through these functional accounts of the capacities in which the different souls fall apart, is that of highly complex systems consisting of various hierarchically ordered functional sub-systems. These combinations of functions deriving from different kinds of souls offer the starting points for the teleological explanations in the biological works, in

which Aristotle sets out to demonstrate how the different organs and features an animal has are there for the sake of these functions, or are contributory to these functions and to the well-being of the animal.

### *2.2.2 Teleology in the explanation of animal locomotion*

In this section, I discuss Aristotle's use of teleology in the account of the faculty and mechanics of locomotion in *DA*.III.9-11. At this point in *DA*, Aristotle has discussed the faculties of nutrition, perception, and thought, all of which are cardinal capacities of the soul (cf. *DA*.II.2, 413b12-13). However, one life-function has not been discussed yet, namely the capacity of living beings to initiate movement by themselves, or locomotion. This movement in respect of place that animals perform 'on their own accord' should be distinguished from such 'automatic' motions as growth and decay, respiration and expiration, and sleep and wake, which animals perform on account of their having both a nutritive soul and a nature (which is their internal principle of motion and rest). I will first discuss Aristotle's use of teleological notions in his account of what makes locomotion different from the motions initiated by the nutritive soul and the living being's nature, and then, in an appendix to this section, turn to an analysis of the relation of teleology to the notions of self-motion and intentionality that seem to play a crucial role in Aristotle's account of locomotion.

The first question Aristotle addresses with regard to locomotion is what part or capacity of the soul it is that moves the animal in respect of place (*DA*.III.9, 432a19-20; *DA*.III.9, 432b7-8: τί τὸ κινοῦν κατὰ τόπον τὸ ζῷόν ἐστιν). Before summarizing and analyzing Aristotle's teleological arguments employed in this investigation, it is important to take notice first of what Aristotle takes to be the starting point of it. This is the preconception that 'the progressive movement' (*DA*.III.9, 432b14: τὴν πορευτικὴν κίνησιν) is always for the sake of something, and always involves imagination and desire. Aristotle justifies this preconception in the following way (*DA*.III.9, 432b16-17):

> οὐθὲν γὰρ μὴ ὀρεγόμενον ἢ φεῦγον κινεῖται ἀλλ' ἢ βίᾳ·
> "Nothing that is not desiring or avoiding [something] moves [with respect to place] unless by force."

From the outset, locomotion is thus characterized as being both a (voluntary) movement according to nature, and a goal-directed movement.[165] This teleological preconception of locomotion will be important for Aristotle in determining the capacity of the soul responsible for locomotion, as well as in explaining the constitutive factors and mechanics involved in locomotion.[166]

The above mentioned concept of locomotion is used by Aristotle in the first place as a criterion for the elimination of the capacities of the soul that are *not* responsible for this type of movement.

First Aristotle rules out the nutritive capacity – which is responsible for movement with respect to growth and decay – as being also responsible for locomotion, because it does not involve imagination or desire (*DA*.III.9, 432b14-15). Besides, Aristotle adds, if the nutritive capacity were responsible for locomotion, plants would also have the capacity of locomotion, and then they would also have had the parts instrumental for this kind of movement (*DA*.III.9, 432b18-19). The underlying teleological principle at play here is that no being lacks the instruments for which it has the capacity; if a being lacks the instruments that are commonly associated with the performance of a particular function, then that being must lack that function.[167] In the case of plants, it is the *complete* kind that lacks such instruments, and therefore the conclusion seems plausible that this kind of living being must lack locomotion altogether.

A similar argument holds for Aristotle's strategy in ruling out the perceptive function as being responsible for locomotion: many living beings have this capacity, but are stationary and unmoving throughout their lives (*DA*.III.9, 432b20-21). Again, the absence of the locomotive parts is used as the counterfactual evidence for

[165] For this account of locomotion, cf. also *MA*.VI.

[166] See Hankinson (1990), 62n.28 for the thought that Aristotle could have made the same points in this chapter without teleology entering the picture.

[167] The inference Aristotle draws here from the absence of such instruments to the absence of functions is not always equally reliable. In some cases, the formal nature of an animal finds a unique way of realizing a certain function in a particular kind of living being without necessitating the coming to be of parts usually associated with (or demonstrated to intrinsically belong to) that function. For instance, snakes lack organs for locomotion, but are still able to move from place to place by bending themselves in virtue of possessing four points of movement. (On the snake, see *IA*.II, 704b12-18; *IA*.VIII, 708a9-20; cf. *PA*.IV.13, 696a10-15. The explanation of the footlessness of snakes is a paradigmatic example of teleological explanations of the absence of parts; it will be further discussed in chapters 3.1.3, 3.3.2, 4.2.1, and 4.2.2.b.)

the absence of the locomotive function, but this time Aristotle makes explicit use of the teleological principle that nature does nothing in vain. The argument runs as follows (*DA*.III.9, 432b22-26):

> εἰ οὖν ἡ φύσις μήτε ποιεῖ μάτην μηθὲν μήτε ἀπολείπει τι τῶν ἀναγκαίων, πλὴν ἐν τοῖς πηρώμασι καὶ ἐν τοῖς ἀτελέσιν τὰ δὲ τοιαῦτα τῶν ζώων τέλεια καὶ οὐ πηρώματά ἐστιν (σημεῖον δ' ὅτι ἐστὶ γεννητικὰ καὶ ἀκμὴν ἔχει καὶ φθίσιν) – ὥστ' εἶχεν ἂν καὶ τὰ ὀργανικὰ μέρη τῆς πορείας.
>
> "If nature does nothing in vain and never leaves out any of the necessary [parts], except in those beings that are maimed and incomplete, while such living beings are complete and not maimed (and a sign of this is that they are able to reproduce themselves and they have a peak and decline [of life]) – then they too would have instruments for locomotion."

The reasoning is that if the perceptive function is responsible for locomotion, and if this teleological principle holds, then living beings that have the perceptive function should also always have instruments for locomotion. As the latter is not the case (for there are some complete animal kinds that have perception but not locomotion), either the principle does not apply, or the perceptive function is not responsible for locomotion. Given that the principle applies for the most part, it is thus reasonable to suppose that the capacity for perception is cannot at the same time be the capacity for locomotion as well.

Thirdly, Aristotle considers the intellective or calculative capacity. However, this capacity cannot be the mover either, for the following reason (*DA*.III.9, 432b27-28):

> ὁ μὲν γὰρ θεωρητικὸς οὐθὲν θεωρεῖ πρακτόν, οὐδὲ λέγει περὶ φευκτοῦ καὶ διωκτοῦ οὐθέν
>
> "For the intellective capacity thinks of nothing practical and it says nothing about what is to be avoided and pursued."

This rules the intellective capacity out as a candidate, because it is concerned with abstractions, while according to Aristotle locomotion is concerned with the avoidance or pursuit of something.[168] Apparently, merely thinking about something that is to be avoided or pursued does not bring about the emotional state necessary

[168] Cf. *PA*.I.1, 641a32-b12, where Aristotle argues that the natural philosopher need not speak about all soul, but only about those that are a source of movement; because intellect (which in this context presumably means the intellective capacity) is not a source of movement, the natural philosopher does not need to speak about it. See Lennox (2001b), 143-145.

for the initiation of locomotion. Even if the intellect were to tell the animal to avoid or pursue something, the animal would not be moved; instead, the animal acts according to desire (*DA*.III.9, 433a1-3). Aristotle uses an analogy with the art of healing to point out that having the intellective capacity is not sufficient as a cause of locomotion, because there is a difference between having knowledge and acting according to that knowledge. On the other hand, desire on its own can also not be the faculty of locomotion: the case of continent people shows that although they may have the cravings and the desire for things, "they do not do those things for which they have a desire, but follow reason" (*DA*.III.9, 433a7-8: οὐ πράττουσιν ὧν ἔχουσι τὴν ὄρεξιν, ἀλλ' ἀκολουθοῦσι τῷ νῷ). Desire, as a single faculty, cannot account for locomotion. Consequently, Aristotle concludes that in order to be able to account for locomotion, the presence and collaboration of *two* capacities are necessary, the one intellective and the other non-intellective.

Having started thus from the assumptions that the function of locomotion is coexistent with both the locomotive parts and the functions of imagination and desire, and that nature does nothing in vain, Aristotle has provided sufficient proof of why the nutritive and perceptive faculties are not the causes of locomotion, and why the intellective and appetitive functions in isolation are also not capable of moving the animal. Accordingly, where *DA*.III.9 builds upon the assumption that locomotion is always 'with' imagination and desire, *DA*.III.10 opens with the preliminary conclusion[169] that imagination (given that imagination is some kind of thinking, and imagination is the only intellective capacity that human beings and animals have in common) and desire are the movers (*DA*.III.10, 433a10-11: Φαίνεται δέ γε δύο ταῦτα κινοῦντα, ἢ ὄρεξις ἢ νοῦς) or "the producers of movement in respect to place" (*DA*.III.10, 433a13: κινητικὰ κατὰ τόπον).

Aristotle stresses that the capacities of the practical intellect and desire are teleologically similar to each other (DA.III.10, 433a15-17): in contrast with the theoretical intellect that finds its end in its own activity, the practical intellect and desire are both directed towards an end. They are also teleologically interrelated, for the practical intellects starts from the object of desire, which is the end of the capacity of desire, and the end in the process of reasoning of the practical intellect,

[169] This is the force of *phainetai* in DA.III.10, 433a9; Ross (1961), 556.

results in action. The capacity of desire precedes and initiates the capacity of practical intellect: practical reason only moves human beings once desire has found an object of desire. The same teleological interrelation holds also between desire and imagination/thought in animals: locomotion is for the sake of moving towards an object that is the animal's object of desire; the object of desire initiates imagination which on its turn initiates locomotion. The true causes of locomotion are therefore desire and ultimately the object of desire[170] (*DA*.III.10, 433b10-13):

> εἴδει μὲν ἓν ἂν εἴη τὸ κινοῦν, τὸ ὀρεκτικόν, ᾗ ὀρεκτικόν—πρῶτον δὲ πάντων τὸ ὀρεκτόν· τοῦτο γὰρ κινεῖ οὐ κινούμενον, τῷ νοηθῆναι ἢ φαντασθῆναι—ἀριθμῷ δὲ πλείω τὰ κινοῦντα.
>
> "While generically the moving cause will be one, namely the capacity of desire, in so far as it desires, and first of all the object of desire, for that moves without being moved by being thought of or by being imagined, in number there is a plurality of movers."

In the remainder of *DA*.III.10, Aristotle addresses the question of how locomotion works, and explains that it basically involves three constituents (*DA*.III.10, 433b13-31).

The first constituent is the mover or the moving cause (*DA*.III.10, 433b13: ἓν μὲν τὸ κινοῦν). Aristotle explains that the moving cause is 'double': on the one hand there is the moving cause that is itself unmoved, on the other hand there is the moving cause that both moves and is moved (*DA*.III.10, 433b14-15: τὸ δὲ κινοῦν διττόν, τὸ μὲν ἀκίνητον, τὸ δὲ κινοῦν καὶ κινούμενον). The unmoved moving cause is the practical good, which is the object of desire, external to the animal that locomotes. The moved moving cause is the capacity of desire, a part of the soul internal to the locomotive animal. Thus, the practical good, without being moved itself, initiates movement in the capacity of desire; the capacity of desire is thereby itself moved, and on its turn moves the animal.

The second constituent is that with which the moving cause produces movement (*DA*.III.10, 433b14: δεύτερον δ' ᾧ κινεῖ). This instrument has already been established as belonging to the body (these 'bodily instruments' are the different body parts that different animals employ to effect movement, such as feet,

[170] This object of desire may be either the good or the apparent good (where good means the practical good, which is capable of being otherwise); *DA*.III.10, 433a28-31.

wings, and fins); for this reason "they must be investigated among the functions common to body and soul" (*DA*.III.10, 433b19-21: διὸ ἐν τοῖς κοινοῖς σώματος καὶ ψυχῆς ἔργοις θεωρητέον περὶ αὐτοῦ). The latter is presumably is a reference to treatise now known as *De Motu Animalium*. Here Aristotle just presents the headlines concerning the mechanisms that are operative in locomotion: instruments for locomotion are found at places in the body where the beginning and the end are the same (like in the case of ball-and-socket joints), and movement itself consists of pushing and pulling (*DA*.III.10, 433b25-26: πάντα γὰρ ὥσει καὶ ἕλξει κινεῖται).

The third and last constituent involved in locomotion is that which is moved (*DA*.III.10, 433b14: ἔτι τρίτον τὸ κινούμενον), the animal or human being endowed with the capacity of locomotion.

Again, the notion of goal-directedness plays a central role in this analysis of the constituents of locomotion. Aristotle starts by identifying the final cause(s) of locomotion, then moves to the bodily instruments conditionally necessary to effect the movement towards the end, and lastly identifies the kinds of subjects that are moved towards an end. For Aristotle, the goal-directedness is essential for a movement to be an instance of locomotion. Throughout both the analyses of the cause and constituents of locomotion, the underlying idea is that the actualization of the capacity of locomotion cannot just be the activity of locomotion (of moving in just any direction; Aristotle defines motion in general also as a end-directed process), but instead must be the activity of locomotion towards a particular end. This also seems to be the reason why the locomotive capacity does not turn out to be a different part of the soul, which is in charge of its own function (that is to say, the capacity of locomotion cannot be actualized by 'its' objects in the way that the passive capacity of hearing is actualized by something sounding). As Aristotle makes clear by way of a conclusion at the end of the chapter, the locomotive capacity is rather a capacity that is concomitant to the capacity of desire (*DA*.III.10, 433b27-28: "in so far as an animal is capable of desire, so far is it capable of moving itself"; ᾗ ὀρεκτικὸν τὸ ζῷον, ταύτῃ αὐτοῦ κινητικόν), with the restriction that in order for an animal to be capable of desire, it must be "with imagination" (*DA*.III.10, 433b28-29: ὀρεκτικὸν δὲ οὐκ ἄνευ φαντασίας), either of the intellective or of the perceptive type.

The distinction is made to include both animals and human beings. The capacity to locomote emerges as it were from the capacities of desire and of imagination.

The capacities of desire and imagination are intrinsically related to the capacity of locomotion, exactly in order to ensure the goal-directedness of the motion initiated in the animal. This becomes clear from *DA*.III.11, where Aristotle discusses the question of what the cause of movement is in the 'imperfect' animals that only have the perceptive capacity of touch, and of whether they can have imagination and appetite, too. Aristotle takes the question of whether or not these animals feel pain and pleasure to be the determinant of whether or not they have appetite; and it appears that they do indeed feel pain and pleasure. But because these animals only have imagination or appetite in a very rudimentary form,[171] their movements will be – not a case of locomotion, but – 'indeterminate' (*DA*.III.11, 434a4-5: κινεῖται ἀορίστως). This is because there will be no object of desire identifiable to the animal that will initiate the movement towards that object, and nothing to direct the movement of the animal towards that object by focusing the animal upon that object as something desirable.[172] Instead, the motions of these animals will be random (and accordingly, they will eat only when they happen to touch upon something edible): the capacity of desire is necessary for the identification of the goal of goal-directed locomotion, and the capacity of imagination is necessary to direct the capacity of desire towards that goal. Animals that do not have these capacities do not move at all. Animals that do have these capacities move towards a perceived object of desire, thought of as being good for the animal in question.

The model of locomotion that is presented in *DA* is thus intrinsically teleological: it takes the object of desire as the starting point of the explanation in the sense of a final cause, and the faculties of desire, imagination, and perhaps also perception as the origins of movement in the sense of efficient causes. It is significant that the notion of locomotion that Aristotle offers applies to both animals and human beings; locomotion arises from some kind of cognitive faculty, but not necessarily from a human one.

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[171] Cf. Schofield (1992), 272n.55.
[172] Frede (1992), 290; Richardson (1992), 384.

However, in *DA*.III.11, 434a12, while emphasizing that it is practical reason that is involved in locomotion, Aristotle also hints at a different kind of explanatory model of action, applying primarily to human beings. This is the model of what has come to be known as 'practical inferences' or 'practical syllogisms' (Aristotle himself does not use these terms).[173] Under this model, Aristotle presents explanations of actions in the form of a syllogism,[174] the conclusion of which is an action (ἡ πρᾶξις)[175] rather than a theoretical proposition (*MA*.7, 701a10-11: ἀλλ' ἐκεῖ μὲν θεώρημα τὸ τέλος). The purpose of these syllogisms is controversial,[176] and unfortunately to large and difficult a subject to do justice here. Let it suffice to say that, in my opinion, the syllogism is set out to elucidate the causal and conceptual relationships among desire, belief, and action.[177] It thus offers a reconstruction of the rational structure of actions taken; Aristotle does not imply that every practical action involves the actualization of a practical syllogism.[178] It also needs to be stressed that the difference between the two models is one of perspective only (the difference is between a realistic and a psychological perspective); they both imply the same underlying causal (i.e. teleological) structure.

Aristotle never develops a systematic discussion of practical inferences, so all we have are a few examples and some remarks about how the premises effect and explain motion or action.[179] According to these 'guidelines', the action is posited as the starting point or explanandum of the syllogism, and is therefore posited as the conclusion. The premises – either of the good or of the possible (*MA*.7, 701a23-25) – posit the preceding steps believed to be necessary for this action to come about

[173] Natali (2001), 61-67 an overview of the problems related to this notion.
[174] Presumably in the sense of a deductive reasoning process, rather than of 'syllogism' in a strict logical sense; on the meaning of the term *syllogismos*, see Barnes (1981), 21-27.
[175] See Charles (1984), 89-96 for the view that the conclusion of the practical syllogism is not an action, but *becomes* an action; the conclusion is a proposition, which – when accepted – by the activity of desire explains the action as an efficient cause.
[176] Natali (2001), 64; for different views, compare Charles (1984); Cooper (1975); Hardie (1968); and Nussbaum (1978).
[177] Nussbaum (1978), 189.
[178] Nor do I believe that Aristotle intends the practical syllogism to demonstrate some truth; pace Anagnostopoulos (1994), 74-75.
[179] See Santas (1969), 163-5 for examples.

right away (*MA*.7, 701a10). Accordingly, we may construct the following pattern underlying[180] the practical syllogism of action for human beings:

| | |
|---|---|
| Premise 1: | A human being desires a certain goal (and this goal is a good or an apparent good);[181] |
| Premise 2: | The human being reasons or calculates that if the goal is to be achieved, a certain action or certain actions will have to come about first; |
| Conclusion: | At once the human being performs the action or actions for the sake of achieving the goal (and consequently, the goal may be achieved, or not, and the goal may turn out to be an actual good for the human being, or not). |

According to this pattern, the explanatory middle term (found through deliberation) picks out the efficient causes (the actions) that are believed – at least for the most part – to bring about the desired goal most efficiently. Extra premises might be added to specify the goal in such a way that it becomes clearer how this goal could be achieved (i.e. such that it is easier to identify the efficient cause of the desired goal), and to direct the desire to a concrete situation. This specification involves either the recognition that a particular available thing (e.g. this slice of bread) belongs to the wider class of desired goods (e.g. dry foods; cf. *NE*.VII.3, 1147a1-9), or a more concrete description or partial definition of the desired good (e.g. being healthy) that focuses on an immediately practicable aspect of it (e.g. having one's body in a uniform state; cf. *Meta*.VII.7, 1032b6-10; b18-21). The conclusion consists of the performance of those actions believed to cause the achievement of the desired goal; the desired goal itself is not an intrinsic part of the conclusion, because the action performed may or may not actually lead to the achievement of that goal.

Animals lack practical reason, but are nevertheless capable of highly complex activities necessary for their nutrition, reproduction, and their survival in general. Because animals do not deliberate about which course of action would lead best to their desired goal (cf. *Ph*.II.8, 199a21-31), their perception of the goal and their focus on it through the use of the faculty of imagination immediately initiates

[180] The examples of practical syllogisms given by Aristotle come in many different forms; the pattern I offer is an attempt to cover for these cases in the most general way. For a recent discussion, to which my analysis is much indebted, see Natali (2001), 63-109.

[181] The question of whether an animal or human being desires some goal because it *perceives* it as something good, or because it is *objectively* good, will be addressed below.

the movement towards that goal. In addition, the desired goal is always something concrete in the direct vicinity or neighborhood of the animal, such that a further specification of the desired goal is not required.[182] The following two psychological stages need to be distinguished in an explanation of the action or locomotion of animals.

| | |
|---|---|
| Stage 1: | An animal desires a particular goal (and this goal is a good or an apparent good); |
| Stage 2: | An animal actively focuses on the desired goal through the capacity of imagination.[183] |

This psychological process will immediately issue the action or locomotion of the animal towards the desired goal.

The fact that Aristotle makes use of syllogisms to explain the actions and locomotions of humans does not imply that Aristotle envisages actions and locomotions to be scientifically demonstrable. The syllogisms are meant to illuminate the necessary psychological states involved in action and locomotion, and maybe to provide a rationale and justification to humans for their actions and locomotions by pointing out the main features of the practical reasoning involved. Moreover, in the case of human action, what is demonstrated seems to be the practicability of the achievement of a particular end, which is not the same as to provide a science of action.[184]

In sum, teleology lies at the heart of both models of locomotion set out or hinted at in *DA*.III.9-11. The goal of the capacity of locomotion is not just the activity of walking, but the activity of walking towards an object (e.g. food, an animal of the other sex with which to mate, a hiding place for predators), the achievement of which will result in the survival and well-being of the animal. Both the faculties of desire and of imagination or practical reasoning serve as sources for locomotion, although it is ultimately the faculty of desire whose objects set the faculty of imagination or practical reasoning in motion, which on their turn will set the organs of movement in motion.

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[182] Natali (2001), 78-79.
[183] For the argument that even the lower animals are able to have imagination in this way, see Hankinson (1990), 50-51.
[184] Natali (2001), 95-100.

*Appendix: Two types of teleological explanations of locomotion*

The explanation of locomotion by the use of the practical syllogisms raises two questions with regard to how precisely Aristotle perceives the nature of animal and human action and locomotion.[185] First, the syllogisms present the action taken as the *necessary* conclusion from the two premises that refer to a desire and a cognitive act; the causal sequence expressed is predominantly one of efficient causation. For example, it seems that once something is perceived as something good, locomotion towards this thing will occur straightaway, automatically, and even necessarily so. Secondly, the syllogisms are ambiguous with regard to the question whether causal priority should be attributed to the desire or to the object of desire that is some good or apparent good.[186] It is not clear whether the desire of a living being for an object *as good* is crucial to the account, or rather incidental to the having of a desire, which is always aimed at some good. The first question pertains to the issue of whether or not animals or humans can be viewed as self-movers in a true sense; the second question to issue of whether intentionality is a necessary part of the teleological account of action and locomotion.

These questions are only tangentially related to the main question of the role of teleology in Aristotle's analysis of the capacities of the soul, but I believe that they are nevertheless important both for our understanding of Aristotle's explanation of locomotion and for our understanding of Aristotle's use teleology as an explanatory principle in general. For one of the main problems I see in the existing scholarly literature on Aristotle's teleology is the tendency to unify the various uses of teleology in explanations under one common pattern, while in fact different types of teleological explanations explain different (aspects of) natural phenomena. As I will argue in this appendix, the complete phenomenon of locomotion can only be understood completely by considering both Aristotle's 'objective' teleological account, and his 'subjective' teleological account.

In *DA*.III.10, 433b28 Aristotle refers to animals as self-movers (αὐτοῦ κινητικόν), and thereby to locomotion as a form of self-movement that is distinct from other

[185] A third question pertaining to the relationship between practical syllogisms and Aristotle's theory of weakness of will or *akrasia* will not be addressed in this dissertation.
[186] See Richardson (1992), 381-2.

forms of movement that cannot be initiated by the mover himself. Aristotle's notion of self-motion has been the subject of much discussion,[187] and has implications not only for Aristotle's psychology and natural philosophy, but also for his ethics and metaphysics. This section focuses on the concept of self-motion only insofar as it is directly related to the issue of the nature of action and locomotion of humans and animals.

Let me first give a short description of the Aristotelian concept of self-motion. According to Aristotle, having a nature is not sufficient to qualify as a self-mover, even though all things that have a nature possess an internal source of change and rest. Aristotle confines the qualification of being a self-mover to things that have souls: to move oneself is a capacity of life (*Ph.*VIII.4, 255a5-10). Natural bodies have a capacity of being acted upon, rather than of causing movement or action themselves. Ensouled bodies, on the other hand, have both a 'part' that causes movement or action without itself being moved or acted upon (this to avoid an explanatory regress of these motions), and a 'part' that is moved or acted upon. The part that moves without being moved is of course the soul;[188] the part that is moved is the animal as a whole. In the case of animals and humans, there are in addition bodily parts by which the animal moves, which are the organs (instruments) of movement.

However, this is not the whole story. As Furley pointed out in his classic paper,[189] Aristotle seems to deny in some accounts (the crucial texts are *Ph.*VIII.2, 253a11-21; *Ph.*VIII.6, 259b1-16; and *MA.*6-8) that animals and humans can initiate motion completely by themselves. Instead, the self-movement of animals and human beings is ultimately dependent on and caused by an external, previous motion in the environment of the animal or human (Aristotle supposedly needs this modification in order to avoid the claim that motions can start *ex nihilo*). Now, if the actual cause of the movement of these beings lies in their environment and is outside of their control (cf. *Ph.*VIII.6, 259b6-8), to what extent can they still truly be called self-movers? Another, but related problem – already noted above with regard to the practical syllogism – arises from the causal determinism by efficient causes, which

[187] See most notably Gill & Lennox (1995).
[188] The only way in which the soul moves is in an incidental way as being part of the moving animal.
[189] Furley (1994).

seems to underlie Aristotle's explanation of self-movement. Locomotion can be explained (as, for example, in *DA*.III.10, 433a17-20) as a sequence of efficient causes. On this account, the object of desire is the first mover in the sequence of movers: the object of desire moves perception; perception moves the faculty of desire; desire moves the faculty of imagination; and imagination initiates the motion and rest of the living being as a whole. Once the goal of the movement has been identified, action seems to be reducible to mechanical movements.[190] The response to these problems will have important repercussions not only for the extent of the goal-directedness of actions and locomotions, but also for Aristotle's ethics. Only if human beings are self-movers in a genuine sense, they (or their character) can be held morally responsible for the actions they take.[191]

Various attempts have been made to 'rescue' the possibility of self-movement for ensouled beings within Aristotle's natural philosophy. Here I will limit my discussion to two types of accounts that pertain most to the question of the relation between locomotion and teleology.

On one type of account, the so called 'intentionality-escape',[192] Aristotle's teleological explanation of locomotion is read as involving a subjective or intentional type of teleology. Because the object of desire is an intentional object, and because an external object can only become an object of desire if it is perceived by the animal *as* something desirable or good, the source of motion can be said to be 'internal' to the animal. Furley, for example, holds that it is crucial for self-movers that objects in the external world are "perceived under certain descriptions."[193] Accordingly, actions can only be explained in terms of what the goal of action means for the living being in question. The importance of the faculty of imagination as a special kind of discriminative awareness in this process of perceiving something as good has been defended most extensively by Nussbaum.[194] In Nussbaum's view, what is central in the teleological explanation of locomotion is not just that animals tend to locomote towards goals that are a component of the definition of their substantial being, but

[190] Furley (1994), 8.
[191] Furley (1994), 10-12.
[192] Coined by Freeland (1995), 37.
[193] Furley (1994), 12.
[194] Nussbaum (1978), Essay 1, 85-88; Essay 5, 221-269.

that they tend to locomote towards goals that they perceive as their objects of desire. The intentionality and subjectivity of locomotion that are brought in through the faculty of imagination offer a solution to the determination-problem: it is the animal's beliefs and desires that ultimately determine whether or not locomotion takes place and that determine in which direction it will take place. In sum, it is not simply the perception of an object that automatically will initiate movement, but the perception of an object *as desirable* or *as good*.

Another type of account, presented by Freeland as the 'final cause escape',[195] focuses on the objectivity of the goal-directedness of animal locomotions. Freeland presents her 'final cause-escape' as a "unified model of Aristotle's teleology" designed to replace the 'intentionality escape' such as has been defended by Furley and Nussbaum.[196] The bottom-line of this defense is this. The real problem Aristotle faces concerns the compatibility of final causation and efficient causation. Now, what is crucial to self-motion according to Freeland is its goal-directedness, not the intentionality of animal perception or their desires (it is not their existence that is denied, but their centrality to the account of self-motion).[197] This goal-directedness is objective rather than subjective. The object of desire is not good or desirable because it is perceived as such, but because it is the good of the species to which the animal belongs. What is good for a particular species is grounded in the definition of the substantial being of that particular of species. Ultimately, Freeland hopes that under this model, explanations of why particular animals move can be subsumed under the general explanation of why all animals move. Rendered schematically, Freeland's teleological account of the locomotion of animals looks as follows:

> "Animal kind K has the capacity for locomotion for the sake of survival or living well = Animal kind K has the capacity for locomotion because locomotion promotes finding food, avoiding enemies, attracting and discovering mates, etc., and these are either necessary or improve the quality of life of animals of kind K."[198]

[195] Freeland (1995), 37.
[196] Freeland (1995), 37.
[197] Freeland (1995), 40-41; 51.
[198] Freeland (1995), 47; Freeland adapted the schema from Woodfield (1976).

In my view, both models are right (and wrong) in some sense, because they in fact *address different explananda.* As I will argue below, the intentionality-escape provides a better explanation of why animals actually locomote, while the final cause-escape provides a better explanation of why (some) animals have the capacity of locomotion.[199] This distinction also applies to the role of the notion of the good: whether or not the pursued good turns out to be an actual good or not, is incidental to the explanation of why this particular instance of locomotion took place; however, the existence of objective goods for each kind of animal outside the limits of their own body is crucial to the explanation of why there is such thing as locomotion.

Let me start with the final cause escape. I agree with Freeland that it is 'built into'[200] the nature of animals to pursue goals that are 'objectively good' for them. The substantial being of each particular species determines and limits, for instance, what kinds of food and what way of reproduction constitute the good for that particular species, and what kinds of foods, objects or animals in the environment constitute the bad for it. However, I do not think that it is ultimately the objective good that is crucial to Aristotle's account of locomotion, because it is not what initiates the movement of particular animals (nor what actualizes the capacity of locomotion). Freeland's teleological model of locomotion accounts perfectly for why animals in general locomote or why they have this capacity: locomotion is present in the animals that have it because it is for the better. Locomotion contributes to the function of nourishment and thus contributes significantly to the well-being of these animals. The presence of objective goods is basic to the explanation of why the capacity of locomotion is present in animals; and surely, locomotion takes place for the sake of acquiring these objective goods.

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[199] That this is Freeland's actual concern is clear in (1994), 47.

[200] I do not think that these goods are actually part of the definition of the substantial being of each kind of animal, but rather that these goods 'follow' from this definition, presumably through principles such as 'like by like'. For example, good foods are those things that are constituted from materials that more or less match the basic elemental make-up of animals and can therefore be processed by these animals, turned into blood, and used for the growth and maintenance of their body. Generally speaking, 'good animals' may be those that share the same substantial being, or are that have lifestyles and forms that are "not very distant" (cf. *PA*.I.4, 644b1-7) such that they can live peacefully and side-by-side.

When we try to account for this movement of this particular animal at this moment, on the other hand, Freeland's model falls short because it only applies to the most general level of explanation. This is problematic, because Aristotle shows much more interest in individual and particular motions than Freeland's model allows for. By reducing the actions of individual animals to the goal-directed actions of the species as a whole,[201] Freeland moves away from what is the most important explanandum, i.e. the particular instance of locomotion. If locomotion is to support the capacities of nourishment and reproduction, and, if, in addition, nourishment and reproduction serve primarily the individual animal (by letting it share in the eternity of form),[202] then Aristotle's account of locomotion must in the first place be concerned with the locomotions of individual animals.

Now, the fact that some pursued good is actually the objective good of that animal does not play a primary explanatory role in the explanation of why actual locomotions take place. This is to some extend visible in the way Aristotle talks about 'the good or the apparent good,' as for example in *DA*.II.10, 433a26-28 when Aristotle states that thought is always right, while desire and imagination may be either right or wrong. He concludes that (*DA*.II.10, 433a28-30):

> διὸ ἀεὶ κινεῖ μὲν τὸ ὀρεκτόν, ἀλλὰ τοῦτ' ἐστὶν ἢ τὸ ἀγαθὸν ἢ τὸ φαινόμενον ἀγαθόν· οὐ πᾶν δέ, ἀλλὰ τὸ πρακτὸν ἀγαθόν. πρακτὸν δ' ἐστὶ τὸ ἐνδεχόμενον καὶ ἄλλως ἔχειν.
>
> "Therefore, it is always the object of desire which produces movement, but this may either be the good or the apparent good; and not every [good], but the practical good. Practical is that which can also be otherwise."

In this account, Aristotle does not distinguish between the good and the apparent good: both are goals that impart movement.[203] In fact, on one occasion (i.e. in *Top.*VI.8, 146b36-147a11) Aristotle criticizes Platonists for not taking the apparent good into account in their explanation of ends. The reason why seems to be that

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[201] Freeland (1995), 48: "Actions of individual animals exemplify the goal-directedness belonging to the species as a whole: if a particular wolf chases a rabbit, it is because smelling and then chasing rabbits serves a good end for wolves – nourishment and survival."

[202] See the section above on the teleology of the capacities of the soul; cf. also Lennox (2001a), 134.

[203] *Ph.*II.3, 195a24-26 (= *Meta.*D.2, 1013b26-28): "That for the sake of which means that which is the best, that is the goal of the things that lead up to it. And it makes no difference whether we say the good or the apparent good." Cf. *MA*.6, 700b23-29

wishing and desiring are only explainable in intentional terms and not reducible to efficient causation (*Rhet.*I.10, 1369a2-4):[204]

> ἔστιν δ' ἡ μὲν βούλησις ἀγαθοῦ ὄρεξις (οὐδεὶς γὰρ βούλεται ἀλλ' ἢ ὅταν οἰηθῇ εἶναι ἀγαθόν).
>
> "Rational desire is wishing, and wishing is a desire for good – nobody wishes for anything unless he thinks it good."[205]

However, the main reason is that it is not the existence of, say, a banana in that tree that sets this monkey in motion (even though that banana fulfills the requirements of what constitutes an objective good for monkeys), but the perception of that object as being something (namely, a banana) that looks like the objective good of the monkey-species. The occurrence of locomotion requires the perception of a particular object being the good sought for to actually initiate desire. It are the animal's beliefs or interpretations of an object (rudimentary and wrong as they may be) that 'turn' the perceived object into a goal properly speaking. In addition, it is only in virtue of the animal's perception of something as good and turning it into a final cause that this object is an efficient cause of locomotion.[206] Not all objects in the vicinity of an animal initiate movement, even if they are all objectively speaking good for that animal. The animal's perceptive and imaginative capacities single out one thing (a process that will be constrained or even guided[207] by what constitutes the objective good of the animal) which will become object of desire and thereby the final cause of locomotion if and only if that object is perceived as good. The external objects need to be identified as means to realize the internal and objective goal, and this is where intentionality comes in. Intentionality is necessary for the perception of external objects as goals or ends, and this is what actualizes the capacity of

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[204] Cf. Charles (1988), 1-2: "Desire's directedness on to the good explains the nature of these inferential connexions in practical reasoning in a way not available if one restricts oneself solely to necessitating efficient connexions between the relevant physical, or psychological, states."; and ibidem, 39-40. For the claim that psychological states cannot be reduced to physical states in Aristotle, see Charles (1984), 227-242.

[205] On the good and the apparent good, see also *Rhet.*I.10, 1369b18, *Meta.*XII.7, 1072a27-28 and *EN.*III.4, 1113a15-b1.

[206] See Judson, (1994), 165: "Note also that in this type of case, there is a sense in which the object of desire is a final cause primarily, and an efficient cause only in virtue of being a final one. This is because it can only act as an efficient cause in the way it does (that is, by being perceived to be good) if it also acts as a final cause; whereas it could in principle act as a final cause in the way it does (by being the object of a desire) without being the efficient cause of the desire."

[207] The intentional character of the faculty of imagination is reflected well in the use of the verb *stochazesthai* in *HA.*V.8, 542a30-2 to describe the teleological orientation of animal mating; see Richardson (1992), 385.

locomotion from within and what is thus crucial for animals to be genuine self-movers.[208] Intentionality here cannot be seen independently from the internal goal-directedness of living beings.[209]

In sum, a complete teleological account of the locomotion of a particular animal includes the following two complementary explanations:

1) Particular kinds of animals locomote towards an object, because its capacity to locomote is given with the kind of soul it has and because the object constitutes the objective good of this kind of animal, this actualizes the capacity into the activity of locomotion. (Locomotive animals have the capacity of walking because it contributes to the nutritive function, which on its turn is necessary for the animal's survival and reproduction.)

2) This individual animal moves towards an object *now*, because this animal perceives this particular object as something that fulfills the requirements of constituting what is objectively good for it. Because the object is perceived as a good, it consequently becomes the object of desire, which initiates the locomotion towards the object through desire and the imagination.

To conclude, the intentionality escape is more crucial because without intentional states of animals no objects could ever be 'identified' as the goods of those animals, and the capacity of locomotion could never be realized. Because in Aristotle's biology animals do not have capacities that they cannot use, the subjective good is more fundamental than the objective good, and hence the subjective teleological account of locomotion is more fundamental than the objective one. Both explanations need to be given, however, in order for the phenomenon of locomotion to be understood.

## 2.3 Conclusion

Following the didactic order of the natural treatises of Aristotle, we have shifted from Aristotle's defense of the teleology of nature in the *Physica* to Aristotle's teleological analysis of *living* nature in *De Anima*, where life is identified with the

[208] Cf. Freeland's views on this point; Freeland (1995), 51.
[209] Cf. Richardson (1992), 394.

possession of soul. The teleological framework that is set out in the *Physica* as an argument to the best explanation of natural phenomena seems to be presupposed in the explanatory strategies of *De Anima*: in order to gain knowledge about the soul, its nature and attributes, Aristotle analyzes it in terms of his theory of four causes; in order to gain better understanding of its operation on and interaction with the body, Aristotle analyzes it in terms of his analogy between nature and art.

From the very outset, Aristotle's analysis of the soul is teleological in nature: the soul is not itself for the sake of something, but rather is that for the sake of which the bodily aspects of the living being are as its instruments. The soul constitutes a unity of capacities for the performance of functions in virtue of which a natural body that is instrumental has life; the complete body with its parts and features is conditionally necessitated by (and therefore explainable by reference to) these life-functions. The realization of functions in these bodies is not compositionally plastic, but is highly determined by factors such as the functional needs of an animal in light of the environment in which it lives, the elemental build-up of the animal, and also by the general goal-directedness and 'economy' of nature. Functions are realized in the best way possible for each individual kind of animal by conditional necessity, and all the life-functions or capacities of the soul together constitute the living being's form and being: body and soul are for Aristotle both causally and essentially connected to each other. Therefore, natural philosophers need to take matter into account when giving explanatory definitions of natural bodies.

In his discussions, Aristotle's bases his arguments upon the teleology of nature in order to consolidate his bio-functional account of the soul. In this way, Aristotle lays out the foundations for his explanatory project in the biological works: by identifying soul with life, it becomes possible to explain various basic forms of life (such as plants, animals, and human beings) by reference to different combinations of interdependent soul-functions, and to explain specific forms of life (such as birds or even crooked-taloned birds) by reference to specific combinations of soul-functions. The classification and hierarchy of capacities or life-functions Aristotle offers help thus first of all to single out 'kinds of animals' sharing a distinctive way of performing some or all of these necessary life-functions, and

secondly to ground the teleological explanations relating differences in parts and features to differences in life-functions. The relevant type of soul serves, among others, as the final cause that explains why a living being has the features it has; while *De Anima* provides – among other things – these final causes, the goal of the other biological works is to provide the explanations for why certain functions belong to the kinds of living beings they do.

The different capacities of the soul are themselves teleologically grounded as well: their presence is necessary given that the living being has to live or live well. In addition, Aristotle offers a specification of the causal framework underlying the teleological model of deliberate action, used in the *Physica* for didactic purposes. This specification is embedded in an analysis of locomotion, which is the goal-directed movement towards an object of desire, caused by this object of desire as a final cause, and the faculties of desire, imagination, and perception as efficient causes. Crucial in these accounts of locomotion and deliberate action is the recognition that these actions themselves are due to objective teleology, that is, they belong to the animals that have these capacities for the sake of the survival and well-being of these animals, while in the explanation of particular locomotions and actions the intentions of the individual animal are causally primary and thus occur due to subjective teleology. Animals and human beings are self-movers, and they move themselves in virtue of perceiving something *as* good.

On Aristotle's account, the soul is the ontological starting point of life, but also the epistemological starting point of the teleological explanation of life-forms. The teleological explanations Aristotle offers in the biological works, which will be the subject of the next chapter, build upon the foundations offered in the *De Anima*.

## CHAPTER THREE:

## EXPLAINING PARTS OF ANIMALS

## THE PRACTICE OF TELEOLOGICAL EXPLANATIONS IN ARISTOTLE'S BIOLOGY

### 3.0 Introduction

This chapter investigates Aristotle's use of teleology as a principle of explanation in his biological treatises. Although the argument will mainly focus on explanations in *De Partibus Animalium* (*PA*), explanations from other biological treatises are also considered where appropriate or necessary.

As has been pointed out in chapters one and two, Aristotle's theory of natural teleology applies in particular to phenomena in the realm of living natural substances, that is, to their existence and coming to be, to their change and development, and to their differentiations. Biological phenomena, like all other natural phenomena, therefore can and must be explained in terms of teleology as an internal tendency of nature. In *PA*, Aristotle attempts specifically to answer the question why certain parts come to be and are present, absent, or differentiated in the way they are in all and only those animals that have those parts. As may be expected, Aristotle answers these questions primarily by reference to teleological factors (both final causes and teleological principles).

For the understanding of Aristotle's use of teleology in biology, it will in the first place be crucial to make a distinction between 'necessary functions' and 'non-necessary functions' on the one hand, and between explanations of the presence of parts and differentiations and of their coming to be on the other hand. For, although Aristotle generally accounts for the *presence* of parts and their differentiations by reference to their function, the explanation of the *coming to be* of those parts and their differentiations will be dependent on the 'status' of their function. Let me give a very rough indication here of what I believe these distinctions amount to. First, the necessary functions are those life-functions that are necessary for the survival and the essential being of each kind of animal, and that are as such part of the form or essence or definition of the substantial being of the animal. Broadly speaking, the *presence* of the necessary parts and of necessary

differentiations will be explained by reference to those vital and essential functions; their *coming to be* will be explained by reference to conditional necessity: given that the animal has to realize its form, it has to have such and such parts, and such and such differentiations of parts. Secondly, there are also parts that are not necessary for the performance of necessary functions, but that rather contribute to these functions. Aristotle explains their presence also by reference to the vital and essential functions to the performance of which they contribute, while he explains their coming to be as being secondary (i.e. dependent upon and later in generation) to that of the necessary parts. Thirdly, the non-necessary functions are those life-functions that are not necessary for a kind of animal in terms of its survival or essential being, but are 'merely' for the better; these functions are not part of the form or essence of the animal. Aristotle refers to non-necessary functions to explain the *presence* of non-necessary parts, while he explains their coming to be by reference to material necessity: because the materials that have come to be by material necessity have certain potentials, they may then be used for the sake of something. The overall framework of explanation will turn out to be a little more complicated than this, but let this suffice by way of introduction.

In the second place, concerning Aristotle's use of teleological principles, I will argue that they are used, not as (extra) premises in the explanation, but rather in order to provide a framework within which the explanation can take place: these teleological explanations hold if and only if nature is truly goal-directed and works within the 'natural boundaries' that are posited.

In the third place, contrary to much recent scholarship on Aristotle, I take the material constraints and the influence of material necessity on the goal-directed actions of the formal nature of an animal to be relatively strong. Animals are what they are *also* and *strongly so* because of the material and their potentials that are available to them during the process of generation and their later life. This is not a negative claim: the goal-directed actions of the formal nature of an animal often (although not always) turn to a good use those materials that have come to be due to material necessity, and thereby equip living beings with features that are perhaps not immediately necessary for its survival, but contribute to its well-being.

In the next four sections, I will argue for these three claims more extensively. In section one (3.1), I introduce the larger scientific context within which Aristotle's use of teleological explanations takes place. I sketch the demonstrative character of biology as a science, and outline Aristotle's specific explanatory project in *PA*, while focusing in particular on his methodology and heuristic strategies. The general picture of Aristotle's explanatory project that follows from these considerations will be elaborated upon in the subsequent sections.

In section two (3.2), I will discuss the three basic types of explanations and their main subdivisions that Aristotle employs in his *PA*. These three basic types of explanations are categorized on the basis of which kind of cause – i.e. formal, material, or final – Aristotle picks out first *in the order of explanation* (that is, the cause picked out first has explanatory priority, but not necessarily also causal priority). Since for Aristotle knowledge involves knowledge of all four causes, his explanations of biological phenomena often pick out more than one cause; the categorization reflects the order of explanatory priority among different causes in different kinds of explanations of biological phenomena. In the analysis of these types of explanations, I will devote special attention to the issue of causal priority versus explanatory or epistemological priority, since the kind of cause that is picked out first is not necessarily causally basic, and vice versa.

In section three (3.3), I discuss three types of teleological principles that are used in Aristotle's biology, and argue for their scientific status as suppositions or hypotheses. I will also show how they are used as a framework for explanation especially in those cases where the final cause cannot immediately be grasped by observation or where a non-necessary function is involved. It is thus my contention that teleological principles are used as heuristics in those cases where teleology is not readily discernable.

In section four (3.4), I discuss the relation between teleology and four different types of necessity (conditional necessity, unqualified necessity, material necessity or natural necessity, and enforced necessity). First, I will analyze passages in the Aristotelian corpus in which Aristotle discusses the relation between teleology and necessity on a theoretical level; *PA*.I.1 will thereby serve as a point of reference. Contrary to what has been often argued, I will show that Aristotle does not deny any

causal role for material necessity in the sublunary realm, but instead attributes unqualified necessity in a *modal* sense to all eternal and cyclical processes. Cyclical natural processes such as the evaporation cycle, for instance, come to be always, without exception, while rectilinear natural processes such as the generation of offspring come to be only for the most part. Secondly, I will lay out the different ways in which Aristotle speaks of necessity in his actual explanations of biological phenomena (in *PA*.II-IV). In addition, I offer a more elaborate picture of the interplay between teleology and necessity in those explanations Aristotle offers in those books, which will complement and exemplify the general framework of types of explanations set out in the earlier sections.

## 3.1 Aristotle's biological method

### *3.1.1 Biology as a demonstrative science*

The relation between Aristotle's theory of scientific demonstration and inquiry as outlined in the *APo.* and his practice in the physical and biological works has been the subject of much discussion in recent years among scholars of Aristotle,[1] and I do not wish to elaborate too much on this issue yet (this will be discussed in chapter five). Instead, I would like to draw attention to two observations from the biological works that indicate to my mind quite clearly that Aristotle himself envisioned applying the demonstrative ideal on the study of living beings. These observations pertain in the first place to Aristotle's concern for following the appropriate methodology, and secondly to his concern for providing demonstrations in biology. Based on these observations, and on the fruits of recent scholarship on Aristotle,[2] I

[1] See among others Barnes (1981); Gotthelf (1987); Kullmann (1990); Lennox (2001a); Lloyd (1990; 1996).

[2] See in particular Gotthelf (1987) and Lennox (1987; 2001a; 2001b; 2004; 2006). Contrary to Gotthelf and Lennox who focus on the similarities between Aristotle's theory of science and his practice, and argue that the two domains are more or less in agreement, Lloyd (1990; especially 29-34) argues that the differences between Aristotle's theory and practice are far more predominant, and denies the applicability of the theory of *APo.* to the biology. My reasons for following the approach of Gotthelf and Lennox, rather than Lloyd's, are twofold. First, I believe a positive approach to the issue to be both more charitable and more fruitful: the purpose is *not* to unify Aristotle's theory and practice as far as possible against all evidence (Detel (1997), for instance, goes in my opinion too far in trying to put explanations taken from Aristotle's practice into syllogistic form), but to use the theoretical framework from *APo.* to make sense of Aristotle's actual scientific practice, and vice versa. Secondly, I do not believe that Aristotle's theory of science as set out in *APo.* is as formal and rigid as Lloyd makes us think (see chapter five for a more flexible and comprehensive interpretation of the theory of scientific demonstration in

will rely on the working hypothesis that Aristotle's biological works are presented as a science that in many ways conforms to the 'guidelines' of the *APo.*

Aristotle's concern for setting out the right methodology to be followed in biological investigations is clear from the whole of the first book of *PA*, which is devoted to the solution of methodological dilemmas pertaining to natural science (*PA*.I.1, 640a2: *phusikê epistêmê*), of which the study of animals is part.[3] In this book, Aristotle aims at providing standards from which one will be able to judge the 'manner of the things brought to light' (τὸν τρόπον τῶν δεικνυμένων) in the natural sciences (*PA*.I.1, 639a12-15). Aristotle provides such standards by addressing a wide range of topics, such as the different kinds of causes referred to in biological explanations and the priority relations that hold among them (Aristotle argues for the priority of teleology over necessity, but without denying explanatory force to the latter); the relation between form and matter in animals (Aristotle explains that the two are complementary, and that therefore both need to be studied by the biologist); and the place of soul in the study of nature (Aristotle explains that the capacity of thinking does not belong to the study of nature). Aristotle also offers a revision of the Platonic method of division and definition. This latter critique of dichotomous division leads among other things to the establishment of what exactly constitutes an animal kind: animal kinds share a commonness of nature, and a 'form that is not too distant' (*PA*.I.4, 644b3). That is, animals that belong to one kind are different only in degree ('by the more and less' or 'by bodily affections'), while animals that differ in kind are similar to each other only by analogy (*PA*.I.4, 644a16-22; 644b12).

However, the most striking feature of this first book of *PA* is that in it Aristotle not only follows but also seems to enrich and to complement the *Analytics'* conception of science in order to make it applicable to the special and distinct study of living beings. As Lennox has pointed out on several occasions,[4] the *Analytics* are devoid of the matter and form distinction and also of the concept of conditional

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*APo.*), nor that Aristotle was not aware of the differences between demonstration in the theoretical sciences and the natural ones. The methodological remarks Aristotle makes in, for instance, *PA*.I.1 show this awareness, and – pace Lloyd – demonstrate that Aristotle was consciously revising the scientific ideal as presented in *APo.* to make it fit to the natural sciences in which a different type of necessity applies and in which the order of a causal sequence matters for the structure of the explanation.

[3] For an outline of the first book of *PA* and for the connections of the methodological issues discussed with the *APo.*, see Lennox (2001a), 100-104.

[4] Lennox (2001a), xxii, 102, and passim.

necessity. Both are crucial to the study of (living) nature and are therefore introduced – consistently with and with reference to the concepts and distinctions that are used in the *Analytics* – in the first book of *PA*. This, I believe, gives evidence for that the fact that Aristotle self-consciously attempts to integrate these notions into the scientific framework supplied by the *Analytics*.

Aristotle's concern for providing demonstrations in the case of biological phenomena is visible in a few (but very well known) methodological statements in the biological works.[5] The clearest and least controversial text concerning the demonstrative nature of biology is stated in *HA*. I.6, 491a7-13:

> Ταῦτα μὲν οὖν τοῦτον τὸν τρόπον εἴρηται νῦν ὡς ἐν τύπῳ, γεύματος χάριν περὶ ὅσων καὶ ὅσα θεωρητέον· δι'ἀκριβείας δ' ὕστερον ἐροῦμεν, ἵνα πρῶτον τὰς ὑπαρχούσας διαφορὰς καὶ τὰ συρβεβηκότα πᾶσι λαμβάνωμεν. Μετὰ δὲ τοῦτο τὰς αἰτίας τούτων πειρατέον εὑρεῖν. Οὕτω γὰρ κατὰ φύσιν ἐστὶ ποιεῖσθαι τὴν μέθοδον, ὑπαρχούσης τῆς ἱστορίας τῆς περὶ ἕκαστον· περὶ ὧν τε γὰρ καὶ ἐξ ὧν εἶναι δεῖ τὴν ἀπόδειξιν, ἐκ τούτων γίνεται φανερόν.
>
> "These things, then, have been put forward in a general way, as a kind of foretaste of the things that we have to investigate and what is about them [that we have to investigate]. Later we shall discuss these matters in greater detail, in order that we may first gain understanding of the differences and the attributes belonging to all. After this we shall try to discover the causal explanations. For it is the natural method to do this after having started with the investigation of the details concerning each thing; for from these it becomes apparent both about which things the *demonstration* must be, and through what things it must proceed."[6]

The zoological research program sketched in this passage starts with a 'factual' investigation (reflected in *HA*). This investigation consists of assembling the basic facts to be explained, and is mainly carried out through (Aristotelian) divisions of the differences between animals. Aristotle thus first establishes a complete overview of the biological diversity, concerning in the first place the attributes and differences of animals (the *differentiae* are differences with respect to the animals' modes of life, their activities, their characters, and their parts), and in the second place the kinds and classes and groupings of animals that exist. Within the *HA*, Aristotle discusses these

[5] In this section I draw heavily on Lennox (2004 and 2006).
[6] Cf. *PA*.I.1, 639a12-15; *PA*. I.1, 640a1-9; *GA*. II.6, 742b23-36.

features and differences in correlation to the animals that have them. For example, in the following text Aristotle discusses similarities and differences between animals concerning the possession of hair (*HA* II.1 498b16-18):

> Πάντα δ' ὅσα τετράποδα καὶ ζῳοτόκα, δασέα ὡς εἰπεῖν ἐστι, καὶ οὐχ ὥσπερ ὁ ἄνθρωπος ὀλιγότριχον καὶ μικρότριχον πλὴν τῆς κεφαλῆς, τὴν δὲ κεφαλὴν δασύτατον τῶν ζώων.
>
> "All viviparous quadrupeds are hair-covered, so to speak, and they are not like man who is sparsely haired and short-haired except on the head; with regard to the head he is the hairiest among animals."

The two correlations that are noted in this section concern 'hairiness' and 'being a viviparous quadruped', and 'having a head with (relatively) the most hair of all animals' and 'being a human being'. Conform the demonstrative ideal as set out in *APo.*, Aristotle collects in *HA* the facts or items in the world of biology that always or for the most part go together, and thus form possible candidates for being picked out as either the predicate or as the subject terms in explanations (which in addition pick out the cause why these biological phenomena always or for the most part go together). These facts or items are the 'about which' of demonstrations. In the above quoted example, 'having a heavy haired head' will be picked out by the predicate term in an explanation, and 'being a human being' will be picked out by the subject term. The explanatory middle term will have to pick out a feature that holds of all human beings, and one that correlates exclusively with the amount of hair and the location of the growth of hair.

Ultimately, Aristotle also hopes that because of this investigation we will be in a better position to single out those features and differentiae that are causally primary from the ones that will have to be explained through these causally primary features and differentiae. The investigation of the *HA* is intended to lead up to the identification of those features and differentiae that will be the 'through which' demonstrations come about; Aristotle thinks that through investigating and describing all the relations and correlations between biological phenomena, we will ultimately discover the causes of those phenomena. The factual investigation is thus a preliminary to the next, demonstrative stage. In this second stage, Aristotle proceeds to the identification of causes (predominantly material and final causes in

*PA* and efficient causes in *GA*),[7] and discusses the ways in which these causes explain why an animal has the features and differentiae it has, and why those features and differentiae are present in all and only those animals that have them. Thus, in the *PA*, Aristotle picks up on the correlations and co-extensive features already collected and organized systematically in his 'big book of data' (i.e. *HA*), and tries to provide an explanation (*PA*.II.1, 646a8-11):

> Ἐκ τίνων μὲν οὖν μορίων καὶ πόσων συνέστηκεν ἕκαστον τῶν ζῴων, ἐν ταῖς ἱστορίαις ταῖς περὶ αὐτῶν δεδήλωται σαφέστερον· δι' ἃς δ' αἰτίας ἕκαστον τοῦτον ἔχει τὸν τρόπον, ἐπισκεπτέον νῦν, χωρίσαντας καθ' αὑτὰ τῶν ἐν ταῖς ἱστορίαις εἰρημένων.
>
> "From which parts and from how many parts each of the animals is constituted has been exhibited more clearly in the inquiries about them; it must now be examined through which causes each animal has this character, by separating [those causes] to stand on their own from what was said in those inquiries."[8]

This is precisely what Aristotle does in the subsequent chapters. For instance, in *PA*.II.14, 658b2-10 Aristotle returns to the observation of human beings having the most hairy head of all animals, and provides a dual explanation:

> Τὴν δὲ κεφαλὴν ἄνθρωπός ἐστι τῶν ζῴων δασύτατον, ἐξ ἀνάγκης μὲν διὰ τὴν ὑγρότητα τοῦ ἐγκεφάλου καὶ διὰ τὰς ῥαφάς (ὅπου γὰρ ὑγρὸν καὶ θερμὸν πλεῖστον, ἐνταῦθ' ἀναγκαῖον πλείστην εἶναι τὴν ἔκφυσιν), ἕνεκεν δὲ βοηθείας, ὅπως σκεπάζωσι φυλάττουσαι τὰς ὑπερβολὰς τοῦ τε ψύχους καὶ τῆς ἀλέας. Πλεῖστος δ' ὢν καὶ ὑγρότατος ὁ τῶν ἀνθρώπων ἐγκέφαλος πλείστης καὶ τῆς φυλακῆς δεῖται· τὸ γὰρ ὑγρότατον καὶ ζεῖ καὶ ψύχεται μάλιστα, τὸ δ' ἐναντίως ἔχον ἀπαθέστερόν ἐστιν.
>
> "With respect to the head, human beings are the most hairy of animals, from necessity, on account of the moistness of the brain and on account of the sutures (for where there is much moisture and heat there must be much growth), and for the sake of protection, so that it may provide covering, warding off the extremes of both cold and heat. And since the human brain is the most moist, it is also most in need of this protection; for what is moist boils and freezes most easily, while what is in the opposite state is less easily affected."

The observation of two correlations may have led to the discovery of the cause of why human beings have the most hairy head of all animals. On the one hand, the

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[7] *GA*.I.1, 715a1-17.

[8] Cf. *IA*.I.1, 740b7-10: "Clearly there needs to be study of all these questions about animal locomotion and any others of the same kind; for that these things are so is clear from our inquiries into nature; the reason why must now be investigated."

amount of moistness present in a body part seems to correlate with the amount of the growth of hair: the more moistness, the more hair there is, and due to presence of the brain in the human head, it is this place that is the moistest. On the other hand, the amount of protection needed correlates with the amount of protection provided by nature: due to the moistness the human head is in a lot of need of protection, and hence nature has provided it with a lot of hair for the sake of this (the causal mechanism underlying this explanation is conditional necessity; I will return to the structure of explanations like these below). Both the moistness and the need of protection are more present in the head of human beings than they are in other animals: this explains why human beings have more hair on their heads than any other animal.

Aristotle acknowledges that the demonstrations in the natural sciences will be different from those in the theoretical sciences.[9] The conclusions of biological demonstrations do not hold always, nor of necessity in the strict sense; they rather hold 'for the most part' (*epi to polu*), and the demonstrations as a whole incorporate a kind of necessity that is conditional upon the end for the sake of which the animal or its features come to be. The structure of demonstrations in the natural sciences will be discussed more extensively in chapter five, but for now, it may suffice to point out that Aristotle is at least trying to follow and adapt the demonstrative ideal of science as set out in his *APo.* In the next sections, I will therefore work from the hypothesis (formulated and defended most prominently by Lennox)[10] that Aristotle's philosophy of biology specifies and builds upon the ideal of the *APo.* Hence I will employ the conceptual framework of the *Analytics* as a tool to analyze and evaluate Aristotle's use of teleology within this 'scientific' biological context.

### *3.1.2 A preliminary picture of Aristotle's explanatory project in PA*

In the course of setting out the methodology of natural investigations, Aristotle also provides standards for how to construe explanations or demonstrations of biological phenomena. Here I will give a schematic characterization of Aristotle's explanatory project as a whole, and a crude sketch of the types of explanations introduced in

[9] See especially *PA*.I.1, 640a1-9; *PA*.I.1, 640a33-b3; *PA*.I.1, 642a32-b2; see also chapter 5.
[10] E.g. in Lennox (2001a), 104.

*PA*.I. In each case, I will also outline the way Aristotle applies these explanations in the practice of explaining animal parts in *PA*.II-IV. In the course of doing so, I will introduce and explain the following key notions: nature (formal nature vs. material nature), animal parts (necessary parts vs. non-necessary parts), teleology (primary teleology vs. secondary teleology), teleological explanations (explanations through final causes vs. explanations through teleological principles), and necessity (material necessity vs. conditional necessity). The distinctions I draw within these notions are not all made this explicitly by Aristotle himself, but they will help me to clarify the various explanatory strategies Aristotle employs in his biological works. The preliminary picture that will thus arise in this section of Aristotle's explanatory project in *PA* will be discussed in more detail in the sections to come.

Let me start by quoting an image that Aristotle draws of the 'economical' workings of nature in the production of parts. This image illustrates two aspects that I believe are crucial for the understanding of Aristotle's explanatory project in the biological works (*GA*.II.6, 744b11-27):

> Τῶν δ' ἄλλων γίγνεται μορίων ἕκαστον ἐκ τῆς τροφῆς, τὰ μὲν τιμιώτατα καὶ μετειληφότα τῆς κυριωτάτης ἀρχῆς ἐκ τῆς πεπεμμένης καὶ καθαρωτάτης καὶ πρώτης τροφῆς, τὰ δ' ἀναγκαῖα μόρια καὶ τούτων ἕνεκεν ἐκ τῆς χείρονος καὶ τῶν ὑπολειμμάτων καὶ περιττωμάτων. ὥσπερ γὰρ οἰκονόμος ἀγαθὸς καὶ ἡ φύσις οὐθὲν ἀποβάλλειν εἴωθεν ἐξ ὧν ἔστι ποιῆσαί τι χρηστόν. ἐν δὲ ταῖς οἰκονομίαις τῆς γιγνομένης τροφῆς ἡ μὲν βελτίστη τέτακται τοῖς ἐλευθέροις, ἡ δὲ χείρων καὶ τὸ περίττωμα ταύτης <τοῖς> οἰκέταις, τὰ δὲ χείριστα καὶ τοῖς συντρεφομένοις διδόασι ζῴοις. καθάπερ οὖν εἰς τὴν αὔξησιν ὁ †θύραθεν ταῦτα ποιεῖ νοῦς οὕτως ἐν τοῖς γιγνομένοις αὐτοῖς ἡ φύσις ἐκ μὲν τῆς καθαρωτάτης ὕλης σάρκας καὶ τῶν ἄλλων αἰσθητηρίων τὰ σώματα συνίστησιν, ἐκ δὲ τῶν περιττωμάτων ὀστᾶ καὶ νεῦρα καὶ τρίχας, ἔτι δ' ὄνυχας καὶ ὁπλὰς καὶ πάντα τὰ τοιαῦτα· διὸ τελευταῖα ταῦτα λαμβάνει τὴν σύστασιν ὅταν ἤδη γίγνηται περίττωμα τῆς φύσεως.
>
> "Each of the other [i.e. necessary parts, with the exception of the eye that has been discussed previously in *GA*.II.6, 743b32-744b11] parts is formed out of the nutriment, (1) the parts that are the noblest and that partake in the most important principle [i.e. the essence of the animal; cf. *GA*.II.6, 742b32] are formed from the nutriment which is concocted first and purest; (2) those parts which are only necessary for the sake of the former parts are formed from the inferior nutriment

> and the residues and leftovers. For just like a good housekeeper, so also nature is not in the habit of throwing away anything from which it is possible to make anything useful. Now in a household (a) the best part of the food that comes in is set apart for the free people, (b) the inferior and the residue [of the best food] for the slaves, and (c), the worst is given to the animals that live with them. Just as the intellect acts thus from outside with a view to the growth of the persons concerned, so nature forms (1) from the purest material the flesh and the body of the other sense-organs, and (2a) from the residues thereof bones, sinews, hair; and in addition, (2b) also nails and hoofs and the like; for this reason these are the last to assume their formation, for they have to wait till the time when nature has some residue to spare."

What is crucial in this image for the understanding of Aristotle explanatory project in the biological works is first the description of nature as a good housekeeper, who produces the different parts from the kinds of material available. This image is representative of the way Aristotle picks out nature in his explanations: nature is always personified as an agent, and portrayed as acting for the sake of something, while following a certain *logos* or formula. Lennox descibes this as the 'formal nature' of an animal:[11] the formal nature of an animal acts as a goal-directed agent according to the animal's form.[12] The concept of formal nature thus incorporates nature as an efficient, final, and formal cause. In this way, formal nature also coincides with soul (*PA*.I.1, 641a23-28): [13]

> καὶ τί ἐστιν ἡ ψυχή, ἢ αὐτὸ τοῦτο τὸ μόριον, καὶ περὶ τῶν συμβεβηκότων κατὰ τὴν τοιαύτην αὐτῆς οὐσίαν, ἄλλως τε καὶ τῆς φύσεως διχῶς λεγομένης καὶ οὔσης τῆς μὲν ὡς ὕλης τῆς δ' ὡς οὐσίας. Καὶ ἔστιν αὕτη καὶ ὡς ἡ κινοῦσα καὶ ὡς τὸ τέλος. Τοιοῦτον δὲ τοῦ ζώου ἤτοι πᾶσα ἡ ψυχὴ ἢ μέρος τι αὐτῆς.
>
> "And [the natural philosopher will state] what the soul, or what that very part of it is, and speak about the attributes it has in virtue of the sort of substantial being it is, especially since the nature of something is spoken of and is in two ways: as matter and as substantial being. And nature as substantial being is both nature as mover and nature as end. And it is the soul – either all of it or some part of it – that is such in the animal's case."

[11] Lennox (2001a), 183.
[12] *PA*.I.1, 641b23-37.
[13] *DA*.II.1, 412a19-21; cf. Lennox (2001a), 185.

We saw in chapter two that the soul of an animal, in the sense of its formal cause, is the complex of capacities for the performance of life-functions (such as the nutritive, the appetitive, the sensory, the locomotive functions), but that it was also identified as the efficient and final cause of the living body.[14] Through the soul an animal possesses the internal source of motion necessary to realize its own internal form that is also soul, and thereby reach its goal, which is to be a living and well-functioning animal. Contrasted with this formal nature is the animal's 'material nature': this is the animal's body with its uniform and non-uniform parts, but it also comprises the animal's basic elemental make-up, and the kinds and amounts of food it can process. In the generation of living beings, these 'two natures' are in constant interaction. In most cases the formal nature will – by conditional necessity – be responsible for the production of the materials that are to be used for the formation of parts (here, the actions of the formal nature are limited by the possibilities inherent in the material nature of the animal). However, given that these processes of part-formation 'directed' by the formal nature take place, necessarily there will also be some leftovers or some materials coming to be due to material necessity. These materials may then be used by the formal nature for the sake of the good: "because as a good housekeeper, she is not in the habit of throwing things away which might be usable." This may involve some regulating and structuring activities of the formal nature, but sometimes it just means allowing parts to come to be by material necessity alone because that will serve some good, as for instance in the case of eyebrows and eyelashes (*PA*.II.15, 658b14-25):

> Αἱ δ' ὀφρύες καὶ αἱ βλεφαρίδες ἀμφότεραι βοηθείας χάριν εἰσίν (...). αἱ δὲ βλεφαρίδες ἐπὶ πέρατι φλεβίων· ᾗ γὰρ τὸ δέρμα περαίνει, καὶ τὰ φλέβια πέρας ἔχει τοῦ μήκους. Ὥστ' ἀναγκαῖον διὰ τὴν ἀπιοῦσαν ἰκμάδα σωματικὴν οὖσαν, ἂν μή τι τῆς φύσεως ἔργον ἐμποδίσῃ πρὸς ἄλλην χρῆσιν, καὶ διὰ τὴν τοιαύτην αἰτίαν ἐξ ἀνάγκης ἐν τοῖς τόποις τούτοις γίνεσθαι τρίχας.
>
> "The eyebrows and eyelashes are both for the sake of protection. (...) The eyelids are at the ends of small blood vessels; for where the skin terminates, the small blood vessels also reach their limit. So because the moist secretions oozing are bodily, it is necessary that – unless some function of nature stops it with a view to another use

[14] *DA*.II.1-4.

> – even owing to a cause such as this, hair from necessity comes to be in these locations."[15]

Aristotle's explanations will reflect the interactions and the causal interrelations between these two natures.[16]

The second significant aspect of the imagery of the household involves the 'hierarchical relations' between parts that Aristotle sketches, reflecting to a large extent the order in which they come to be.[17] Roughly speaking, the more necessary a part will be for the animal as a whole and for the process of generation, the earlier it will be produced in the development of the embryo, and the finer the material will be from which it will be produced.

First, there are parts which (as Aristotle calls it) 'partake' in the essence of an animal: these are produced first (starting with the heart[18] and the bloodvessels out of which all the other parts are formed, first the internal, then the external parts; first the upper, then the lower parts) and are made from the best materials available.

Secondly, there are parts that contribute to the essential parts, as slaves do to the free people: these are produced only after the first ones have come to be, and are made from the next best materials available or from the immediate leftovers from the first category of parts (cf. *GA*.II.6, 742b5-8: "all those parts which are for

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[15] Lennox translates the section concerning the action of the formal nature in Lennox (2001b), 42 as "unless some function of nature redirects it to another use" and concludes in (2001a), 192 that the necessity involved must be conditional. However, the Greek shows that nature is not doing anything yet, but may intervene to *stop* the flow with a view to another use; this suggests the operation of secondary teleology and material necessity. Cf. the actions of the formal nature in *GA*.I.8, 718b16-28 and *GA*.I.11, 719a14-15, where they consist in not hindering the processes that take place of material necessity.

[16] See e.g. *PA*.III.2, 663b22-24: "We must say what the character of the necessary nature is, and, how nature according to the account has made use of things present of necessity for the sake of something." (πῶς δὲ τῆς ἀναγκαίας φύσεως ἐχούσης τοῖς ὑπάρχουσιν ἐξ ἀνάγκης ἡ κατὰ τὸν λόγον φύσις ἕνεκά του κατακέχρηται, λέγωμεν).

[17] The whole of *GA*.II.6 is devoted to a discussion of the order of the generation of parts, differentiating between ends which have to be realized first (i.e. the parts that contain a source of movement and that partake of the essence), and which later (i.e. the parts that are for the sake of the latter); cf. *GA*.II.6, 742a18-19: τῶν γὰρ μορίων ὥσπερ καὶ ἐπὶ τῶν ἄλλων πέφυκεν ἕτερον ἑτέρου πρότερον ("it is with the parts as with other things: one naturally exists prior to another") and *GA*.II.6, 742b10-12: καίτοι κατὰ ταύτην τὴν μέθοδον δεῖ ζητεῖν τί γίγνεται μετὰ τί· τὸ γὰρ τέλος ἐνίων μὲν ὕστερον ἐνίων δὲ πρότερον ("and yet it is in accordance with this method that we must inquire what comes into being after what: for the end is later than some parts and earlier than others"). Aristotle also discusses the exceptions to these rules, such as the development of the eye, which comes to completion relatively late (*GA*.II.6, 743b33-744b10).

[18] On the primacy of the heart, see Lloyd (1987), 58. Cf. *PA*.III.666a18-21: "That it appears to be this way not only accords with our account, but with perception as well; for of the parts in the embryos, the heart is straight away manifestly in motion, as if it were an animal – like an origin of nature in the blooded animals."

the sake of something else but are not of the nature of beginnings must come into being later").

The fact that Aristotle also mentions a third category of beings to be fed in a household, suggests that there is also a third category of parts, which could perhaps be categorized as a subcategory of the second category. This third category consists of those parts that are neither included in the essence of an animal, nor contribute immediatly to the parts that are included in the essence of an animal. Rather, they make some other kind of contribution, or are just present without doing any harm, just as the animals do within a household, and they are made from a second group of leftovers, corresponding to the worst of foods that is given to the animals. I submit that parts like nails and hoofs belong to this third category.

This hierarchy of parts is intimately connected to a corresponding typology of explanations. The basic picture, which I will elaborate below, is the following:

The first stage of animal generation (i.e. of the growth of the embryo) pertains to the necessary parts: the parts that partake in the form of the animal come to be first. The presence of these parts is explained by reference to primary teleology, and their coming to be by reference to conditional necessity. Because necessary parts are those parts whose function is included in the definition of the substantial being of the animal (i.e. the essence of each animal comprises the necessary functions to be realized), their presence can be accounted for as the realizations of those functions. The formal nature of the animal is also responsible for the coming to be of the materials used for the formation of the part, for the type of necessity involved in the coming to be of these parts is conditional. If this part is to come to be and to perform this function (and this part necessarily *has* to come to be, given the substantial being of the animal), then these materials have to be produced first; and the formal nature always uses the best material. Because the function is part of the form of the animal, and because the function is in that sense causally and chronologically prior to the generation of the part, I call the type of teleology involved 'primary teleology'.

The second stage of animal generation pertains to non-necessary, subsidiary parts. The presence of these parts is also explained by reference to primary teleology,

but only on a secondary level. Subsidiary parts are parts that are not necessary for the performance of a necessary function, but that contribute to the necessary functions performed by other, necessary parts. It is only on account of the presence of those necessary parts that perform necessary functions, that the presence of the subsidiary parts is a good for the animal. Because the function these parts perform is included in the definition of the substantial being of the animal and is thus prior to the coming to be of the part, the teleology involved is primary. The necessity involved in the coming to be of the subsidiary parts is again conditional, but conditional on two levels. If the necessary part that performs a necessary function is present (i.e. has already come to be in the development of the embryo), and if the performance of this function can be enhanced by the presence of another, subsidiary part, certain materials will have to be present for the formation of the subsidiary parts. The formal nature of the animal uses the next best material available or producible, which is sometimes identified as the seminal residue (cf. *GA*.II.6, 744b29-30: ἐκ τῆς σπερματικῆς περιττώσεως).

The third and last stage of animal generation pertains to non-necessary, mostly 'luxurious'[19] or 'tool-like' parts. The presence of these parts is explained by reference to secondary teleology, while their coming to be is due to material necessity. These parts are not necessary for the being or survival of the animal, nor are their functions included in the definition of the substantial being of the animal.[20] Rather, the formal nature of an animal produces these parts because there is still some material left over in the form of residues, and this material has the right potentials to be used for something that contributes to the well-being of the animal, without being necessary for it.

The residues that are used for these parts are the leftovers from "the nutriment that is taken in later and that is concerned with growth, which is acquired from the mother and from the outer world" (*GA*.II.6, 745a3: ἐκ τῆς ἐπικτήτου τροφῆς καὶ τῆς αὐξητικῆς, ἥν τε παρὰ τοῦ θήλεος ἐπικτᾶται καὶ [τῆς] θύραθεν). This also explains why the growth of these parts often continues throughout the life of

[19] Note that Sorabji (1980, 157-158) uses the term 'luxurious' with regard to all non-necessary parts, while I use it in a more restricted manner to refer only to those non-necessary parts whose presence is not conditionally necessitated and that do not contribute to a necessary function.
[20] Cf. *GA*.V.1, 778a29-35.

the animal. This category of parts mainly consists of parts that are used for the sake of defense and protection, such as for example horns and spurs.[21] Note that these parts are always uniform parts, and that they are not complex enough to perform complex functions. Aristotle calls them tool-like: they have to be moved 'from the outside' and therefore are only produced in animals that are able to use them (cf. *PA*.III.1, 661b28-30). In most of these cases, material necessity is responsible for the coming to be of the constitutive materials of these parts, and sometimes also for their coming to be as such, while the formal nature is responsible for their function and presence: following the material potentials available, the formal nature puts the material to some good use. The explanation of the presence of these parts is teleological in Aristotle's view,[22] but it is not so without qualification: the formal nature of the animal attributes a function to a part or to a flow of material, but only *after* this part or material has already come to be.[23] The coming to be of the part is not conditional upon the function the part ultimately performs; instead, the function is secondary to the coming to be of the part and imposed on it by the formal nature. The formal nature is the cause of the part's presence, and of its structure, location, and function. The teleology involved is thus secondary teleology. If the material available cannot be put to any good use, the formal nature expels it from the animal's body.

The examples of explanations that Aristotle offers in *PA*.I, which are supposed to set the standards for biological investigations, are directly connected with these three general scenario's.

The first type of explanation that Aristotle mentions explicitly is the type of explanation that proceeds through an essence that comprises functions (*PA*.I.1, 639b13-19):

> Φαίνεται δὲ πρώτη, ἣν λέγομεν ἕνεκά τινος· λόγος γὰρ οὗτος, ἀρχὴ δ' ὁ λόγος ὁμοίως ἔν τε τοῖς κατὰ τέχνην καὶ ἐν τοῖς φύσει συνεστηκόσιν. Ἡ γὰρ τῇ διανοίᾳ ἢ τῇ αἰσθήσει

[21] In Aristotle's biology 'defense' is a luxury-function: given that species are eternal and that nature, as a good housekeeper, provides food for each kind of animal, there is no 'struggle for existence' and thus no 'vital' need for ways of protection.
[22] See *PA*.II.9, 655b15-20: here Aristotle emphasizes that also in the case of non-necessary parts it is necessary to know them from their functions and thus to provide teleological explanations for them.
[23] Cf. also *Mete*.IV.12, 390b2-9, where Aristotle explains how uniform parts such as flesh, bone, hair, and sinew can come to be by heat and coldness alone, whereas non-uniform parts can only be produced by 'art'.

> ὁρισάμενος ὁ μὲν ἰατρὸς τὴν ὑγίειαν, ὁ δ' οἰκοδόμος τὴν οἰκίαν, ἀποδιδόασι τοὺς λόγους καὶ τὰς αἰτίας οὗ ποιοῦσιν ἑκάστου, καὶ διότι ποιητέον οὕτως.
>
> "Now it is apparent that the first [explanation][24] is the one we describe as being for the sake of something. For that is an account, and an account is a principle alike in things that are composed according to art and in those composed by nature. For after having defined by thought or perception – the physician [having defined] health, and the house-builder [having defined] the house – they [i.e. the physician and the house-builder] provide the accounts and the explanations of that which each of them produces, and the reason why they have to be produced in that way."

These lines are usually taken as a defense of the priority of final causality over efficient causality,[25] but I believe that the argument rather applies to the priority of teleological *explanation* over efficient cause explanations. However, the explanans in the examples of explanations Aristotle offers is not a goal or function as such (which one would expect in the case of a teleological explanation), but, in the case of art, a functionally defined essence. In the case of nature, it is an essence that may or may not comprise functions. In either case, the final cause – if there is one – is as it were subsumed under a formal cause. The house-builder provides an explanation of the house he builds (namely of why he builds it and why he builds it in the way he does) by defining the house: what is produced and the way it is produced are explained by reference to the definition of the end product that contains the function of that product (i.e. 'shelter'). This defining account of an end product[26] in art translates for natural cases into the definition of the substantial being of something, which contains among others references to the functions to be realized.[27] The definition of health as, for instance, the not floating of food at the entrance of the stomach, points to the necessary condition to be realized if the physician is to make someone healthy and explains his actions. Aristotle's argument is that, because definitions are primary, so too are explanations that proceed through such definitions. A few lines

[24] Here the term '*aitia*' cannot be translated with 'cause', for the final cause is not itself for the sake of something, rather the type of causation picked out by a teleological explanation is.
[25] E.g. in Lennox (2001b), 124-126.
[26] Cf. *Ph.*II.9, 200a14: "necessity is in the matter, while that for the sake of which is in the definition (*logos*)."
[27] Cf. *GA.*I.1, 715a4-6: "There are four causes underlying [everything]: namely, that for the sake of which as an end, and the definition of the substantial being – and these two we may regard pretty much as one and the same; (…)."

later, Aristotle explains how such an explanation would work in the natural sciences (*PA*.I.1, 640a33-35):

> Διὸ μάλιστα μὲν λεκτέον ὡς ἐπειδὴ τοῦτ' ἦν τὸ ἀνθρώπῳ εἶναι, διὰ τοῦτο ταῦτ' ἔχει· οὐ γὰρ ἐνδέχεται εἶναι ἄνευ τῶν μορίων τούτων.
>
> "Therefore one should state in particular that since that is what it is to be a human being, on account of that it has these things: for it is not possible to be without those parts."[28]

In cases like this one, the definition of the substantial being of human being provides the explanans for the presence of certain parts: if a human being is to be what he is, then he cannot be without certain parts; therefore these parts are present in human beings. I take it that for Aristotle, all and only those parts whose functions are included in the definition of the substantial being of the animal can and will be explained in this way. These are parts whose presence is, as we stated above, (immediately) necessary for the animal: they are either of vital or of essential importance to the animal (without them, the animal could not survive or would not be the animal it is). This category of features comprises features that are actually given in the definition of the substantial being of the animal (e.g. wings and being blooded are *kath'hauta* features of birds; *PA*.IV.12, 693ab10-14), as well as features that follow directly from the features that are part of the definition (e.g. being two-footed is a *kath'hauta sumbebêkos* feature of birds; *PA*.IV.12, 693ab5).[29]

In the example Aristotle provides, the explanation takes the definition of the substantial being of man as a starting point, and deduces from there a man's essential features, such as for example being blooded or having a heart, lungs, and two feet. All these features are according to Aristotle part of the substantial being of man,[30] and are necessary for his being and existence. What in effect is being explained is why one of the necessary conditions of some animal being the kind of animal it is (namely that it has certain parts) is such a necessary condition (e.g. in the case of man, what is explained is that he is essentially two-footed). For this reason, I will refer to this type of explanations as formal cause explanations (rather than as teleological explanations, which I reserve for explanations that pick out final causes

[28] Cf. *PA*.I.1, 641ab23-25.
[29] Code (1997), 139.
[30] Cf. the examples of parts and features that belong to the substantial being of animals in Gotthelf (1987), 190-191.

or functions directly): they establish what being a certain kind of animal is. Once it has been established what parts are necessary for a certain kind of being (or, in other words, what functions necessarily have to be realized given the substantial being of an animal), the presence of such parts can be explained by reference to primary teleology and their coming to be can be explained by reference to conditional necessity.[31]

Aristotle offers two alternatives if this type of explanation does not apply (*PA*.I.1, 640a35-b4):

> Εἰ δὲ μή, ὅτι ἐγγύτατα τούτου, καὶ ἢ ὅλως (ὅτι ἀδύνατον ἄλλως) ἢ καλῶς γε οὕτως. Ταῦτα δ' ἕπεται. Ἐπεὶ δ' ἐστὶ τοιοῦτον, τὴν γένεσιν ὠδὶ καὶ τοιαύτην συμβαίνειν ἀναγκαῖον. Διὸ γίνεται πρῶτον τῶν μορίων τόδε, εἶτα τόδε. Καὶ τοῦτον δὴ τὸν τρόπον ὁμοίως ἐπὶ πάντων τῶν φύσει συνισταμένων.
>
> "If one cannot say this, one should say the nearest thing, namely that it is thus either in general (because it cannot be otherwise), or that it is in a good way thus. And these things follow. And since it is such, its generation necessarily happens in this way and is such as it is. This is why this one of the parts comes to be first, then that one. And similarly in this way with regard to all the things that are constituted by nature."

Again, Aristotle's words are elliptical here, but I take it that in cases where (i.) the function the part will perform is not part of the definition of the substantial being of the animal; and (ii.) the part is not necessary for the being or survival of the animal, the explanations (as presented in *PA*.I.1, 640a35-b1), the explanations will have to refer to material necessity and/or the good, where the good indicates secondary or subsidiary teleological relations.[32] As Aristotle points out, the types of explanations

[31] This explains why Aristotle's predecessors did not arrive at providing explanations in terms of forms and functions for biological phenomena "because there was no 'what it is to be' and no 'defining of the substantial being" (*PA*.I.1, 642a25-26: ὅτι τὸ τί ἦν εἶναι καὶ τὸ ὁρίσασθαι τὴν οὐσίαν οὐκ ἦν); they lacked a proper starting point from which to determine functional parts and a means to connect them with the essential being of an animal.

[32] I take the necessity and the good mentioned in these explanations to refer to the cause of the coming to be and/or the presence of parts in an animal, and not to the relation between the part and the animal as such. The latter interpretation is defended by Code (1997), 139-42. Code distinguishes the following three groupings of parts: (i) parts that follow from the definition of the animal; (ii) parts that are necessary, but do not follow from the definition; (iii) parts that are not necessary, but are present in the animal because it is good. Under this scheme, the second category only comprises parts like the spleen (in fact, it is the only part Code mentions as an example), which seems a bit of a stretch to me. The spleen is an exceptional case in Aristotle's biology (the spleen does not have a proper function, and its presence rather derives from a symmetry-principle; *PA*.III.6, 669b25-31 – the necessity involved in the coming to be is material,

offered as an alternative correspond to different stages in the order of generation. The parts whose functions are part of the essence of an animal are first in the order of generation; the parts that contribute to the performance of necessary functions, or whose functions are not necessary, are second in order of generation. We have already discussed some of the possible patterns of explanation here, pertaining to either non-necessary, subsidiary parts, which are explained by reference to primary teleology and conditional necessity on a secondary level, or to non-necessary, luxurious parts, which are explained by reference to secondary teleology and material necessity. In each case, the explanation pertains to non-necessary parts,[33] and the 'good' they contribute to the overall functioning or well-being of the animal forms an important part of the explanation.

However, the reference to material necessity also suggests another pattern of explanation – a pattern in which teleology is completely absent. This type of explanation pertains to some residues or parts like the spleen,[34] which do not perform any function of their own, nor contribute to the performance of the function of another part. Their coming to be and presence is explained fully in terms of material necessity, that is, of material elements acting according to their natures; the material structures are not expelled by the body because they do no harm, or because perhaps at some point they might be usable for some other good. Parts like these are not included in the definition of the substantial being of the animal, but rather follow from the animal's material nature: given the elemental make-up of an animal and the kinds and amounts of food it can process, the presence of these material structures necessarily follows (or "cannot be otherwise"). The phrase "and these things follow" in *PA*.I.1, 640b2 is so elliptical that it is hard to make sense of.[35] Perhaps it just means that the latter kind of parts (that is, those parts whose presence and coming to be are explained by reference to material necessity and/or the good,

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the necessity involved between the part and the animal that has is accidental; *PA*.III.7, 670a31-32), and it is odd that Aristotle would refer to such exceptional cases in laying out the larger explanatory framework for his biological investigations. I also disagree with Gotthelf (1987), 189, who takes the second category of parts to refer to the case in which a part is "necessary given an essential function because it makes some necessary contribution to the performance of that function." For Aristotle contributions are never necessary; if they were, parts who contribute to the performance of necessary functions could never be absent, and observation shows that they sometimes are (*GA*.I.4, 717a11-21); moreover, Aristotle explicitly states with regard to parts like these that they are not present of necessity (*PA*.III.7, 670b23-27).

[33] Pace Balme (1972), 87 and Gotthelf (1987), 189.

[34] For the spleen, see *PA*.III.7, 669b27-670a30.

[35] See Lennox (2001b), 135 for an overview of possible interpretations offered by scholars of Aristotle.

but are not included in the definition of the substantial being of the animal), comes to be after the first kind of (necessary) parts and 'follow' in a temporal sense. This reading is consistent with Aristotle's focus on the order of generation in the next few lines: because the animal's nature is the way it is, its generation necessarily takes place in the way it does – some parts (i.e. the ones that are necessary) come to be first, others (i.e. the ones that are non-necessary) next.

The importance of providing both teleological explanations and explanations that refer to necessity for natural phenomena is emphasized several times in the first book of the *PA*.[36]

In general, the final causes referred to in the teleological explanations in *PA* will be the functions performed by the animal's parts. In the case of primary teleology, "the parts will be for the sake of the functions in relation to which each of them has naturally developed (*PA*.I.5, 645b18-20)." In the case of secondary teleology, the parts will be present for the sake of the function to which the formal nature has put it, while it will have come to be as a result of material necessity.

Functions are not only invoked to explain the presence of parts, but also to explain their differentiations. As will become clear, Aristotle uses references to functions to explain why a certain part is materially, structurally, or topographically differentiated the way it is in this particular kind of being, relative to other parts with the same name and approximately the same function in other living beings. Roughly speaking, if the differentiation is necessary, its presence will be explained by reference to primary teleology, while its coming to be will be explained by reference to conditional necessity. If the differentiation is not necessary, but 'merely' for the better, its presence will be explained by reference to secondary teleology, and its coming to be by reference to material necessity.

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[36] In *PA*.I.1, 642a1-15, Aristotle recapitulates that there are two types of explanations or causes (i.e. teleology and necessity), explains the type of necessity that predominates in things that partake of generation (i.e. conditional necessity), and urges the natural philosopher to state both kinds of explanations, or "at least try to state both." In *PA*.I.1, 642a32-b2, Aristotle integrates teleological explanations with explanations referring to material necessity in his explanation of breathing, and claims that this is the way in which one should explain or demonstrate things (*PA*.I.1, 642a32: Δεικτέον δ' οὕτως). In *PA*.I.5, 645a22-25 argues for the pervasiveness of teleology in the works of nature, and introduces the good as that for the sake of which eahc animals has come to be. In *PA*.I.5, 645b15-36, Aristotle discusses a variety of teleological relationships between body and soul, parts and functions, and different activities, but also indicates that "there are things that are necessarily present because others are" (*PA*.I.5, 645b32-b33: ὧν ὄντων ἀναγκαῖον ὑπάρχειν).

In the practice of explaining biological phenomena, Aristotle also employs another type of teleological explanation that does not refer to final causes as such, but rather relies on general principles of teleology. These principles entail generalizations over the goal-directed actions of formal natures, explicating what they 'always' or 'never' do when they are said to produce living beings and their parts. They also indicate the scope of nature's goal-directedness. As I will show below, these principles function as limits: they provide a framework (established inductively through observation) within which the explanation of a particular phenomenon must take place. These two 'kinds' of teleological explanations will be analyzed and assessed in separate sections.

### *3.1.3 General outline of Aristotle's methodology in PA*

Before turning to an analysis of the actual explanations Aristotle offers in *PA*.II-IV, a few more words need to be said about the methods Aristotle follows in order to arrive at these explanations.

One important characteristic of *PA* that one should be aware of from the outset is that, although *PA* is part of Aristotle's investigation of animals, its main focus is not on animals as such, but – as the title suggests – on their parts. This focus on parts guides both the overall-organization of *PA*, and the organization of the explanations offered with regard to each part. The explanatory project in the *PA* is not concerned with gaining knowledge about say, a chicken and its nature, parts, and affections; hence we will not find an unified entry on chickens or other animals in the *PA*, nor will we get a complete picture of all the different animals that were known to Aristotle. Rather, Aristotle is trying to gain understanding about parts and their interrelationships. *PA* thus does contain an entry on, say, beaks (*PA*.III.1, 662a34-b17). He wants to know which animals have a beak; and why all and only those animals have it (and why they have a beak, and not a mouth with teeth, and lips etc.); and why those animals who have a beak have the kind of beak they have (that is, why the beak is differentiated the way it is in different animals that have it). Again, Aristotle will not enumerate all the different kinds of animals that have beaks, but rather name the (clusters of) differentiae with which the having of beaks for the most part correlates. Because Aristotle leaves the extension of the correlation open,

this may prompt the question why some animals are lacking a certain part when its presence could reasonably be expected based on the presence of the other differentiae with which that part for the most part correlates. Individual animal kinds are only singled out in the discussion when a part is differentiated in this animal kind in a way that is distinctively different from its realization in other animals or because it has other anomalous features (note that there are relatively few animal species that are named in *PA*).[37]

This does not mean that the animals to which the parts belong are unimportant: parts are only truly (and not merely homonymously) parts when they belong to a living being and when they are able to act and function for the sake of that living being. The being and presence of parts is dependent on the being of the animal as a whole, and the presence of parts is therefore explained first and foremost in terms of the functional contribution it makes to the animal as a whole. In sum, the various animal parts form the starting points for the investigation conducted in *PA*, while the identification of the animal kinds to which those parts belong is the starting point of the explanation, but is only on a secondary level important for the organization of *PA*.

The extent to which Aristotle focuses on parts within *PA* will easily be illustrated by a brief outline of *PA*.II-IV. We will see two principles of organization at work: first, following the teleological hierarchy between parts, Aristotle discusses – part by part – first the uniform parts, and next the non-uniform parts. Secondly, the discussion of the non-uniform parts takes human physiology as a starting point, and works from top to bottom: separating the blooded animals from the bloodless, Aristotle first covers all the parts located on the head, next the parts located around the heart, and finally the limbs.

The organization of *PA*.II-IV runs as follows. Aristotle opens the second book of the *PA* with an elaborate and general discussion of the *uniform* parts (*PA*.II.1-9), focusing on their teleological relationships to other parts, their distinctions (into soft and moist, and dry and solid parts), their role in the animal's body, and their influence on the animal's character. He then moves on to a

[37] For instance, the Indian ass and the Oryx are singled out for having only one horn, while the majority of animals have two (*PA*.III.2, 663a21-23). Cf. Balme (1987), 9 and 88 on the famous case of the mole.

discussion of the *external, non-uniform* parts. First (in *PA*.II.10-III.2), Aristotle discusses the non-uniform parts that are located on the *head* of blooded animals, such as the organs of sense perception, kinds of eye-protection (eyelids, eyelashes, and eyebrows), and the mouth. Next (in *PA*.III.3-VI.4), moving down from the neck, Aristotle turns to a discussion of all the *internal, non-uniform* parts located around the *heart*, such as the viscera, heart and blood-vessels, lungs, and liver. At this point, Aristotle moves to a discussion of the *external and internal non-uniform* parts of *bloodless* animals (mainly the crustaceans and insects; *PA*.VI.5-9), limiting his discussion to the things that are different in the bloodless animals in comparison to the blooded animals. Having discussed the bloodless animals, Aristotle returns to his discussion of the *remaining external, non-uniform parts* of blooded animals (*PA*.VI.9-13). Here Aristotle's organization of his discussion of parts is more intrinsically connected to the kinds of animals that have those parts: he first discusses the parts left unexplained in the live-bearing animals, then in the egg-laying animals, and finally in birds and fish. Aristotle ends his explanation of parts by a brief discussion of animals that dualize between two natures, such as dolphins, whales, seals, bats, and the Libyan ostrich (*PA*.IV.13-14). In conclusion, Aristotle sums up the general aims of his investigation in *PA* and refers forward to the *De Generatione Animalium* (*PA*.IV.14, 697b26-29):

> Περὶ μὲν οὖν μορίων, διὰ τίν' αἰτίαν ἕκαστόν ἐστιν ἐν τοῖς ζῴοις, εἴρηται περὶ πάντων τῶν ζῴων καθ' ἕκαστον. Τούτων δὲ διωρισμένων ἐφεξῆς ἐστι τὰ περὶ τὰς γενέσεις αὐτῶν διελθεῖν.
>
> "About the parts, then, the cause owing to which each is present in the animals has been stated, of each of the animals in turn; these things having been determined, the next step is to go through the facts about their generation."

Within this larger organizational structure, the method Aristotle employs to arrive at explanations of particular parts of animals runs – schematically, and in a somewhat generalized form – as follows:[38]

1. Take part P;
2. Find the widest kind of subjects ($S_{1\text{-}n}$) to which P belongs;

[38] For explicit statements about Aristotle's explanatory projects, see *PA*.II.1, 646a8-12; *PA*.II.3, 650b8-12; *PA*.II.5, 651b18-19; *PA*.II.6, 652a20-23; *PA*.II.7, 653b9-18; *PA*.III.4, 667b12-14; *PA*.III.10, 673a32-b4; *PA*.IV.14, 697b27-30; all but a few of these references are taken from Lennox (2001a), 5.

3. Explain why P belongs to each S that has P, by identifying the cause for the presence of P in S;
4. (Explain why P is absent in those animals in which the presence of P could be expected;)
5. Take the differentiations of P (ΔP);
6. Find the widest kind of subjects ($S_{1-n}$) to which ΔP belongs;
7. Explain why P is differentiated the way it is in each S that has P, by identifying the cause for the differentiation of P (ΔP).

By way of illustrating this somewhat abstracted 'seven-step method', I will briefly go through Aristotle's discussion of the lung. The discussion of the lung takes place in the context of the larger discussion of the viscera, which Aristotle starts in *PA*.III.4, 665a27-31:

> Καὶ περὶ μὲν αὐχένος τε καὶ οἰσοφάγου καὶ ἀρτηρίας εἴρηται, ἑπόμενον δ' ἐστὶ περὶ σπλάγχνων εἰπεῖν. Ταῦτα δ' ἐστὶν ἴδια τῶν ἐναίμων, καὶ τοῖς μὲν ἅπανθ' ὑπάρχει, τοῖς δ' οὐχ ὑπάρχει. Τῶν δ' ἀναίμων οὐδὲν ἔχει σπλάγχνον.
>
> "Having spoken about the neck, esophagus, and windpipe, the next things to speak about are the viscera. These are distinctive to the blooded animals, and while all the viscera are present in some of them, in others they are not. None of the blooded animals has a visceral part."

Aristotle works his way down from the parts related to the head and the neck, to the parts that are near the heart; the parts that come up next in following this route over the human body are the viscera. Thus having introduced the parts that will be explained now, Aristotle first identifies the animals to which the viscera belong: these are the blooded animals. Note that Aristotle does not enumerate all the different kinds of animals that have viscera, but instead picks out a differentia shared by all and only those animals that have viscera (the widest kinds of subject of the explanation are, as it were, differentia-bearers rather than 'cats' or 'dogs'). In this case, he correlating differentia is being blooded; none of the bloodless animals has viscera, because, as Aristotle later explains, they do not have blood, which is the constitutive material of the viscera. Before explaining the presence of the individual viscera in the blooded animals, Aristotle mentions that the viscera are different in different animals (*PA*.III.4, 665b1-9), thus introducing a discussion of why the viscera are differentiated the way they are in the animals that have them. Then

Aristotle moves on to a discussion of the presence (*PA*.III.4, 665b10-11) and differentiation of the heart (*PA*.III.4, 666b21-23), of the parts related to the heart, and then finally Aristotle introduces the lung (*PA*.III.5, 668b30-III.6, 668b33):

> Καὶ περὶ μὲν φλεβῶν καὶ καρδίας εἰρήσθω, περὶ δὲ τῶν ἄλλων σπλάγχνων σκεπτέον κατὰ τὴν αὐτὴν μέθοδον. Πλεύμονα μὲν οὖν ἔχει διὰ τὸ πεζὸν εἶναί τι γένος τῶν ζῴων.
> "We may take it that the blood vessels and heart have been discussed; we need to examine the other viscera according to the same method. A certain kind of animal has a lung because it is a land-dweller."

Here the same method is applied all over again: Aristotle identifies those blooded animals that have lungs (i.e. those animals that are land-dwellers), and identifies the cause for the sake of which all animals that have a lung have it (i.e. breathing; *PA*.III.6, 669a14). Next, he brings up the question of the differentiation of lungs (*PA*.III.6, 669a24-25: "the lung differs in many ways in animals"), connects the different kinds of lungs to the animals that have those kinds of lungs, and states the causes of this distribution. After this, Aristotle picks up his discussion of the other viscera, and again tries to answer the same set of questions. So, although Aristotle may vary in the order in which the questions are answered, and perhaps employs a somewhat associative manner of connecting the discussions of animal parts to each other, his basic 'format' is the same: take P, find $S_{1\text{-}n}$ to which P belongs, explain why P belongs to each S that has it (or why it is absent in others); take ΔP, find $S_{1\text{-}n}$ to which each particular ΔP belongs, explain why ΔP belongs to each S that has it.

In describing this basic format, I have focused on Aristotle's explanations of the presence and the differentiation of parts. However, Aristotle is also interested in providing explanations for why a certain part is *absent* in a certain kind of animal.

There are two cases in which the question why a certain part is absent seems reasonable and appropriate (in the way that asking for an explanation of the absence of horns in pigs is, and of wings in cows is not). This question is reasonable and appropriate in the first place in cases where the observations of all the other kinds of animals belonging to the same wider class as that to which the animal in question belongs show that these other animals all have that part. A famous example is the snake. All blooded land-dwellers possess feet, except for snakes; the footlessness of snakes thus needs to be explained. In the second place, the question arises in

those cases where an analogy based on the correlations of parts within other kinds of animals suggests that the animal-kind in question also could have used the part commonly possessed by the other kinds. Take the example of the presence of outer ears in human beings and four-footed vivipara and ovipara, but their absence in birds. All these animals are blooded, and given that birds do have auditory channels, one might expect birds to have outer ears also. Since they are absent, this fact needs to be explained. In short, it is through the comparison of observations of other related or 'similar' animals having a certain part (a comparison which thus establishes inductively a natural set of parts possibly owned by certain kinds of animals) that the question why that part is lacking in this particular kind of animal becomes reasonable. (The heuristics employed in discovering 'significant' absence of parts will be discussed more explicitly below.)

One could argue that in each case where a lack of a certain part is observed in an animal kind (and where this lack is surprising considering the fact that other related or similar animals do have that part), the part in question can no longer be considered as a genus-specific differentia of the wider kind of animals to which the animal lacking the part belongs. If Aristotle uses as an explanatory rule the fact that all blooded land-dwellers have four feet, and the snake, which is also a blooded land-dweller, is observed not to have feet, doesn't that mean that having four feet is only incidental to blooded land-dwellers, or at least that snakes are not really blooded land-dwellers? There are two reasons why Aristotle considers cases like these merely as exceptions to the rule (which need to be explained, of course) and not as refutations of it. On the one hand, it is exactly because Aristotle holds that natural processes happen 'for the most part' and not 'always' (in an unqualified sense), that he – to some extent – allows for exceptions and variations among genus-specific differentia.[39] On the other hand, if the explanatory network based on the assumption of the existence of animal-kinds or wider classes sharing specific and discriminatory natures, parts and features still holds for the parts the animal in question does have, then there is no reason for Aristotle to drop the whole network. A snake, for instance, might be lacking feet, but its other main parts and features can be accounted for by reference to its being blooded or being a land-dweller, and thus

[39] Cf. *PA*.III.2, 663b27-29: "And one should study nature with a view to the many; for it is what happens either in every case or for the most part that is in accordance with nature."

Aristotle opts to explain the lacking part.[40] This is not an ad-hoc solution, for Aristotle in fact provides explanations for why things are for the most part: if there is an exception in nature, then there is an explanation for it. It also shows the comprehensiveness of Aristotle's explanatory project.

### *3.1.4 Aristotle's heuristic strategies in PA*

The systematic way in which Aristotle presents his explanations of parts of animals reveals that he is in fact offering us his conclusions of an investigation that he has already carried out (although perhaps not entirely finished yet).

On the other hand, it is also clear that the structure of *PA* still reflects to some extent Aristotle's explanatory project and strategies of the *Posterior Analytics*.[41] For instance, Aristotle follows a teleological ordering in first discussing the uniform parts that are for the sake of the non-uniform parts, which are discussed next; he also discusses the parts of the bloodless animals by analogy to the parts of blooded animals that (presumably) are better known. Less clear from Aristotle's exposition is how he deals with the transitions in his explanations from (differentiations of) parts to animals that have those (differentiations of) parts, and from there to the explanation of (the differentiation of) parts in those animals. For, how does one go about in finding all and only those animals that have a particular part or a particular differentiation of a part? And next, how does one go about finding the explanation of why a particular part or a particular differentiation of a part belongs to a particular subset of animals?

Here I will sketch briefly two heuristic strategies Aristotle uses to find all and only those animals to which a part belongs: the identification of the widest class to which a part belongs, and the identification and grouping of the relevant differentiae. These two heuristic patterns largely coincide with what Lennox has labeled A-type explanations and B-type explanations.[42] The distinction I make by discussing these explanatory strategies under 'heuristics' rather than under 'explanations' is one of accent, but I believe it is nevertheless an important one. The

[40] The being without horns of the camel, however, remains a problem in this respect; see Lennox (2001a), 280-1.
[41] See Gotthelf (1987), 175-178, who mentions five features (I only mention the two of them that are most relevant in this context) that reveal an axiomatic structure in the organization of *PA*.II-IV.
[42] Lennox (1987a), 92-114.

full explanation of the presence, absence, or differentiation of a part is usually more complicated, and the heuristics, as I will show below, 'merely' point the way to causal explanations, without being themselves fully fledged causal explanations yet. One should also note that part of the reason why these heuristics remain implicit in Aristotle's explanations of parts of animals is because in many cases Aristotle draws from his conclusions already laid down in *HA*.[43]

### *3.1.4.a Heuristic pattern I: identification of widest class*

In those cases where a part is known to belong to a particular kind of animal, or is known to belong to animals that (at first sight) seem very distinctive, Aristotle searches 'vertically' for the wider classes of those animals that all have that part, until he touches upon the widest class[44] to which that part belongs primitively.

Take for instance the viscera. These can be seen to belong to a wide range of animal kinds (i.e. to man, viviparous quadrupeds, oviparous quadrupeds, birds, fish, and cetaceans), but right at the beginning of his discussion of the viscera Aristotle points out that having viscera is distinctive (ἴδια) of blooded animals, while none of the bloodless have viscera (οὐδὲν ἔχει) (*PA*.III.4, 665a27-31). The widest class to which viscera belong primitively is thus the class of blooded animals. Another example derives from Aristotle's discussion of the presence of wings in different animals: some insects have wings (*PA*.IV.6, 682b5-11), but so do all birds (*PA*.IV.12, 693b5-14). In both cases, Aristotle points to the widest class of animals to which wings belong primitively, that is, to the class of fliers.

By subsuming species under the widest classes that have a certain part, Aristotle does not immediately *explain* the presence of that part, but rather *unifies* animals that have the same part under a common denominator, which may point to the relevant correlations or differentiae. In both the examples mentioned the identification of the widest class points the way to causal explanations, but along different lines. In the case of the viscera, the fact that viscera are distinctive of all blooded animals points to a material explanation of the presence of viscera in those

[43] Cf. Lennox (2006), 9-10.
[44] These classes can consist of the 'major genera' (i.e. man, viviparous quadrupeds, oviparous quadrupeds, birds, fish, cetaceans, cephalopods, crustaceans, testaceans and insects), but also of other genera such as blooded/bloodless, terrestrial/aquatic/flying/stationary, footless/biped/quadruped/polypod.

animals: the viscera are made from blood, and since blood (i.e. red blood) is lacking in all the bloodless animals, they do not have viscera. In the case of animals with wings, the case is a bit more complicated. For birds, being a flyer is part of the definition of the substantial being of birds (cf. *PA*.IV.12, 693b5-14):

> τῶν γὰρ ἐναίμων ἡ τοῦ ὄρνιθος οὐσία, ἅμα δὲ καὶ πτερυγωτός. (...) τῷ δ' ὄρνιθι ἐν τῇ οὐσίᾳ τὸ πτητικόν ἐστιν.
>
> "For the substantial being of the bird is that of the blooded animals, but at the same time that of the winged animals (...); and the ability to fly is in the substantial being of the bird"

Therefore, the explanation of the presence of wings in birds will have to refer to the form of birds, which includes the form of being a flyer (all birds are essentially fliers). For insects, on the other hand, being a flyer correlates with a differentia that is causally more basic, namely the having of only six feet: those insects that have only six feet are fliers, and they have wings because they are fliers (*PA*.IV.6, 682b5-6: those insects that have fewer feet are fliers in consequence of the deficiency of feet).[45] Here, the explanation will refer to the form of fliers, but not to the form of insects. The structure of explanations like these will be discussed in more detail below, for now the two examples must suffice to illustrate the way in which Aristotle seems to have used this heuristic.

In the case of 'dualizers', that is, of animals that seem to share in two natures without actually having either one or both natures completely,[46] the heuristic also functions at a more basic level, namely at the level of the discovery of parts whose presence or absence needs to be explained. Dualizers have some parts that fall under one of the widest classes, while they have other parts that fall under another. Taking these two widest classes as a starting point, Aristotle deduces what parts should be present in the animal if it were a member of both of them, and matches these with the parts actually present. This procedure mainly points to the absence of parts,

[45] Apparently, Aristotle also includes such animals as spiders, ticks, and millipedes in the insect-family.
[46] Balme (1987; 85-86) defines 'dualizers' (the expression in Greek is: ἐπαμφοτερίζει τὴν φύσιν) as animals that 'tend to both sides of a division' and therefore escape precise grouping.

which requires an explanation, and sometimes also towards the explanation of the parts that are present by reference to the form possessed by the widest kind.[47]

Take the examples of apes.[48] Aristotle has first discussed the 'posterior parts and the parts around the legs' in human beings, which are distinctive of them when compared to the four-footed animals (*PA*.IV.10, 689b1-31). For all four-footed animals have tails, no buttocks, and fleshless legs, while all human beings have buttocks, no tails and fleshy legs; Aristotle explains why each kind of animal has the parts it has, and then turns to the ape (*PA*.IV.10, 689b31-34):

> Ὁ δὲ πίθηκος διὰ τὸ τὴν μορφὴν ἐπαμφοτερίζειν καὶ μηδετέρων τ' εἶναι καὶ ἀμφοτέρων, διὰ τοῦτ' οὔτε οὐρὰν ἔχει οὔτ' ἰσχία, ὡς μὲν δίπους ὢν οὐράν, ὡς δὲ τετράπους ἰσχία.
>
> "But the ape, because its shape tends in both directions [towards two-footed and towards four-footed] and because it is neither one and also both, has neither a tail nor buttocks – as two-footed, no tail, as four-footed, no buttocks."

The absence of the tail and buttocks in apes is only significant from the perspective of its dual nature: we could reasonably have expected these parts to be present, but since they are lacking, this fact needs to be explained.[49] The explanation to which Aristotle points for the absence of these parts involves referring alternately to the forms of the two widest classes to which apes (in virtue of the parts that they have) belong. Apes do not have a tail, because in this respect, they are like two-footed human beings; apes do not have buttocks, because in this respect, they are like four-footed animals. However, the complete explanation of why apes are like two-footed human beings in one respect, and like four-footed animals in another will have to refer to other, causally more basic factors, pertaining e.g. to the ape's life and to what parts would be useful or harmful to the ape's kind of life. What is important for now is to note that it is only through comparison with the animals that belong to the two widest classes towards which the nature of dualizers tend that the absence of particular parts becomes evident.

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[47] For instance, in *PA*.III.6, 668b32-669a14, Aristotle uses the fact that dualizers such as whales and dolphins also have lungs to discover the widest kind of breathers, the form of which explains the presence of lungs in both blooded land-dwellers as in some blooded water-dwellers.

[48] For the example, see Lennox (1987a), 108.

[49] Cf. the case of seals and bats in *PA*.IV.13, 697b1-13, and the case of the river crocodile in *PA*.IV.11, 690b19-24; in all these cases, Aristotle employs the identification of widest classes mainly to detect and start to explain the absence of parts.

*3.1.4.b Heuristic pattern II: identification and grouping of correlating differentiae*

In other cases, where a part or its differentiation seems to be distinctive of a particular kind or sub-kind of animal, Aristotle searches 'horizontally' *within* that kind itself in order to identify and group together all the correlating differentiae (i.e. the other parts an animal possesses, the animal's *bios*, its activities, or its character) that might be causative of the presence or the differentiation of that part. The heuristic strategy is thus to look for simultaneous occurrences of the presence (or absence or differentiation) of a part and other features that are characteristic of this animal, not by focusing on the wider class of animals to which the animal kind that has the part belongs, but on the particular nature of that animal kind. One of these features could be (the link to) the cause of the presence (or absence or differentiation) of that part. Instead of, so to speak, moving further away from the animal itself in order to find the widest class of animals that possesses the part per se, Aristotle stays at the level of the particular kind of animal that owns the particular part, in order to find something in its immediate nature responsible for it. In these cases, too, the identification and grouping of differentiae that correlate with the part to be explained precede the actual explanation, because not all of the differentiae found need to be causally basic.

Take the example of the presence of tails (*PA*.IV.10, 689b1-31). The widest kind to which all animals that have tails belong is that of the viviparous animals. However, the identification of this widest kind does not give us any conclusive indications about the explanation of the presence of tails in all animals that have them, because having a tail and being a viviparous animal are not entirely coextensive (*PA*.IV.10, 689b2-3: "almost all of them have a tail"; κέρκον δ' ἔχει πάντα σχεδόν). The implication only works in one direction: all animals that have tails are viviparous, but 'merely' most viviparous animals have tails. Hence Aristotle looks for differentiae that are distinctive to tailed animals, and finds it in the fact that they have four feet. Because all animals that have tails have four feet and all animals that have four feet have tails this differentia may well be causally relevant for the explanation of the presence of tails. The having of four feet points indeed to the teleological explanation of the presence of tails. For four-footed animals are dwarf-like, and hence lack the buttocks that in two-footed, upright beings protect the outlet

for residue; therefore "so that the part serving as the residual outlet may be guarded and sheltered, nature has provided to them the so-called tail-end and tail (*PA*.IV.10, 689b29-31)" – tails are present for the protection of the residual outlet. I have not found any examples in the biological works in which the identification of a differentia that correlates with the presence of a part is also the cause of the presence of that part; my hypothesis is that what Lennox calls B-type explanations in biology only pertain to the differentiations of parts, and not to their presence (or absence) as such.[50]

This heuristic pattern seems to work most successfully, however, in the case of (necessary) differentiations of parts that functionally optimize the part for each individual kind of animal that has it. By grouping together all the differentiae and features that are characteristic of the animal kind within which a part is differentiated in a particular way, it becomes quite easy to pick out the one feature that immediately necessitates this particular differentiation.

A clear example derives from Aristotle's discussion of the differentiations between the beaks of birds. These differentiations cannot be accounted for by trying to find the widest class of animals to which animals with beaks belong: beaks are distinctive of birds.[51] Because beaks are distinctive of birds, there must be something in the particular nature of each kind of bird that is responsible for the particular differentiation of its beak. Aristotle finds the differentia which points to the explanation of the differentiation of beaks in the bird's way of life (*bios*; *PA*.IV.12, 693a10):

> Διαφορὰν δ' ἔχει καὶ τὰ ῥύγχη κατὰ τοὺς βίους.
>
> "Their beaks also differ in accordance with their way of life."

Cf. *PA*.III.1, 662b5-16:

> Τῶν δ' ἄλλων ἑκάστῳ πρὸς τὸν βίον χρήσιμόν ἐστι τὸ ῥύγχος,
>
> "In each of the other birds the beak is useful for its way of life."

[50] Lennox (2001a), 9-15; 22; 24-29.

[51] The presence of beaks in birds can be explained by reference to the definition of the substantial being of bird, although having a beak is not itself part of this definition (rather it is a necessary consequence of being two-footed and winged, which are part of the definition of the substantial being of bird; see *PA*.II.16, 659b4-13).

Different types of beaks correlate with different types of environment and the ways birds employ to acquire food in their own specific environments. Aristotle thus concludes (*PA*.IV.12, 693a15-17):

> Ὅσων δὲ ὁ βίος ἕλειος καὶ ποηφάγος, πλατὺ τὸ ῥύγχος ἔχουσιν· πρός τε γὰρ τὴν ὄρυξιν χρήσιμον τὸ τοιοῦτον καὶ πρὸς τὴν τῆς τροφῆς σπάσιν καὶ κουράν.
>
> "All birds whose way of life includes swamp-dwelling and plant-eating have a flat beak; for such a beak is useful both for digging up and cropping off their nourishment."

We will look at the structure of these explanations more closely below, but for now, it may suffice to state the following. Given that for Aristotle differentiations of parts are for the sake of the functional optimization of that part within a particular kind of animal, differentiations and the animal's differentiae must be intimately connected (see Aristotle's explicit statements about this relation in *PA*.II.2, 648a14-19 and *PA*.II.13, 657b22-29).[52] In order to explain these differentiations, one will have to identify that aspect of an animal that makes it require such a functional optimization; next one will need to show how this functional optimization follows from the material differentiation of the part.

As teleological explanations will be the main focus in this chapter, I would like to say a few more words about how Aristotle goes about to find the final cause of a particular part or its differentiation, before finally turning to Aristotle's actual explanations.

Aristotle seems to use two basic methods for the 'discovery' functions. In the first place, as we have seen already, functions that belong to the definition of the substantial being of an animal can be identified *kata ton logon*. Once the full and real (as opposed to the nominal) definition of an animal has been established through division, the *per se* parts and functions follow from that definition.[53] For example, 'animal' is defined by its perceptive capacity and from this, it follows that it necessarily has a heart, the primary perceiver,[54] and flesh, the organ of the primary

[52] Lennox (2001b), 331, calls this type of explanation 'adaptation explanations'.
[53] Cf. *PA*.I.1, 639b16-19; *GA*.I.18, 724a14-16.
[54] *PA*.III.4, 666a34-5.

mode of perception.[55] Moreover, when an animal has been defined as being a flyer, we may expect to find parts that are for the sake of flying.

Where this definition has not been established yet, functions may also 'simply' be detected by observation; Aristotle indicates on occasion that the causal relation between a part or feature and its function are apparent to perception.[56] In most cases, the parts and features of which the causal relations are discussed in *PA* are recorded as facts in *HA*;[57] this latter treatise may have included reports of dissections, which also provided visual aids in the discovery of causal relations and hence of functions.[58]

Thus having set out Aristotle's biological method, I will now turn to his actual explanations.

## 3.2 Explanations in biology: references to form, matter, and function

### *3.2.1 Three ways of classifying explanations in* PA

The explanations Aristotle offers in *PA* can be classified in different ways.

First, taking the three most common types of questions in *PA* as a point of reference, one might say that there are three types of explanations: (1) explanations that answer the question why a part is present in the animals that have it; (2) explanations that answer the question why a part is absent in the animals that could reasonably be expected to have that part; and finally (3) explanations that answer the question why a part is differentiated the way it is in each kind of animal that has it.

Second, taking the types of parts whose presence, absence, or differentiation need to be explained as a point of reference, one might distinguish the following four types of explanations: (a) explanations that answer questions concerning necessary (essential or vital) parts; (b) explanations that answer questions concerning non-necessary, subsidiary parts; (c) explanations that answer questions

[55] *PA*.II.8, 653b22-23.
[56] See, for example, *PA*.II.8, 653b30-31: "It is apparent to perception (*kata tên aisthêsin phaneron*) that all the other uniform parts are for the sake of flesh (…)," and *PA*.III.14, 674a12-13: "and the cause owing to which each of the animals has these parts is apparent to everyone." Cf. *GA*.II.4, 740a5-6.
[57] *PA*.IV.5, 679b35-680a3, *IA*.I, 704b8-10.
[58] See *PA*.IV.5, 679b35-680a3: "The manner in which each of them has these parts should be studied with the help of the inquiries about animals and of the dissections. For some of these things need to be clarified by an account (*tôi logôi*), others rather by visual inspection (*pros tên opsin*)." Cf. *PA*.III.5, 668b27-30.

concerning non-necessary, luxurious parts; and finally perhaps (d) explanations that concern functionless parts.

A third way of categorizing Aristotle's explanations in *PA* is to differentiate them according to the first cause that is picked out in the explanation.[59] This is sometimes the only cause picked out in the whole explanation, but sometimes one of several. In the latter case, the cause picked out first by Aristotle does not have to be the cause that is causally basic or prior in the explanation; it may instead be epistemologically prior – i.e. once this cause is grasped, it is easier to find the other causes involved in the phenomenon to be explained. Thus there are (i) explanations that refer first to formal causes; (ii) explanations that refer first to material causes; and finally (iii) explanations that refer first to final causes.[60] Since our interest here is in the role of final causes in explanations, I will use this latter categorization based on the three causes as the primary organizational format for this section. The categorization based on the three types of questions (1-3) will be used to organize the subsections (starting, as Aristotle does, with the explanation of the presence, then the absence, and finally the differentiation of parts); where relevant I will point out which type of part (a-d) is at stake.

It needs to be noted from the outset, that a separate discussion of the different types and sub-types of explanations is in a sense artificial, for Aristotle usually explains the presence, absence or differentiation of different kinds of parts by complicated sets of different (sub)-types of explanations, and he often does so in the context of explaining another part. My objective here is to isolate the various explanatory patterns Aristotle employs in order to determine exactly what role final causes play in Aristotle's biology; a more integrated account will be offered in section 3.4.

[59] This categorization thus lends support for the view that not "all individual strings of explanatory necessitation have as their starting point an instance of hypothetical necessity" (Charles (1988), 5) and that therefore there can be material and efficient causation independent of final causation in biology.
[60] Aristotle offers explanations that refer first to efficient causes in the treatise in which he attempts to account for the generation of animals (*GA*).

### *3.2.2 Explanation by reference to formal causes*

Pattern F1: *Explanation of the presence of necessary parts by reference to essential features included in the definition of the substantial being of an animal*

As we saw in 3.1, Aristotle explains the presence of necessary parts by reference to the definition of the substantial being of the animal. In these cases, the animal's essence or form is picked out as the cause of why the animal has the part whose presence needs to be explained.

Take for instance fins: these are present in all fish. Aristotle explains the presence of fins in fish in the following way (*PA*.IV.13, 695b16-24):

> Οὐκ ἔχουσι δὲ ἀπηρτημένα κῶλα οἱ ἰχθύες, διὰ τὸ νευστικὴν εἶναι τὴν φύσιν αὐτῶν κατὰ τὸν τῆς οὐσίας λόγον, ἐπεὶ οὔτε περίεργον οὐδὲν οὔτε μάτην ἡ φύσις ποιεῖ. Ἐπεὶ δ' ἔναιμά ἐστι κατὰ τὴν οὐσίαν, διὰ μὲν τὸ νευστικὰ εἶναι πτερύγια ἔχει (…).
>
> "Fish do not have distinct limbs, owing to the fact that the nature of fish, according to the account of their substantial being, is to be able to swim, and since nature makes nothing either superfluous or pointless. And since they are blooded in virtue of their substantial being, it is on account of being swimmers that they have fins (…)."

Given that fish are blooded animals, one would expect the presence of 'distinct limbs', but instead fish have fins. Fish do not have distinct limbs, because nature does nothing in vain, and having distinct limbs would be in vain for fish. Fish have fins, however, because being a swimmer is part of the definition of the substantial being of fish (just as being blooded is): the possession of fins is thus a necessary condition of being a fish, and the presence of fins is conditionally necessitated by the function of swimming that is subsumed in the essence of fish as swimmers.

As I stated before, explanations like these[61] pertain not only to parts whose functions are included in the definition of the substantial being of an animal, but also to parts that derive from the necessary features which are included in the definition (i.e. parts that belong to the animal *kath' hauta sumbebêkos*). For instance, having a

[61] For examples of parts whose presence is explained by reference to the definition of the substantial being, see Code (1997), 139-140 and Gotthelf (1987), 190-191.

heart and liver is a necessary consequence of being a blooded animal (*PA*.III.7, 670a23-27):

> Καρδία μὲν οὖν καὶ ἧπαρ πᾶσιν ἀναγκαῖα τοῖς ζῴοις (…). Πάντα δὲ δεῖται τὰ ἔναιμα δυοῖν τούτοιν, διόπερ ἔχει πάντα τὰ ἔναιμα δύο τὰ σπλάγχνα ταῦτα μόνον· ὅσα δ' ἀναπνεῖ, καὶ πλεύμονα τρίτον.
>
> "Now the heart and liver are necessary to all animals (...). All blooded animals must have both of these, which is why these two viscera alone are possessed by all blooded animals, while those that breathe have a third, the lung."

Being blooded (or not) is part of the definition of the substantial being of an animal (*PA*.IV.5, 678a31-35):

> Ἐξ οὗ γὰρ συνέστηκεν ἡ τῶν σπλάγχνων φύσις, οὐδὲν τούτων ἔχει αἷμα διὰ τὸ τῆς οὐσίας αὐτῶν εἶναί τι τοιοῦτον πάθος αὐτῆς· ὅτι γάρ ἐστι τὰ μὲν ἔναιμα τὰ δ' ἄναιμα, ἐν τῷ λόγῳ ἐνυπάρξει τῷ ὁρίζοντι τὴν οὐσίαν αὐτῶν.
>
> "For none of these animals has blood, out of which the nature of the viscera is constituted because some such affection of it is constitutive of their being; for that some animals are blooded while some are bloodless will belong in the account defining their substantial being."

In these cases, being blooded or not, which is part of the form or essence of an animal, is explanatorily basic (because the form or essence is causally primary), while the presence of the heart and the liver are necessary consequences of this basic feature. Although the parts (or their function) are not given in the definition, their presence can immediately be derived from it. In the example of birds discussed in 3.1.4, Aristotle deduces in a similar way the presence of two feet in birds (*PA*.IV.12, 693b5-14): on account of being essentially blooded, birds possess a maximum of four points of movement; on account of being essentially fliers, birds have two wings (which take up two of the total of four points of movement). Hence, "it remains for them [i.e. birds] to be, of necessity, two-footed (*PA*.IV.12, 693b13-14)." The necessity involved is that of a 'per se incidental' predication, which pertains to the proper attributes belonging necessarily to all the members of a kind qua that kind. Being two-footed is not itself part of the definition of the substantial being of birds, but two-footedness can immediately be derived from the two features that are part of that definition and is therefore a proper attribute of birds.[62]

[62] Cf. Bayer (1998), 501-502.

It is important to note with regard to this type of explanation, that Aristotle distinguishes three kinds of parts that are present in *all* animals because they follow from the definition of animal, or, in other words, from that what it is to be an animal. These parts are: a) the heart (and its analogue; including a life-sustaining liquid), b) parts for nutrition (the mouth or its analogous part; a stomach, and a part for the outlet of waste matter), and c) parts for (at least a minimal form of) perception (that is, at least the organ for tactile perception, which is flesh or its analogue).[63] The explanations of the presence of these parts all refer to the form (or the vital and essential functions subsumed in the form) shared by all animals.

In some cases, Aristotle does not refer to the definition of the substantial being of the animal itself in explaining the presence of its necessary parts, but rather to the definition of the substantial being of the widest kind of animals of which the animal in question is a sub-species. The reasoning is that because a particular part belongs necessarily and per se to a particular kind of animals, all animals that belong to this kind will also necessarily (and per se incidentally) have this particular part. For example, the ostrich is two-footed because it tends towards the nature of birds. Two-footedness is a proper attribute of birds, and because ostriches are *in this respect* like birds (i.e. they belong in this respect to the wider kind of birds), they are two-footed as well (*PA*.IV.14, 697b13-27):

> Τὸν αὐτὸν δὲ τρόπον καὶ ὁ στρουθὸς ὁ Λιβυκός· τὰ μὲν γὰρ ὄρνιθος ἔχει, τὰ δὲ ζώου τετράποδος. (...) καὶ δίπους μέν ἐστιν ὡς ὄρνις, διχαλὸς δ' ὡς τετράπους·
>
> "In the same way too is the Libyan ostrich; in some respects it has the manner of a bird, in others that of a four-footed animal. (...) and while two-footed like a bird, it is hoofed, as though four-footed."

In order to make this explanation complete, however, one would need to refer to other differentiae in order to account for the fact that the ostrich tends in this respect towards birds, rather than towards four-footed animals.

In all the above mentioned examples of explanations of the presence of parts, some feature in the form or essence of the animal is explanatorily basic: an animal has a part either per se (it is part of the definition of its substantial being in virtue of being part of the substantial being of the widest kind to which the animal

[63] *PA*.II.8, 653b19-29, *PA*.III.4, 666a34-5, *PA*.IV.5, 678b1-6.

belongs), or it belongs to it per se incidentally (the part follows from the definition of the animal's substantial being).

Pattern F2: *Explanation of the necessary differentiation of necessary and non-necessary parts by reference to the ways of life (bioi) and dimensions included in the definition of the substantial being of an animal*

Aristotle often picks out formal causes included in the definitions of substantial beings as the primary causes for the differentiation of parts.

From the outset it is important to note that Aristotle does not refer to the part of the essence or definition that picks out the genus of the animal in question to explain differentiations of parts, since the genus rather explains the similarities of the parts possessed by the animals belonging to the same kind.

Aristotle unifies animals under one kind if they differ from each other by the more and the less or by degree,[64] while keeping the animals that differ from each other by analogy apart (*PA*.I.4, 644a16-22):

> Ὅσα μὲν γὰρ διαφέρει τῶν γενῶν καθ' ὑπεροχὴν καὶ τὸ μᾶλλον καὶ τὸ ἧττον, ταῦτα ὑπέζευκται ἑνὶ γένει, ὅσα δ' ἔχει τὸ ἀνάλογον, χωρίς· λέγω δ' οἷον ὄρνις ὄρνιθος διαφέρει τῷ μᾶλλον ἢ καθ' ὑπεροχήν (τὸ μὲν γὰρ μακρόπτερον τὸ δὲ βραχύπτερον), ἰχθὺς δ' ὄρνιθος τῷ ἀνάλογον (ὃ γὰρ ἐκείνῳ πτερόν, θατέρῳ λεπίς).
>
> "For those animals that differ by degree and the more and the less have been brought together under one kind, while those that are analogous have been kept apart. I mean, for example, that bird differs from bird by the more or by degree (for some has long feathers, another short feathers), while fish differs from bird by analogy (for what is feather in the one is scale in the other)."

Animals that belong to one kind all have the same nature,[65] have more or less the same form (or forms that are not too far apart; *PA*.I.4, 644b4-5: καὶ ἔχει τε μίαν φύσιν κοινὴν καὶ εἴδη ἐν αὐτῷ μὴ πολὺ διεστῶτα), and possess the same parts (with the same primary function, name, and form); their parts differ only with respect to their bodily affections (*PA*.I.4, 644b7-15):

> Σχεδὸν δὲ τοῖς σχήμασι τῶν μορίων καὶ τοῦ σώματος ὅλου, ἐὰν ὁμοιότητα ἔχωσιν, ὥρισται τὰ γένη, οἷον τὸ τῶν ὀρνίθων γένος πρὸς αὐτὰ πέπονθε καὶ τὸ τῶν ἰχθύων καὶ

[64] On the principle of the more and the less, see Lennox (2001a), 160-181.
[65] For what it means for animals within one genus to have a common nature, see Charles (2000), 316-326.

> τὰ μαλάκιά τε καὶ τὰ ὄστρεια. Τὰ γὰρ μόρια διαφέρουσι τούτων οὐ τῇ ἀνάλογον ὁμοιότητι, οἷον ἐν ἀνθρώπῳ καὶ ἰχθύϊ πέπονθεν ὀστοῦν πρὸς ἄκανθαν, ἀλλὰ μᾶλλον τοῖς σωματικοῖς πάθεσιν, οἷον μεγέθει μικρότητι, μαλακότητι σκληρότητι, λειότητι τραχύτητι καὶ τοῖς τοιούτοις, ὅλως δὲ τῷ μᾶλλον καὶ ἧττον.
>
> "Roughly speaking, it is by the shapes of the parts and of the whole body, when they bear a likeness, that kinds have been defined. For instance members of the bird kind are so related to each other, as are those of the fish kind, the soft-bodied animals, and the hard-shelled animals. For their parts differ not by analogous likeness, as bone in mankind is related to fish-spine in fish, but rather by bodily affections, e.g. by large/small, soft/hard, smooth/rough, and the like – speaking generally, by the more and the less."

The differentiations of parts thus pertain to the differences in the material constitutions, locations, and morphology of these parts between members of one kind. By definition, these differentiations cannot be caused by the form of the widest kind, since this form is shared by all members of the kind (i.e. the functions that conditionally necessitate the coming to be of the necessary parts are included in the definitions of the substantial being shared by all animals within one kind). Differences between parts that are due to the form of the genus are parts possessed by animals belonging to different widest kinds. Rather, it seems that in most cases differentiations between parts are caused by the way of life that is distinctive of each species.

For instance, the fact that elephants have a nose can be accounted for by reference to the widest kind of which they are part: having a nose is a 'per se incidental'-feature of all (blooded) breathers of air, and since elephants are (blooded) breathers of air, they necessarily have a nose, too. However, the fact that elephants have an extraordinary long nose – the elephants' trunk – (which is a material, and not a formal, differentiation of noses) cannot be explained by reference to the form of the widest kind of which elephants are part; for the long nose is distinctive to the elephant (*PA*.II.16, 658b33-35):

> Ὁ δ' ἐλέφας ἰδιαίτατον ἔχει τοῦτο τὸ μόριον τῶν ἄλλων ζῴων· τό τε γὰρ μέγεθος καὶ τὴν δύναμιν ἔχει περιττήν.
>
> "In the elephant, however, this part is most distinctive compared with the rest of the animals – it is extraordinary in both size and potency."

The explanation of why elephants have such a long nose is quite complicated,[66] but in addition to basic features such as being blooded and having a large size (on dimensions being included in the definition of the substantial being of each kind of animal, see below) the specific combination of the ways of life the elephant has by nature establishes the need for such a long nostril (*PA*.II.16, 659a2-12):

> Τὴν γὰρ φύσιν ἑλῶδες ἅμα τὸ ζῷόν ἐστι καὶ πεζόν, ὥστ' ἐπεὶ τὴν τροφὴν ἐξ ὑγροῦ συνέβαινεν ἔχειν, ἀναπνεῖν δ' ἀναγκαῖον πεζὸν ὂν καὶ ἔναιμον, καὶ μὴ ταχεῖαν ποιεῖσθαι τὴν μεταβολὴν ἐκ τοῦ ὑγροῦ πρὸς τὸ ξηρόν, καθάπερ ἔνια τῶν ζῳοτόκων καὶ ἐναίμων καὶ ἀναπνεόντων, τὸ γὰρ μέγεθος ὂν ὑπερβάλλον, ἀναγκαῖον ὁμοίως ἦν χρῆσθαι τῷ ὑγρῷ ὥσπερ καὶ τῇ γῇ. Οἷον οὖν τοῖς κολυμβηταῖς ἔνιοι πρὸς τὴν ἀναπνοὴν ὄργανα πορίζονται, ἵνα πολὺν χρόνον ἐν τῇ θαλάττῃ μένοντες ἕλκωσιν ἔξωθεν τοῦ ὑγροῦ διὰ τοῦ ὀργάνου τὸν ἀέρα, τοιοῦτον ἡ φύσις τὸ τοῦ μυκτῆρος μέγεθος ἐποίησε τοῖς ἐλέφασιν.
>
> "This animal is at once a swamp-dweller and a land-dweller by nature. So, since on occasion it gets its nourishment from water, and, being a blooded land-dweller, must breathe, and, on account of its size, is unable to make the transition from moist to dry environments as quickly as some of the live-bearing, blooded animals do, it necessarily uses the water as it does the land. Thus as some divers equip themselves with instruments for breathing, in order that they can inhale air through this instrument from outside their moist environment while remaining in the sea for an extended time, nature makes the length of the nostril such an instrument for elephants."

The elephants' natural ways of life, combined with other essential features, conditionally necessitate the length of the nose.

However, Aristotle does not in all cases pick out the animal's specific way of life as the primary cause for the differentiation of a particular part, but only in those cases where the differentiation is necessary, and not 'merely' for the better (this distinction will be discussed in more detail below). In the case of the webbedness of the feet of ducks, Aristotle refers primarily to the material necessity causative of the coming to be of the material from which the webs are made, and to the use nature subsequently has made of those materials. So, although the differentiation for which the material is used is determined by reference to what is

[66] For Aristotle's explanation of why an elephant has the kind of nose it has, see Gotthelf's detailed analysis; Gotthelf (1997), 85-95.

better in view of the specific way of life of ducks, the differentiation is not necessary for ducks (*PA*.IV.12, 694b6-10):

> ὡς δὲ διὰ τὸ βέλτιον ἔχουσι τοιούτους τοὺς πόδας τοῦ βίου χάριν, ἵνα ζῶντες ἐν ὑγρῷ καὶ τῶν πτερῶν ἀχρείων ὄντων τοὺς πόδας χρησίμους ἔχωσι πρὸς τὴν νεῦσιν. Γίνονται γὰρ ὥσπερ κῶπαι εἰσπλέουσι τὰ πτερύγια τοῖς ἰχθύσιν ·
>
> "And it is on account of the better that they have such [i.e. webbed] feet, for the sake of their way of life – in order that, since they live in water where wings are useless, they will have feet that are useful for swimming. For they become oars for sailing just as do the fins of fish."

Having webbed feet is not necessary for ducks, but it is for the better that they have such feet: it contributes to their way of life.[67] I will return to this type of 'for the better' explanations for (non-necessary) differentiations of parts below, but for now it suffices to note that a particular species' way of life is not always picked out as the formal cause of the differentiations of parts within a larger kind.

In addition to differentiae, there is another aspect of the definition of the substantial being of each individual kind of animal which Aristotle picks out as being (at least partly) responsible for the differentiations between parts within a widest kind. This is the inclusion of the dimensions of the animal in the definition of its substantial being.[68] For instance, among the octopuses, there is one kind that is longer and thinner compared to the other kinds of octopuses. As Aristotle points out, these dimensions are included in the definition of the substantial being of this kind of octopus, and it is these dimensions that account for the differentiation (or perhaps rather the absence of a second row of suckers in one kind of octopuses because of lack of space) in the distribution of rows of suckers among different kinds of octopuses (*PA*.IV.9, 685b12-16):

> Τὰ μὲν οὖν ἄλλα δικότυλά ἐστι, γένος δέ τι πολυπόδων μονοκότυλον. Αἴτιον δὲ τὸ μῆκος καὶ ἡ λεπτότης τῆς φύσεως αὐτῶν · μονοκότυλον γὰρ ἀναγκαῖον εἶναι τὸ στενόν. Οὐκ οὖν ὡς βέλτιστον ἔχουσιν, ἀλλ' ὡς ἀναγκαῖον διὰ τὸν ἴδιον λόγον τῆς οὐσίας.

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[67] It is thus questionable whether being a water-dweller is part of the definition of the substantial being of ducks; it seems that if that were the case, the function of swimming would have conditionally necessitated the coming to be of organs for swimming in ducks, such as fins, which ducks obviously lack.

[68] On the inclusion of dimensions in the definition of the substantial being of animals, see Gotthelf (1985), 41; 44-45. At 53n.22 Gotthelf cites a passage (*GA*.II.6, 745a5-6: ἔστι γάρ τι πᾶσι τοῖς ζῴοις πέρας τοῦ μεγέθους; "for all animals there is a limit to their size") that suggests that dimensions are always part of the definition of the substantial being.

> "Now while the other octopuses have two rows of suckers, one kind of octopus has a single row. This is because of the length and thinness of their nature; for it is necessary that the narrow tentacle should have a single row of suckers. It is not, then, because it is best that they have this feature, but because it is necessary owing to the distinctive account of their substantial being."

The octopuses that are long and thin on account of the definition of their substantial being necessarily only have one row of suckers. There is only one other instance in the Aristotelian corpus where Aristotle explicitly refers to dimensional properties being included in the definition of the substantial being of an animal (namely to the disproportionate length of the snake in *IA*.8, 708a9-20), but there is evidence that on occasion Aristotle takes such properties as size and length as explanatorily basic. (An example of the latter is Aristotle's account of the nostril of the elephant. Part of the explanation of the extraordinary size and and potency of the elephant's trunk is the extraordinary size of the elephant (*PA*.II.16, 659a7: τὸ γὰρ μέγεθος ὂν ὑπερβάλλον); the elephant's being extraordinary large is taken as a given that is not further explained by reference to other features.) However, a passage in *DA* suggests that form is, among other things, precisely that which limits and determines size and natural growth of substantial beings, and that these limits belong to the definition (presumably, the definition of substantial natures; *DA*.II.4, 416a15-18):

> ἡ μὲν γὰρ τοῦ πυρὸς αὔξησις εἰς ἄπειρον, ἕως ἂν ᾖ τὸ καυστόν, τῶν δὲ φύσει συνισταμένων πάντων ἔστι πέρας καὶ λόγος μεγέθους τε καὶ αὐξήσεως· ταῦτα δὲ ψυχῆς, ἀλλ' οὐ πυρός, καὶ λόγου μᾶλλον ἢ ὕλης.
>
> "While the growth of fire goes on without limit so long as there is a supply of fuel, in the case of all complex wholes formed in the course of nature there is a limit or ratio which determines their size and increase, and limit and ratio are marks of soul but not of fire, and belong to the side of definition rather than that of matter."

The definition of the substantial being of each kind of animal includes the limits and ratios of that kind of animal and thus includes its dimensions. These dimensions determine the differentiations of parts in regard to their size: larger animals within one widest kind will have larger parts than the smaller animals within that kind. (For instance, part of why the elephant's trunk is exceptionally large is because the elephant itself is exceptionally large.)

Note that Aristotle never refers to formal causes as the causes of the absence of parts, as privative differentiae are not part of the definition of the substantial being of animals.

The only exception seems to be bloodlessness (see *PA*.IV.5, 678a31-35 quoted above), a seemingly privative feature which Aristotle claims is part of the definition of the substantial being of certain kinds of animals. However, 'bloodless' means nothing more than 'not having red blood, but something analogous to red blood'; 'bloodlessness' indicates not that the animal lacks a part completely, but rather that he lacks the better known part, red blood, and has the analogous part with the same potential as red blood instead (cf. *PA*.I.1, 654b9-10).

In the case of dualizers, Aristotle sometimes explains the absence of a part that belongs to one of the substantial beings towards which it tends by reference to the other substantial being to which the animal tends. Here, the one substantial being seems to account for the absence of parts that are normally present on account of the other substantial being. Bats, for example, tend in their nature both towards fliers and towards land-dwellers, and "on this account they parttake of both and neither" (*PA*.IV.13, 697b3: διὰ τοῦτο ἀμφοτέρων τε μετέχουσι, καὶ οὐδετέρων). Now, fliers have two feet, wings and a rump, while land-dwellers usually have four feet and a tail; bats on the other hand (*PA*.IV.13, 697b7-9):

> ὡς μὲν πτηνὰ ἔχουσι πόδας, ὡς δὲ τετράποδα οὐκ ἔχουσι, καὶ οὔτε κέρκον ἔχουσιν οὔτ' οὐροπύγιον, διὰ μὲν τὸ πτηνὰ εἶναι κέρκον· διὰ δὲ τὸ πεζὰ οὐροπύγιον.
>
> "As fliers have feet, but as four-footed they do not; and they have neither tail nor rump – no tail owing to being a flyer, no rump owing to being a land-dweller."

However, as Aristotle makes clear in the following lines, there are other, causally more basic differentiae belonging to bats that account for the absence of the rump and tail (*PA*.IV.13, 697b10-13):

> Συμβέβηκε δ' αὐταῖς τοῦτ' ἐξ ἀνάγκης· εἰσὶ γὰρ δερμόπτεροι, οὐδὲν δ' ἔχει οὐροπύγιον μὴ σχιζόπτερον· ἐκ τοιούτου γὰρ πτεροῦ γίνεται τὸ οὐροπύγιον. Ἡ δὲ κέρκος καὶ ἐμπόδιος ἂν ἦν ὑπάρχουσα ἐν τοῖς πτεροῖς.
>
> "And this happens to them of necessity: for they are skin-winged, and nothing has a rump unless it is winged with split-feathers. For the rump arises from such a feather. And a tail would also be an impediment if it were present among the feathers."

Bats having membranous wings and feathers makes the presence of a rump and a tail impossible and in vain, and these are the primary causes of the absence of these parts, not the tendency of the bat towards two natures; that is, it is not because 'tailless' is part of the definition of the substantial being of fliers that bats have no tail, but because it would be an impediment to have one. This example makes clear how the concept of a dualizer helps Aristotle to find the explananda, in this case the absence of the rump and tail (i.e. how it is a successful part of his heuristics). The explanation of the absence of parts is to be found in features outside the two definitions of substantial beings which to a certain extent apply to the animal in question. Formal causes are thus never the primary cause of the absence of parts.

In sum, formal causes (F) are picked out first in:

(1) the explanation of the presence of parts; formal causes are picked out in the explanation of necessary parts whose functions are included in the definition of the substantial being, and also of parts that follow directly and necessarily from the necessary parts; and in:

(2) the explanation of differentiations of parts in regard to differentiations in size; the dimensions of an animal are included in the definition of its substantial being.

The formal causes picked out in these explanations are the (partial) definitions of substantial beings, which include both essential features and functions as the dimensions of a particular kind of animal.

### *3.2.3 Explanation by reference to material causes*

Pattern M1: *Explanation of the coming to be of non-necessary, tool-like parts by reference to material necessity*

As outlined above (see 3.1.2), Aristotle explains the coming to be of non-necessary, tool-like or luxurious parts by reference to material necessity. As for Aristotle parts are either necessary or for the better, the presence of these non-necessary parts is

explained by reference to the function these parts are assigned to perform by the formal nature of the animal and to their contribution to the well-being of the animal.

Take for instance the omentum. Aristotle explains the coming to be of this membrane completely in terms of materially necessitated processes, while accounting for its presence by referring to the use nature makes of it in concocting food (*PA*.IV.3, 677b22-32):

> Ἡ μὲν οὖν γένεσις ἐξ ἀνάγκης συμβαίνει τοιαύτη τοῦ μορίου τούτου· ξηροῦ γὰρ καὶ ὑγροῦ μίγματος θερμαινομένου τὸ ἔσχατον ἀεὶ δερματῶδες γίνεται καὶ ὑμενῶδες, ὁ δὲ τόπος οὗτος τοιαύτης πλήρης ἐστὶ τροφῆς. (...) Ἡ μὲν οὖν γένεσις τοῦ ἐπιπλόου συμβαίνει κατὰ τὸν λόγον τοῦτον, καταχρῆται δ' ἡ φύσις αὐτῷ πρὸς τὴν εὐπεψίαν τῆς τροφῆς, ὅπως ῥᾷον πέττῃ καὶ θᾶττον τὰ ζῷα τὴν τροφήν·
>
> "The generation of this part occurs of necessity in the following way; when a mixture of dry and moist is heated, the surface always becomes skin-like and membranous, and this location is full of such nutrient. (...) The generation of the omentum, then, occurs according to this account, and nature makes use of it for the proper concoction of the nutrient, in order that the animals may concoct their nutrient easily and quickly."

The interactions between the material elements explain the coming to be of the omentum, which is not conditionally necessitated in any way. It is also the material potential of the omentum (i.e. its being hot) that explains its contribution to nourishment; the function the part performs is attributed to it, because of the material potentials present in the available material. The teleology operative in these cases is thus secondary teleology.

In a small number of cases, Aristotle refers solely to material necessity to account for the presence of parts or other features, which are not necessary for the performance of necessary functions and also do not immediately contribute to the main function performed by the other parts with which they are associated. The processes that take place because of material necessity and accidentally produce a part are not affected by the actions of the formal nature of an animal (that is, they are not cast out of the body, nor are they actively put to any good use). Ultimately these parts, such as the

spleen[69] and the esophagus,[70] or features such as the color of eyes or the curliness of hair (*GA*.V.1, 778a18-20), seem to be present of necessity in an incidental way.

Pattern M2. *Explanation of the absence of parts by reference to the lack of constitutive material*

This type of explanation appeals to the material make-up of the animal, by simply pointing out that the animal lacks the material necessary for the constitution of a certain part; hence the animal must by necessity lack the part.[71] For instance, the absence of (red) blood in the bloodless animals explains why they do not have any

[69] The explanation of the coming to be and of the presence of the spleen is complicated, as Aristotle refers to different types of necessity in the account. For instance, in *PA*.II.647b3-4 Aristotle compares the generation of the viscera with the coming to be of mud banks, which are deposited by a running stream (the viscera are deposits of the current of blood); this indicates that all the viscera come to be of material necessity. In *PA*.III.7, 669b27-670a2 Aristotle states that there are animals that have a spleen of necessity, while others that do not have it from necessity still have it as a token (for the use of *sémeion* here, see Preus (1975), 128-9). Its presence is then accounted for by reference to the principle of optimal balance and bilateral symmetry: "And it is on account of the liver being positioned more on the right that the nature of the spleen has developed; so that while in a way it is necessary, it is not exceedingly necessary [on this reading, see Lennox (2001b), 346 ad 670a2] in all the animals." The presence of the spleen is necessary for the sake of a symmetrical ordering of the internal organs, but it is not necessary for the sake of some proper function. Next Aristotle claims that "the spleen is present in those that have one of necessity in an incidental way (*kata sumbebékos ex anagkés*), just as the residues are, both the one in the stomach and the one in the bladder" (*PA*.III.7, 670a31-33), and that, although it does not have a proper function, it is not completely useless: "For the spleen draws off the residual fluids from the stomach and because it is blood-like it can assist in the concoction (*dunatai sumpettein*) of them" (*PA*.III.7, 670b4-6).

On the whole it seems that the spleen is not teleologically necessitated in any way (pace Lennox (2001b), 270), and that both its coming to be and its presence are due to some form of material necessity (the more residue is available, the bigger the spleen, unless the residue is directed to feed other parts; the spleen thus seems to take shape when the formal nature does not interact with the natural flow of the residue). Because the presence of the spleen does not harm the animal, but rather, if it becomes big enough, the spleen helps the concoction of food and adds to the symmetry of the body, it is not discharged by the formal nature of those animals in which a spleen 'happens' to come to be.

[70] Aristotle's explanation of the esophagus is even less explicit with regard to both the causes of its coming to be and of its presence (*PA*.III.3, 664a22-24):

> Ὁ δ' οἰσοφάγος ἐστὶ δι' οὗ ἡ τροφὴ πορεύεται εἰς τὴν κοιλίαν· ὥσθ' ὅσα μὴ ἔχει αὐχένα, οὐδ' οἰσοφάγον ἐπιδήλως ἔχουσιν. Οὐκ ἀναγκαῖον δ' ἔχειν τὸν οἰσοφάγον τῆς τροφῆς ἕνεκεν· οὐθὲν γὰρ παρασκευάζει πρὸς αὐτήν.
>
> "The esophagus is that through which nourishment proceeds to the gut; so that all those without necks manifestly do not have an esophagus. But it is not necessary to have the esophagus for the sake of nutrition; for it prepares nothing for nutrition."

The presence of the esophagus seems to be a necessary consequence of the respiratory organ having length, but as Aristotle points out it is not a necessary organ: the mouth could have been placed next to the stomach (*PA*.III.3, 664a24-31; *PA*.III.3, 664a29-31: "And since the organ connected with breathing from necessity has length, it is necessary for there to be the esophagus between the mouth and the stomach"). Aristotle denies that the esophagus performs any proper function: it does not concoct food itself, nor does it contribute anything to nourishment other than letting food pass through (see Lennox (2001b), 252). In this case, again, some derived form of necessity seems to be the cause of the presence of the part.

[71] On this pattern of material explanation, see Lennox (2001b), 228.

viscera (*PA*.IV.5, 678a27-34; discussed in 3.1.4) or fat (*PA*.II.5, 651a26-27), as both are made from blood. Similarly, birds and oviparous quadrupeds lack the outer ears that are present in the other blooded animals (with the exception of fish who lack clear organs of hearing altogether; *PA*.II.10, 656a33-37), because "they do not have the sort of matter from which ears may be formed" (*PA*.II.12, 657a18-24; *PA*.II.12, 657a19-20: *οὐκ οὖν ἔχει τοιαύτην ὕλην ἐξ ἧς ἂν ἔπλασε τὰ ὦτα*). Or, to take yet another example, among the animals with a windpipe, the hard-scaled and feathered animals lack an epiglottis because they have dry flesh and a hard skin, instead of the moist flesh and soft skin that are required for the production of a well-functioning epiglottis (they do have a larynx, which performs the same function as the epiglottis; *PA*.III.3, 664b20-665a9). These animals lack the materials they lack because they are not part of their material nature.[72]

In other animals, the required material is present, but there is not enough of it. Aristotle explains that the reason why the material needed to make the part in question is absent in these animals is because it has already been used up for the constitution of some other part. For instance, it is (partly) for this reason that human beings lack a tail (*PA*.IV.10, 689b21-24: "for the nourishment which is conveyed there is used up on these parts"), or that horned animals generally lack upper incisors (*PA*.III.2, 664a1-3):

> *ἀφελοῦσα γὰρ ἐντεῦθεν ἡ φύσις τοῖς κέρασι προσέθηκε, καὶ ἡ διδομένη τροφὴ εἰς τοὺς ὀδόντας τούτους εἰς τὴν τῶν κεράτων αὔξησιν ἀναλίσκεται.*
>
> "For nature takes from there and adds to the horns, that is, the nourishment assigned to the upper front teeth is expended in the growth of the horns."

The reason why the limited material is distributed to the one part instead of to the other, e.g. to horns rather than to upper incisors, is because in this case the formal

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[72] Cf. *PA*.II.13, 657b13-15; b36. A variation of this type of explanation for the absence of parts by reference to lack of constitutive material is the explanation that refers to the lack of the 'proper location' of a part: the part is absent because the proper location for it is absent. For example, snakes do not have a penis because they lack feet, and the proper place of the penis is between the lower feet (*GA*.I.5, 717b14-19; cf. *GA*.I.7, 718a18):

> *Ἔτι δὲ τὸ ὄργανον τὸ πρὸς τὸν συνδυασμὸν τὰ μὲν τετράποδα ἔχει· ἐνδέχεται γὰρ αὐτοῖς ἔχειν—τοῖς δ' ὄρνισι καὶ τοῖς ἄποσιν οὐκ ἐνδέχεται διὰ τὸ τῶν μὲν τὰ σκέλη ὑπὸ μέσην εἶναι τὴν γαστέρα, τὰ δ' ὅλως ἀσκελῆ εἶναι, τὴν δὲ τοῦ αἰδοίου φύσιν ἠρτῆσθαι ἐντεῦθεν καὶ τῇ θέσει κεῖσθαι ἐνταῦθα.*
>
> "Further, whereas the four-footed animals have the organ for coition, since it is possible for them to have it, birds and footless animals cannot have it because the former have their legs up by the middle of the belly and the latter have no legs at all, while the nature of the penis is connected with the legs and its position is there".

nature assigns priority to the formation of parts for the sake of defense over the formation of a complete set of teeth, which, if realized, would have contributed more to the function of nourishment than an incomplete set of teeth does.[73] Because the two kinds of parts are both non-necessary (for horns do not serve a necessary function, and teeth contribute to the function of nourishment but are not necessary for it),[74] the formal nature of an animal distributes the material present in different ways in each kind of animal, according to what is best for each kind of animal. Here the formal nature distributes the available material according to the function that receives priority in this particular kind of animal after all the necessary parts performing necessary functions have already been formed.

In all the above cases, the formal nature of the animal is constrained in its possibilities to produce parts that could contribute to the animal's well-being by the availability of the right kind of material. The explanation proceeds in two steps: first, Aristotle identifies the kind of material necessary for the production of the part in question in the animals that have it, and secondly, claims that this kind of material is absent in the animals that do not have the part in question.

Pattern M3. *Explanation of non-necessary differentiations of parts by reference to material necessity (and 'the better')*

Aristotle explains non-necessary differentiations by reference to material necessity *and* by reference to the principle that these differentiations are for the better (this principle will be discussed in more detail in 3.3). Non-necessary differentiations are differentiations of parts that contribute to the animal's well-being, but are not necessary for the animal's vital and essential functions and do not constitute a functional optimization of a part technically speaking (i.e. their presence is not necessary on account of – for instance – the animal's way of life to such an extent that the material differentiation is conditionally necessitated by this need). The teleology at stake in these explanations of the differentiation of parts is again

[73] On this 'principle of functional priority', see Lennox (2001a), 192-3.
[74] Horns are not part of the form of horned animals. When Aristotle claims in *PA*.III.2, 664a3-8 that female deer are of the same nature as male deer are, i.e. horn-bearing (αἴτιον τὸ τὴν αὐτὴν εἶναι φύσιν ἀμφοῖν καὶ κερατοφόρον), Aristotle refers to the material or necessary nature of the animal not to its formal nature.

secondary: the material differentiations of a part that occur of necessity are retained (and sometimes adapted) by the formal nature of an animal, which then turn out to be for the best.[75]

We have already seen an example of this type of explanation in discussing the cause of why ducks have webbed feet (see above in 3.2.2). Having webbed feet is a necessary consequence of the earthen effluence occurring of material necessity in the body of birds (*PA*.IV.12, 694a22-694b1), but it is also for the better, as such feet contribute to their aquatic way of life. The contribution this differentiation makes to the specific animal's way of life explains why the feet of ducks are the way they are, but not why the material necessary to make this differentiation came to be; the coming to be of the material constituting this differentiation is due to material necessity. A similar 'double' explanation holds for the fatness of the kidneys. Among all the viscera these organs are the fattest, both because of necessity, and for the better (*PA*.III.9, 672a1-21):

> Ἔχουσι δ' οἱ νεφροὶ μάλιστα τῶν σπλάγχνων πιμελήν, ἐξ ἀνάγκης μὲν διὰ τὸ διηθεῖσθαι τὸ περίττωμα διὰ τῶν νεφρῶν· (...) Ἐξ ἀνάγκης μὲν οὖν πιμελώδεις γίνονται διὰ ταύτην τὴν αἰτίαν ἐκ τῶν συμβαινόντων ἐξ ἀνάγκης τοῖς ἔχουσι νεφρούς, ἕνεκα δὲ σωτηρίας καὶ τοῦ θερμὴν εἶναι τὴν φύσιν τὴν τῶν νεφρῶν. (...)
>
> "The kidneys have the most fat of all the viscera. On the one hand, this is out of necessity, because the residue is filtered through the kidneys. (...) So on the one hand it is of necessity – this is the cause owing to which the kidneys come to be fatty, a consequence of what happens of necessity in animals with kidneys; on the other hand, they are also [fatty] for the sake of the preservation of the hot nature of the kidneys. (...)."

The fat that makes the kidneys the fattest among all viscera comes to be of material necessity, i.e. as a result of the material processes that take place in the kidneys themselves;[76] however, the formal nature of the animals that have kidneys does not

[75] Cf. Aristotle's account of the differences between tails in *PA*.IV.10, 690a1-4. Note that these explanations are different from the ones Aristotle offers with regard to the differentiations of parts that are functional optimizations in a technical sense: those differentiations are explained solely by reference to the best, while the type of necessity at stake is conditional; the need for a functional optimization conditionally necessitates the material differentiation.

[76] Here I disagree with Lennox (2001a), 106-108, who argues that (2001a, 107) "we are told that kidney fat arises for the sake of the contribution it makes to preserving the (hot) nature of the kidneys. This makes it crystal clear that goals are causes, and that in explanation they take priority." I take the function to follow the material potentials present in the material produced by material necessity, and thus to be secondary to the material causes involved. As Lennox points out (2001a, 108) even if there was no good use to which

expel this fat because it serves a good purpose, i.e. it helps the kidneys to preserve their heat.[77]

In sum, material causes (M) are picked out first in:

(1) the explanation of the coming to be of non-necessary, tool-like parts. These parts are made by the formal nature of an animal from the material that is present of material necessity; the function is attributed to the part in accordance with it material potentials;

(2) the explanation of the absence of parts. The material necessary for the constitution of a particular part is altogether lacking in a particular kind of animal or has been used up to produce a part that has functional priority; it is outside the potential of the formal nature of the animal to necessitate the coming to be of – more of – this material;

(3) the explanation of the differentiation of parts that contribute to the animal's well-being; the parts are differentiated the way they are because of the material present due to material necessity, while the formal nature does not expel this material because the differentiation of the part also serves a good purpose.

The material causes picked out in these explanations are the materials that come to be of material necessity; due to their material potentials they serve (or can be put to serve) some good use.

### *3.2.4 Explanation by reference to final causes*

Pattern T1: *Explanation of the presence of all kinds of parts by reference to the function these parts perform*

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the fat around the kidneys could be put, the fat would nevertheless be present due to the material processes described; this indicates that the necessity involved is not conditional upon the end served by the fat.

[77] Another clear example is the explanation Aristotle offers for the ability of snakes to turn their head to the rear while the rest of the body is at rest, which is a distinctive feature of snakes (*PA*.IV.11, 692a2-7): the capacity to coil is a necessary consequence of snakes having a cartilaginous backbone; the function of coiling follows from the material potentials present in the backbone. This capacity is also for the better, as it allows snakes to protect themselves better and thus contributes to their well-being.

With a few exceptions, Aristotle ultimately explains the presence of parts by reference to the function they perform within the animal. For instance, the larynx is present in the animals that have it for the sake of breathing (*PA*.III.3, 664a17-20):

> Ὁ μὲν οὖν φάρυγξ τοῦ πνεύματος ἕνεκεν πέφυκεν· διὰ τούτου γὰρ εἰσάγεται τὸ πνεῦμα τὰ ζῷα καὶ ἐκπέμπει ἀναπνέοντα καὶ ἐκπνέοντα.
>
> "The larynx is present by nature for the sake of breath; for through this part animals draw in and expel breath when they inhale and exhale."

Animals for which breathing air is a necessary function all have a larynx; the function of breathing conditionally necessitates the presence of the larynx. The teleology involved is thus primary teleology. However, the need for the function that the larynx is to perform follows from the essence of the animal as being a breather: what is thus causally primary in this explanation is the animal's being a breather[78] (which is a formal cause),[79] while the function that explains the presence of the part follows from this essence.

Another example is Aristotle's explanation of the presence of eyebrows and eyelashes (*PA*.II.15, 658b14-25):

> Αἱ δ' ὀφρύες καὶ αἱ βλεφαρίδες ἀμφότεραι βοηθείας χάριν εἰσίν (...). αἱ δὲ βλεφαρίδες ἐπὶ πέρατι φλεβίων· ᾗ γὰρ τὸ δέρμα περαίνει, καὶ τὰ φλέβια πέρας ἔχει τοῦ μήκους. Ὥστ' ἀναγκαῖον διὰ τὴν ἀπιοῦσαν ἰκμάδα σωματικὴν οὖσαν, ἂν μή τι τῆς φύσεως ἔργον ἐμποδίσῃ πρὸς ἄλλην χρῆσιν, καὶ διὰ τὴν τοιαύτην αἰτίαν ἐξ ἀνάγκης ἐν τοῖς τόποις τούτοις γίνεσθαι τρίχας.
>
> "The eyebrows and eyelashes are both for the sake of protection. (...) The eyelids are at the ends of small blood vessels; for where the skin terminates, the small blood vessels also reach their limit. So because the moist secretions oozing are bodily, it is necessary that – unless some function of nature stops it with a view to another use – even owing to a cause such as this, hair from necessity comes to be in these locations."

Eyebrows and eyelashes are both for the sake of protection, and it is this function that explains the *presence* of these parts. However, what is causally prior in this explanation is the materially necessitated *coming to be* of the materials forming the eyebrows and eyelashes. The function eyebrows and eyelashes perform is non-necessary (but rather contributes to the animal's well-being) and is posterior to the

[78] Cf. Lennox (2001b), 251.
[79] Cf. Charles (1997), 30: "The favoured mode of explanation applicable to biological natural kinds is teleological, and the Form of the kind is the explanatorily basic feature."

coming to be of the materials constituting the parts. The function these parts perform explains why nature has not redirected this flow of material to another place or why it has not used it for something else.

In both examples, the function explains the presence of a part, but the role of the final cause in the explanation is very different in each case: in the first example by being subsumed in the definition of the substantial being of an animal it precedes (and conditionally necessitates) the coming to be of the parts, while in the second example it follows from the presence of materially necessitated parts. In both examples there are other causes at play that turn out to be causally prior to the final causes: final causes are thus picked out first in these examples, but they are not explanatorily basic. The functions parts play and for which they are present are either contained in an animal's essence, or are attributed to a part because of the material potentials present.

In addition, Aristotle explains the presence of parts not only by reference to one function, but to a plurality of functions performed by the part.

For instance, this is how Aristotle explains the presence of teeth (*PA*.II.9, 655b8-11):

> Ἐν τούτῳ δὲ τῷ γένει καὶ ἡ τῶν ὀδόντων ἐστὶ φύσις, τοῖς μὲν ὑπάρχουσα πρὸς ἓν ἔργον τὴν τῆς τροφῆς ἐργασίαν, τοῖς δὲ πρός τε τοῦτο καὶ πρὸς ἀλκήν, οἷον τοῖς καρχαρόδουσι καὶ χαυλιόδουσι πᾶσιν.
>
> "The nature of teeth is also in this kind [i.e. in parts that have been devised for the sake of protection], in some cases present for a single function, the preparation of nourishment, in other cases present both for this and for defense, e.g. in all those with saw-like teeth or with tusks."

In some animals, teeth are both present for the sake of nourishment (which is the function for which teeth are present in all animals that have teeth) and for the sake of defense. In those animals that have teeth for both functions, the teeth are differentiated in such a way to accommodate for this second function; as Aristotle points out, their teeth are saw-like or they have tusks. A comparison with Aristotle's account of lips in human beings might be helpful here. According to this account, lips are present in those animals that have them for the sake of protecting their teeth,

but in human beings they serve the second function of speech (*PA*.II.16, 659b30-660a2):

> οἱ δ' ἄνθρωποι μαλακὰ καὶ σαρκώδη καὶ δυνάμενα χωρίζεσθαι, φυλακῆς τε ἕνεκα τῶν ὀδόντων ὥσπερ καὶ τὰ ἄλλα, καὶ μᾶλλον ἔτι διὰ τὸ εὖ· πρὸς γὰρ τὸ χρῆσθαι τῷ λόγῳ καὶ ταῦτα. Ὥσπερ γὰρ τὴν γλῶτταν οὐχ ὁμοίαν τοῖς ἄλλοις ἐποίησεν ἡ φύσις, πρὸς ἐργασίας δύο καταχρησαμένη, καθάπερ εἴπομεν ποιεῖν αὐτὴν ἐπὶ πολλῶν, τὴν μὲν γλῶτταν τῶν τε χυμῶν ἕνεκεν καὶ τοῦ λόγου, τὰ δὲ χείλη τούτου τε ἕνεκεν καὶ τῆς τῶν ὀδόντων φυλακῆς.
>
> "But human beings have lips which are soft, fleshy, and capable of separation, both for the sake of protecting the teeth (as the others do), and even more on account of the good; for these can also be used for speech. For just as nature made the human tongue unlike the tongues of other animals, using it for two operations, as we say it does in many cases, so it does with the lips – it makes use of the tongue for the sake of both flavors and speech, while it makes use of the lips for the sake of both speech and the protection of teeth."

What this latter example makes especially clear is that the reference to the second function a part performs does not so much explain the presence of that part, but rather its material differentiation relative to similar parts in other animals where this second function is missing (for this type of explanation, see below).[80] The second function is presumably lower in the functional hierarchy than the first and primary function,[81] which conditionally necessitates the coming to be of the part in question.

Regardless of the cause(s) of the coming to be of a part, its presence is always accounted for by reference to its function within the animal kind to which it belongs.

Pattern T2: *Explanation of the presence of non-necessary, subsidiary parts by reference to the function to which these parts contribute*

[80] Cf. Aristotle's remarks on the material adaptations of the tongue and lips required for the accommodation of the second function in *PA*.II.16, 660a4-6: "For vocal speech is composed out of articulate sounds; and if the tongue were not such as it is, nor the lips moist, most of these articulate sounds could not be spoken, since some result from pressing of the tongue, other from pursing of the lips."

[81] For instance, because the first is present in all animals and the second is not; or because the first is more necessary for the survival and overall well-being of the animal than the second function is.

Aristotle explains the presence of non-necessary, subsidiary parts by reference to the function (primarily and properly performed by another part) to which these parts contribute. The parts to be explained are either (i) a container or protective device of other parts, or, most commonly, (ii) 'for the good' or 'for the better', where 'better' means a better performance of the function that belongs primarily and properly to another part (the expression is part of a principle that will be discussed below in 3.3). As was indicated before (see above in 3.1.2), Aristotle endorses a hierarchy between parts, where some are necessary, others are non-necessary but subsidiary to other parts, and still other non-necessary but performing 'luxurious' functions, thus contributing to the well-being of an animal. This type of explanation pertains to the second category of parts that are in a sense supervening on the presence of other parts.

Take the examples of the head and the kidneys. Aristotle explains the presence of the head by referring to its function as being for the sake of the brain (*PA*.IV.10, 686a5-6):

> Ἔστι δ' ἡ μὲν κεφαλὴ μάλιστα τοῦ ἐγκεφάλου χάριν·
>
> "The head is present above all for the sake of the brain."

The function of the head is to be a container[82] for the brain, which is itself a necessary part in blooded animals.

The presence of the kidneys is explained as being for the better. The function of the kidneys is to 'assist' another part, in this case the bladder, which performs a function on its own (*PA*.III.7, 670b23-27):

> Οἱ δὲ νεφροὶ τοῖς ἔχουσιν οὐκ ἐξ ἀνάγκης, ἀλλὰ τοῦ εὖ καὶ καλῶς ἕνεκεν ὑπάρχουσιν· τῆς γὰρ περιττώσεως χάριν τῆς εἰς τὴν κύστιν ἀθροιζομένης εἰσὶ κατὰ τὴν ἰδίαν φύσιν, ἐν ὅσοις πλεῖον ὑπόστημα γίνεται τὸ τοιοῦτον, ὅπως βέλτιον ἀποδιδῷ ἡ κύστις τὸ αὑτῆς ἔργον.
>
> "The kidneys are present in those that have them not of necessity but for the sake of the good and doing well. That is, they are present, in accordance with their distinctive nature, for the sake of the residue which collects in the bladder in those animals in which a greater amount of such excrement comes about, in order that the bladder may perform its function better."

[82] Cf. the 'container-function' of the neck in *PA*.III.3, 664a15-18 "for not all animals have this part, but only those with the parts for the sake of which the neck is naturally present, and these are the larynx and the part called the esophagus."

Aristotle claims that kidneys are not necessary parts, but rather are parts that contribute to the well-being of animals – they are for the good. Kidneys contribute to the function performed by the bladder (which is the collection of residue) by providing extra storage-room for residue; the function could be performed without the presence of the kidneys, but their presence adds to the performance of the function and therefore to the well-being of the animal.

Subsidiary parts are thus parts that are present in order to contribute to functions properly and primarily performed by other parts.

Pattern T3: *Explanation of the absence of all kinds of parts by reference to their (presumed) presence being functionless*

Aristotle explains the absence of parts mostly by pointing out that if they had been present, they would not have had a function (or they would have functioned badly), and that because 'nature does nothing in vain', nature does not create such parts. In these explanations, Aristotle introduces a principle concerning "what nature always or regularly does" into the explanatory framework, namely that the principle that 'nature does nothing in vain, but always, given the possibilities, what is best for the substantial being of each kind of animal'. The nature and explanatory force of this principle will be further discussed below (see 3.3), but for now it may suffice to outline its basic use as defended by Lennox.[83] All the explanations that make use of this principle build upon the counterfactual argument that had the part been present in the animal in question, the part would have been in vain (*matên*) or superfluous (*periergon*), and since nature does nothing in vain or superfluously, there is no such part. Aristotle uses as it were a kind of thought-experiment: imagine the part would have been present in the animal, and then think of the consequences. If the consequences are bad, then that is why the part is not present in reality.

There are four reasons why Aristotle considers parts or features to be without a function. In the first place, a part is considered to have no function in a particular kind of animal because the animal in question already possesses another part performing that function. Because nature does not allow for functionally

[83] Lennox (2001a), 205-23.

equivalent or redundant parts, the 'second' part is not produced. For this reason, no animal has both gills and lungs, because (*Resp.*10, 476a11-15):

> ἓν δ' ἑφ' ἑν χρήσιμον ὄργανον, καὶ μία κατάψυξις ἱκανὴ πᾶσιν, ὥστ' ἐπεὶ μάτην οὐδὲν ὁρῶμεν ποιοῦσαν τὴν φύσιν, δυοῖν δ' ὄντοιν θάτερον ἂν ἦν μάτην, διὰ τοῦτο τὰ μὲν ἔχει βράγχια τὰ δὲ πνεύμονα, ἄμφω δ' οὐδέν.
>
> "One organ is useful for one thing, and in every case one mode of cooling is sufficient. So, since we see that nature does nothing in vain, and that if there were there two [organs for cooling] one would be in vain, for this reason some have gills, some have a lung, but none has both."

It is thus not because the part itself is without a function entirely, but rather that it is without a function in the context of the whole animal to which it would belong. The presence of lungs is very much required in all blooded animals that breathe air, and because these animals do indeed have lungs that perform the function of cooling the body, they do not need a second part performing that same function. In some sense, it is the presence of another part performing a particular function, which makes the presence of the part in question in vain. For this reason there are no heavy birds with both spurs and talons, since having only one of those parts is sufficient for the protection of the bird (*PA.*IV.12, 694a13-20). Moreover, spurs could not be used by taloned and powerful fliers – a fact which makes spurs double useless (*PA.*IV.12, 694a16: ἄχρηστα) in these kinds of birds.

In the second place, Aristotle thus also considers a part to be in vain or superfluous when the animal in question is not able to use the part – either at all or to use it properly. For instance, Aristotle explains the absence of horizontal jaw motion in fish, birds, and egg-laying, four-footed animals by their lack of having teeth suitable for the grinding of food, which would make the presence of a horizontal jaw motion superfluous (*PA.*IV.11, 691b1-5):

> Τοῖς μὲν οὖν ἔχουσι γομφίους χρήσιμος ἡ εἰς τὸ πλάγιον κίνησις, τοῖς δὲ μὴ ἔχουσιν οὐδὲν χρήσιμος, διόπερ ἀφῄρηται πάντων τῶν τοιούτων· οὐδὲν γὰρ ποιεῖ περίεργον ἡ φύσις.
>
> "Therefore for those that have grinding teeth, sideways motion is useful, but for those that do not, it is not useful at all, which is why they have been taken away from all such animals; for nature produces nothing superfluous."

Aristotle's description of the action of the formal nature within this 'thought-experiment' is striking: parts or features that could reasonably be expected to have

been present in the 'design' of a particular kind of animal, are 'taken away' by nature if they are not functional given the other parts and features the animal has.

In the third place, Aristotle explains the absence of a part not only by its functional redundancy, but also by its potential harmfullness had it been present in the animal. This is for instance how Aristotle explains the absence of crooked claws in heavy birds (*PA*.IV.12, 694a16-18):

> διὸ ὑπάρχει ἐνίοις τῶν βαρέων. Τούτοις δ' οὐ μόνον ἄχρηστοι ἀλλὰ καὶ βλαβεροὶ οἱ γαμψοὶ ὄνυχες τῷ ἐμπήγνυσθαι ὑπεναντίοι πρὸς τὴν πορείαν ὄντες.
>
> "That is why [spurs] belong to the heavy [birds], while in these birds crooked claws would not only be useless but actually harmful, being, by getting stuck in the ground, contrary to walking."

Similarly, in the case of serpentine fish, having fins would be in vain, because moving by only four points would make the serpentine fish (just as snake on land) move in a bad way (*PA*.IV.13, 696a10-15; *PA*.IV.13, 696a12: Ἢ γὰρ κακῶς ἂν ἐκινοῦντο).

In the fourth and last place, Aristotle considers parts to be in vain or functionless in the case where the animal does not need the function performed by the part.[84] This is the explanation Aristotle offers for the absence of eyelids in fish (an absence which is remarkable, since all other kinds of animals with moist eyes have eyelids for the sake of protection). Because fish live in a habitat where there are not many things that strike them from without, their eyes do not need any extra protection – eye-protection would be in vain (*PA*.II.13, 658a6-10):

> ἐκείνοις δ' ἐπεὶ τὸ ὕδωρ πρὸς μὲν τὸ ὀξὺ βλέπειν ἐναντίον, οὐκ ἔχει δὲ πολλὰ τὰ προσκρούσματα πρὸς τὴν ὄψιν ὥσπερ ὁ ἀήρ, διὰ μὲν τοῦτ' οὐκ ἔχει βλέφαρον (οὐδὲν γὰρ ἡ φύσις ποιεῖ μάτην), πρὸς δὲ τὴν παχύτητα τοῦ ὕδατος ὑγρόφθαλμοί εἰσιν.

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[84] In a small number of cases, Aristotle connects the notion of *kairos*, the right moment, to the principle that nature does nothing in vain; the implication is that nature does not make parts before, nor after an animal needs the part (which explains the absence of a part before or after the *kairos*). This connection can be used to explain the moment of generation of a part. This is how Aristotle explains the moment of the separation of the two eyelids (*GA*.II.6, 744a35-b1; cf. *GA*.V.8, 788b20-789a2 concerning teeth):

> τοιοῦτον δ' ἐστὶ μόριον τὸ βλέφαρον. ἐπεὶ δ' οὐθὲν ποιεῖ περίεργον οὐδὲ μάτην ἡ φύσις δῆλον ὡς οὐδ' ὕστερον οὐδὲ πρότερον· ἔσται γὰρ τὸ γεγονὸς ἢ μάτην ἢ περίεργον. ὥσθ' ἅμ' ἀνάγκη τὰ βλέφαρα διαχωρίζεσθαί τε καὶ δύνασθαι κινεῖν.
>
> "Now the eyelid is such a part. But since nature makes nothing superfluous nor in vain, it is clear also that she makes nothing too late or too soon, for if she did the result would be either in vain or superfluous. Hence it is necessary that the eyelids should be separated at the same time as [the heart] is able to move them."

> "But for those [i.e. fish], since water has the opposite effect on sharp vision, but there are not as many obstacles to vision than with air – for this reason fish on the one hand do not have eyelids (for nature does nothing in vain), and on the other have moist eyes in consequence of the density of the water."

If the items that are responsible for causing a specific need for a particular kind of animal are absent in a related or similar group of animals, then the part that fulfills this need in the first group of animals must also be absent in the second group of animals.

Pattern T4: *Explanation of non-necessary and necessary differentiations of parts by reference to 'the better'*

As we saw above in 3.2.3, Aristotle frequently explains differentiations of parts by reference to 'the better', and does so often in conjunction with references to necessity.

Here the distinction between two types of differentiations between parts becomes important. On the one hand there are non-necessary differentiations that are due to materials and material changes that have come to be of material necessity and that are preserved within the part because they contribute to the well-being of the animal. The teleology at stake is secondary, and the necessity is material. On the other hand, there are differentiations that are necessary for the sake of the functional optimalization of a part within a specific kind of animal. For instance, all animals have eyes, but the specific kind of eye (moist or hard, with or without eyelids, etc.) they have depends on their particular way of life (the cause of the differentiation is generally a factor belonging to one of the four kinds of differentiae). The need for a specific kind of animal to perform a function *in a certain way* determines by conditional necessity the particular material constitution of the part that performs that function within that kind of animal. 'For the better' here means not just what contributes to the well-being of the animal in question, but specifically what is best for the substantial being of this kind of animal given the possibilities; the particular material differentiation of a part is for the sake of a better performance of the function for the sake of which the part has come to be in this particular kind of animal. The teleology at stake is thus primary, and the necessity is conditional. Note

that Aristotle explains necessary differentiations *only* by reference to the functional optimalizations these differentiations provide.

Aristotle formulates the difference between the two types of differentiations as follows (*PA*.II.2, 647b29-648a15):

> Αὐτῶν δὲ τούτων αἱ διαφοραὶ πρὸς ἄλληλα τοῦ βελτίονος ἕνεκέν εἰσιν, οἷον τῶν τε ἄλλων καὶ αἵματος πρὸς αἷμα· (...) Διὸ καὶ τὰ ἄνω μόρια πρὸς τὰ κάτω ταύτην ἔχει τὴν διαφοράν, καὶ πρὸς τὸ θῆλυ αὖ τὸ ἄρρεν, καὶ τὰ δεξιὰ πρὸς τὰ ἀριστερὰ τοῦ σώματος. Ὁμοίως δὲ καὶ περὶ τῶν ἄλλων καὶ τῶν τοιούτων μορίων καὶ τῶν ἀνομιομερῶν ὑποληπτέον ἔχειν τὴν διαφοράν, τὰ μὲν πρὸς τὸ βέλτιον ἢ χεῖρον, τὰ δὲ πρὸς τὰ ἔργα καὶ τὴν οὐσίαν ἑκάστῳ τῶν ζώων, οἷον ἐχόντων ὀφθαλμοὺς ἀμφοτέρων τὰ μέν ἐστι σκληρόφθαλμα τὰ δ' ὑγρόφθαλμα, καὶ τὰ μὲν οὐκ ἔχει βλέφαρα τὰ δ' ἔχει πρὸς τὸ τὴν ὄψιν ἀκριβεστέραν εἶναι.
>
> "The relative differences between things of the same kind are for the sake of the better – that is, the differences both of other parts and of blood from blood. (...) It is for this reason too that the upper parts differ in this way compared with the lower parts, and again the male compared to the female, and the right side of the body with the left. And likewise with the other parts, both the parts such as these and the non-uniform parts: they should be assumed to possess a difference in some cases relative to what is better or worse, in other cases relative to each animal's functions and substantial being – for example, among those two kinds with eyes, some are hard-eyed, and others are moist-eyed, and some do not have eyelids, while others do with a view to a greater accuracy of sight."

I take the example of the differentiation of eyes to be an example of differentiations that are *necessary* for each animal's functions and substantial being (and that are therefore conditionally necessitated). The differentiation pertains to a modification of a part that performs an essential function, while the modification allows for a better performance of this function in those animals that need it; this functional optimalization of the part is necessary for all animals that have it given their way of life (and/or given other basic features). All eyes are present for the sake of sight, while the differentiations between the eyes in different kinds of animals are for the sake of the better, i.e. for the sake of enhancing the accuracy of sight in those animals that need a greater accuracy of sight relative to other animals that have vision. The differentiations that are for the better or the worse I take to be

differentiations that are not necessary for the animal's performance of essential and vital functions, or for its substantial being, but rather contribute to its well-being.

We have already discussed a few examples of non-necessary differentiations that Aristotle explains by reference to the better and to material necessity: ducks having webbed feet (*PA*.IV.12, 694a22-694b10); human beings having the most hairy heads of all animals with hair (*PA*.II.14, 658b2-8); kidneys being the fattest of all viscera (*PA*.III.9, 672a1-21). The material constitution of these parts are differentiated the way they are both on account of the flow of material that is present of material necessity, and on account of the formal nature of the animal being able to use this extra material in adapting the part in such a way that it is for the better for the animal that has the part.[85]

Let me now give an example of a necessary differentiation of a part that Aristotle explains by reference to how it is for the sake of the functional optimalization of that part: the case of the birds' wings. Aristotle explains the differentiation of the birds' wings by reference to how this differentiation is useful for the way of life of each particular kind of bird (*PA*.IV.12, 693b28-693a9):

> Ἔτι τῶν ὀρνίθων οἱ μὲν πτητικοὶ καὶ τὰς πτέρυγας ἔχουσι μεγάλας καὶ ἰσχυράς, οἷον οἱ γαμψώνυχες καὶ οἱ ὠμοφάγοι· ἀνάγκη γὰρ πτητικοῖς εἶναι διὰ τὸν βίον, ὥσθ' ἕνεκα τούτου καὶ πλῆθος ἔχουσι πτερῶν καὶ τὰς πτέρυγας μεγάλας. Ἔστι δ' οὐ μόνον τὰ γαμψώνυχα ἀλλὰ καὶ ἄλλα γένη ὀρνίθων πτητικά, ὅσοις ἡ σωτηρία ἐν τῇ ταχυτῆτι τῆς πτήσεως ἢ ἐκτοπιστικά. Ἔνια δ' οὐ πτητικὰ τῶν ὀρνίθων ἐστὶν ἀλλὰ βαρέα, οἷς ὁ βίος ἐπίγειος καὶ ἔστι καρποφάγα ἢ πλωτὰ καὶ περὶ ὕδωρ βιοτεύουσιν. Ἔστι δὲ τὰ μὲν τῶν γαμψωνύχων σώματα μικρὰ ἄνευ τῶν πτερύγων διὰ τὸ εἰς ταύτας ἀναλίσκεσθαι τὴν τροφὴν εἰς τὰ ὅπλα καὶ τὴν οἰθειαν· τοῖς δὲ μὴ πτητικοῖς τοὐναντίον τὰ σώματα ὀγκώδη, διὸ βαρέα ἐστίν.
>
> "Further, some of the birds are able to fly and have large, strong wings, e.g. those with talons, and the flesh-eaters; it is a necessity for them to be able to fly on

[85] In addition, there are differentiations that concern the location of a part within an animal's body relative to the location the part usually has in other related or similar animals, rather than its material constitution. Aristotle explains these too by reference to the better, but here 'the better' means the most valuable location, which is as far as possible to the right, to the front, and in the upper part of the body. For example, Aristotle answers the question why human beings have more hair on their underbellies than on their backs (while other four-footed animals have more hair on their backs) by reference to the better (*PA*.II.14, 658a16-24; 658a22-24):

> τοῖς τιμιωτέροις ὑπέγραψεν ἡ φύσις τὴν βοήθειαν· ἀεὶ γὰρ ἐκ τῶν ἐνδεχομένων αἰτία τοῦ βελτίονός ἐστιν.
>
> "Therefore nature adds this protection to the more valuable parts, because it is always a cause of the better among the possibilities."

> account of their way of life, so for the sake of this they have both many feathers and large wings. It is not, however, only the taloned birds, but other kinds of birds as well that are able to fly, namely all those for whom self-preservation lies in the quickness of their flight or that are migratory. But some birds are not able to fly, but are heavy – those whose way of life is earthbound and that are fruit-eaters or are swimmers and spend their life around water."

Wings are differentiated in the way they are in the birds that have them according to their ways of life. For those birds for which it is necessary to be able to fly – or more specifically, for which it is necessary to fly fast or for long distances – the wings are made large and strong, with many feathers. For those birds for which it is not necessary to fly, because they find their food on the ground or in and around the water, the wings are heavy. Wings have to perform the function of flying in different ways in different kinds of birds; the way in which the function has to be performed in a particular kind of bird is determined by the animal's way of life (or another factor among the differentiae). Thus, in explanations like these, the differentiae will have causal priority: the differentia (e.g. being migratory) specifies the function a part has to perform within a particular kind of animal (e.g. flying long distances); this functional specification conditionally necessitates the material differentiation of the part (e.g. large, strong wings); and the material differentiation of the part facilitates the functional optimization of the part within this animal.

In sum, through picking out the differentiae that specify the function parts have to play within particular kinds of animal, Aristotle shows how a material differentiation of a part is for the sake of the functional optimization of that part. We find again that the function is the first cause picked out in this type of explanation (differentiations are for the sake of functional optimizations), but it is not explanatorily basic; the functional specification a part will have to play is determined by some other basic factor, such as the animal's way of life. I will return to this issue in chapter five.

Pattern T5: *Explanation of the differentiation of parts by reference to a second function the part needs to perform*

As we saw above, Aristotle on occasion refers to two or more functions to explain the presence of a part in the animals that have it. In these explanations, only the first and primary function explains properly the presence of the part. The secondary and lower functions (i.e. the functions that are lower in the functional hierarchy, e.g. because they are less necessary) explain the *extra* differentiations of the part among those animals in which the part has to fulfill a multiplicity of functions (these differentiations are extra because they come on top of the differentiations that are already present for the sake of the better performance of the first function in each specific kind of animal).[86] The differentiations are explained as being necessary for the accommodation of the second function that needs to be performed by the part, in addition to its first and proper function.

The two following examples will make clear how these two different types of explanations are used together to account for both the presence and the differentiation of a part. The first concerns the presence and the differentiation of mammae in human beings. The common function of mammae in human beings is the protection of the region around the heart (and it is this function that account for the presence of mammae in human beings), but in females, the mammae also perform a second function (*PA*.IV.10, 688a19-25):

> τοῖς δ' ἀνθρώποις διὰ τὴν εὐρυχωρίαν καὶ τὸ σκεπάζεσθαι δεῖν τὰ περὶ τὴν καρδίαν, διὰ τοῦτο ὑπάρχοντος τοῦ τόπου σαρκώδους οἱ μαστοὶ διήρθρωνται, σαρκώδεις ὄντες τοῖς μὲν ἄρρεσι διὰ τὴν εἰρημένην αἰτίαν, ἐπὶ δὲ τῶν θηλειῶν παρακέχρηται καὶ πρὸς ἕτερον ἔργον ἡ φύσις, ὅπερ φαμὲν αὐτὴν πολλάκις ποιεῖν· ἀποτίθεται γὰρ ἐνταῦθα τοῖς γεννωμένοις τροφήν.
>
> "In human beings, however, because of the wide expanse of the breast and the need to shelter the parts around the heart, and since the location is fleshy, the mammae have been differentiated. In males they are fleshy owing to the aforementioned cause, while in females nature has turned them to an additional function as well, which we claim it often does; for it stores nourishment there for the offspring."

[86] For the two 'layers' of differentiations, see Lennox (2001b), 245.

Aristotle introduces the storage of milk or lactating as an addition function of the mammae, and this explains the material differences between male and female breasts.[87]

A similar explanation holds for the differentiations between teeth (*PA*.III.1, 661a36-b6):

> Τοῖς μὲν οὖν ἄλλοις ἡ τῶν ὀδόντων φύσις κοινὴ μὲν ἐπὶ τὴν τῆς τροφῆς ἐργασίαν ὑπάρχει, χωρὶς δὲ κατὰ γένη τοῖς μὲν ἀλκῆς χάριν, καὶ ταύτης διῃρημένης, ἐπί τε τὸ ποιεῖν καὶ τὸ μὴ πάσχειν· τὰ μὲν γὰρ ἀμφοῖν ἕνεκεν ἔχει, καὶ τοῦ μὴ παθεῖν καὶ τοῦ ποιεῖν, οἷον ὅσα σαρκοφάγα τῶν ἀγρίων τὴν φύσιν ἐστίν, τὰ δὲ βοηθείας χάριν, ὥσπερ πολλὰ τῶν ἀγρίων καὶ τῶν ἡμέρων.
>
> "In animals other than mankind, the nature of the teeth is present in common[88] for the preparation of nutrition, yet distinctively according to kinds. In some it is present for the sake of strength, which in turn has been divided into strength to attack and strength to avoid attack; for some animals have teeth for the sake of both of avoiding attack and of attacking, e.g. those wild animals which are carnivorous in nature; while others have them for the sake of protection, as many of the wild and tame animals do."

According to this passage, the common function of teeth is the preparation of nutrition, which means that in all animals that have teeth, the teeth are present for the sake preparing nutrition. On top of this, teeth are 'differentiated according to kinds', that is, according to the second function teeth have to perform in the different kinds of animals that have teeth. In some animals, teeth are also for the sake of strength, which is subdivided into the functions of strength to attack and strength to avoid attack. Now, according to Aristotle some animals have teeth (for the sake of the preparation of nutrition and) for the sake of both the strength to attack and to avoid attack, such as wild carnivorous animals do. Other animals have teeth (for the sake of the preparation of nutrition and) for the sake of avoiding attack or protection only, such as many of the wild and tame animals do. In the

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[87] Here Lennox (2001b, 322) notes a problem regarding this explanation of mammae in human beings: if lactating is the secondary, and not the primary function, for which breasts are present, how come males have nipples? There might not be a satisfactory answer to this problem, but perhaps Aristotle could have replied that having mammae is a distinctive feature of all animals that bear live young internally (cf. *PA*.IV.11, 692a8-15). Now since both male and female share the same formal nature, i.e. they are both live-bearing even though only the females bear young, and since the nipples are harmless in males (unlike horns in hoofed females, see *PA*.III.2, 664a), they are present in males, too. Usually, it are the females, instead of the males, who 'have less' of the necessary parts (*PA*.III.1, 661b34-662a1).

[88] Cf. *PA*.III.1, 661b7: *koinê chrêsis*.

remainder of the chapter, Aristotle connects this division of animals based on the multiplicity and hierarchy of functions their teeth have to perform to the material differentiations of teeth. For instance, male pigs have tusks (for the sake of nutrition and protection in the form of spearing), while the female pigs have sharp, interlocking teeth (i.e. they are saw-toothed for the sake of nutrition and protection in the form of biting). Aristotle summarizes his explanation of the differentiation of parts where a multiplicity of functions is at stake as follows (*PA*.III.1, 662a22-24; this is near the end of the chapter, where Aristotle discusses the differentiation of the mouth):

> Ἡ δὲ φύσις ἅπαντα συνήγαγεν εἰς ἕν, ποιοῦσα διαφορὰν αὐτοῦ τοῦ μορίου πρὸς τὰς τῆς ἐργασίας διαφοράς.
>
> "But nature has collected all these uses together in one, producing a differentiation of this part for the differences of its operation."

In sum, the first and common function of a part explains primarily its presence and secondarily and in a general way its material constitution and location in the animal's body. The secondary and specific functions of that part (which are different in all the animals that have that part) explain primarily and in a very specific way its material constitutions and only secondarily its presence. The exact differentiation a part has within a specific kind of animal is thus determined by all the functions that part has to perform within that animal (and also by restrictions on the way these functions have to be performed); with each addition of another function the dispositional properties of the part get more determined.

In sum, final causes (T) are picked out first in:

(1) the explanation of the presence of all kinds of parts by reference to the function(s) these parts need to perform in the kinds of animals that have those parts; the function explains the presence and coming to be of necessary parts; the function explains the presence of non-necessary parts;

(2) the explanation of the presence of non-necessary, subsidiary parts by reference to the function to which these parts contribute; subsidiary parts are for the sake of enhancing the performance of a function that is primarily performed by other parts;

(3) the explanation of the absence of all kinds of parts by reference to their presence being functionless; here Aristotle employs the principle that 'nature does nothing in vain' (on this principle, see more below in 3.3.1.c);

(4) the explanation of non-necessary and necessary differentiations of parts by reference to 'the better' (non-necessary differentiations are of necessity and for the better, i.e. their contribution to the well-being of the animal; necessary differentiations are for the sake of the functional optimization of the part within the specific animal that has it);

(5) the explanation of the differentiation of parts by reference to a second function the part needs to perform; both the primary and secondary functions cause material differentiations of the part, but it is in particular the secondary function that explains the differentiations of a part relative to other animals in which this part only performs the primary function.

The final causes picked out in these explanations are the functions of parts, which are either primary or secondary in the functional hierarchy of all functions that an animal needs to perform, and the result of either primary or secondary teleology.

Aristotle's *PA* is very rich in its explanatory strategies. Depending on whether it is the presence, absence, or differentiation of a part that needs to be explained, and depending on the status of the part involved (i.e. either necessary or 'for the better', where for the better points to a subsidiary or luxurious function), Aristotle employs different kinds of explanations.

In almost every type of explanation, we find some reference to teleology. Functions are included in essences and the latter figure as the causes of the presence of necessary parts; non-necessary, luxurious parts are explained by reference to secondary teleology, where the formal nature of the animal follows the potentials of the material present due to material necessity in forming a functional part. Differentiations of parts, whether or not they come to be of necessity, and whether or not they are necessary or non-necessary for the animals that have them, are always 'for the better': they enhance the performance of the function of a part for which the part is present and thereby contribute to the animal's survival or well-being.

However, in all these explanations, it is either the form (i.e. the definition of the substantial being of the animal), a differentia (i.e. the animal's way of life, its activities, character, and the parts it possess), or matter (or, more specifically, material potentials) that turns out to be causally basic, while the functions parts perform and for the sake of which they are present follow from these causally basic factors. Final causes seem to be most pervasive and often picked out first in the explanations Aristotle provides of biological phenomena, but they are not primary in a causal way. Final causes rather seem to be primary in an epistemological or in a heuristic way, for they are primary in understanding and explanation. I will return to this observation at the end of section 3.4, after having discussed the use and explanatory force of teleological principles in 3.3 and the relation between teleology and necessity in 3.4.

In any case, what should be clear by now is that Aristotle does not take one basic, defining feature of the animal as the starting point for the explanations of all the other features belonging to (or missing in) the animal in question.[89] The essence or form of an animal is an important explanatory feature, but only of all the necessary parts the animal actually has; other (missing) features are explained by reference to other explanatorily basic facts, such as life style and the material potentials available to the animal during generation. Moreover, the analysis of different types of explanations above suggests that essences are complexes of explanatorily basic facts (minimally including all the necessary life-functions, all the distinctive essential functions, the animal's dimensions, and perhaps also the ratio of the elemental materials of which the animal is constituted), rather than exhibiting one, simple, and unifying feature from which all the other features can be derived.

## 3.3 Teleological principles of explanation

### *3.3.1 The use and function of principles in Aristotle's biology*

In the examples of explanations discussed above, we sometimes found Aristotle drawing inferences from universal statements concerning what the formal nature of an animal – simply referred to as 'nature' – always or never does or make when it is

[89] On this conclusion, cf. Charles (1997), 33.

said to generate the animal. These universal statements are principles positing the goal-directedness of the actions of the formal nature.[90]

I distinguish three teleological principles (formulated variously) that are operative in Aristotle's biology. First, there is the principle of 'balanced distribution', pertaining to the goals formal natures pursue in distributing the parts over the animal's body. Secondly, there is the principle of 'economical assignment', pertaining to the goals formal natures pursue in assigning functions to parts. Thirdly, there is the principle of 'optimal production', pertaining to the goals formal natures pursue in producing parts (and their material differentiations) for the sake of functions in animals. All three principles boil down to what seems to be the most basic principle in Aristotle's biology, namely that nature does what is necessary for the substantial being of each kind of animal, or does what is best for it. Nature always places parts in the most honorable places, never wastes what is available, and always produces parts for the sake of some good (unless prevented from doing so, of course).

Note that 'nature' in these statements is used 'trans-specifically': 'nature' refers to a generalized conception of the particular formal natures found in animals.[91] It is important to realize that this way of speaking about nature does not give evidence for some kind of cosmic or demiurgic conception of nature that is supposed to exist over and above the particular formal natures of animals (the viability of such an interpretation has already been challenged in 1.3).[92] The universal statements are generalizations pertaining to the 'observed' actions of actual and particular formal natures,[93] not descriptions of one unified and universal nature. It is my contention that the verbs of agency ascribed to formal natures are more than mere metaphors, or reflections of the analogy between art and nature. As I will show below, the different actions attributed to formal natures reflect different causal

[90] The principles stand out from other sentences describing the actions of the formal nature of an animal by their appeal to universality or their appeal to the 'for the most part-character' of the actions described. In many cases, Aristotle states the principle first, and then shows how the current fact can be explained in the light of it (see e.g. *PA*.II.16, 659a20-22: ὑπάρξαντος οὖν τοιούτου τοῦ μυκτῆρος, ἡ φύσις παρακαταχρῆται, καθάπερ εἴωθεν, ἐπὶ πλείονα τοῖς αὐτοῖς μορίοις, ἀντὶ τῆς τῶν προσθίων ποδῶν χρείας; "And since the trunk is present, nature, as usual, turns the same part to more than one use, [here] using the trunk in place of the front feet.").

[91] Lennox (2001a), 190.

[92] Against such interpretations, Lennox (2001a), 182-204 has provided convincing arguments.

[93] Cf. Lennox (2001a), 184 and 220n.3.

patterns underlying the generation of an animal and all the parts that it has and does not have.

In this section, I will discuss Aristotle's use of these teleological principles in the explanations of biological phenomena offered in chiefly *PA*. In particular, I will argue that these teleological *hypotheses* are not used as premises in the explanations (for the status of the teleological principles as hypotheses, see below in 3.3.2).[94] Propositional principles of explanation,[95] such as Aristotle's teleological principles, function as the framework within which the explanation needs to take place: they both limit the amount and kinds of explanations possible, and license the explanations actually given. Outside the framework set up by these kinds of principles, explanations lose their explanatory force and fail to make sense altogether. The teleological principles establish a causal framework within which, first, that which is necessary for an animal can be shown to be necessarily present. For instance, organs for perception are necessary for all animals on account of their being animals, and they come to be due to primary teleology and conditional necessity on account of the potential for perception being part of the substantial being of each kind of animal. Secondly, also that which is functionally best can be shown to be necessarily present, *but* on a secondary or subsidiary level: for instance,

[94] Pace Charles (2000, 72n.20) and Lennox (2001a, 209) who take *APo*.I.10, 76b36 (ἀλλ' ἐν ταῖς προτάσεσιν αἱ ὑποθέσεις; "hypotheses belong to the propositions") to mean that the hypotheses are among the *premises* of demonstrations, and Gotthelf (1987b, 185-194), who uses the terms 'principle' and 'premise' interchangeably for all of the three types of principles he distinguishes in Aristotle. (Gotthelf distinguishes between three types of principles, which all figure as premises in explanations; these principles are: (1) principles about the nature and the potentials of elements of which animals are composed (cf. *PA*.II.2, 648a19-24; 23: Πολλῶν γὰρ ἡ φύσις ἀνάγεται πρὸς ταύτας τὰς ἀρχάς – "for the nature of many things is referred back to these principles"); (2) principles asserting the existence of the various formal natures of animals and their status as ends (teleological principles are subsumed under this category); and (3) principles consisting of the definitions of those animal forms.) Goldin (1996, 54 and 54n.26), on the other hand, argues that in *APo*.I.10, 76b36 'hypotheses' means 'premise', and that accordingly the claim is that "premises belong to the propositions." I can think of no internal argument within *APo*.I.10 that would favor one reading over the other; however, in *APo*.I.2, where Aristotle introduces his notions of axioms, hypotheses, and definitions, '*protasis*' means proposition (Barnes; 1993, 97-98), and therefore I prefer to take it that way also in *APo*.I.10.

My argument that hypotheses are not used as premises in demonstrations is based on Aristotle's use of teleological hypotheses in the biological practice, and the question of whether or not Aristotle's theory and practice are in perfect harmony in this particular case, will have to be addressed on another occasion. Cf. on this issue also Detel (2006, 255-256), who argues that hypotheses never show up as part of the demonstrations, but that only definitions do.

[95] For the distinction between elemental and propositional principles, see Irwin (1988), 4. Aristotle discusses propositional principles in *APo*.I.2 (these are the hypotheses and the axioms); he discusses elemental principles in *APo*.I.10, 76a31-36 (these include all causally basic and non-demonstrable facts or features, such as for example material causes in the form of material potentials, or formal causes in the form of essences whose existence has to be posited).

the feet of ducks are necessarily webbed due to material necessity and because this use of the material is best given the ducks specific way of life.

Although the goal-directedness of nature is assumed in all the explanations Aristotle gives for biological phenomena, the principles are invoked explicitly only in those cases where this goal-directedness is not immediately evident. The principles are used as a heuristic tool: given that nature acts goal-directedly, we must look for a biological good in these cases, too. I will first give a description of the three principles describing different kinds of actions of the formal nature, and explain their specific usage; next, I will discuss their scientific status and their usage from a more general methodological perspective.

### *3.3.1.a Principles of 'balanced distribution'*

The principles of 'balanced distribution' I call those principles that concern the goal-directed actions of the formal natures in *distributing* the animal's parts over its body. Aristotle posits that formal natures always or for the most part co-ordinate the distribution of the bodily parts over the animal body, in such a way that (i) each part is located at the most valuable position possible for it (in accordance with its own value), while at the same time safeguarding the balance or symmetry between the two halves of the body (along three dimensions), such that (ii) each part is has a counterpart. The actions that the formal nature is said always to perform according to these principles are mainly described in terms of 'placing', 'positioning', and 'ordering'. The animal that results from these actions has its parts distributed over its body in the best possible way.

One such principle is that where nothing prevents it, nature places the parts in the most valuable locations, that is, in the upper, right, and front parts of the body. Aristotle uses this principle for instance to explain the position of the heart (*PA*.III.4, 665b18-21):

> Ἔχει δὲ καὶ ἡ θέσις αὐτῆς ἀρχικὴν χώραν· περὶ μέσον γάρ, μᾶλλον δ' ἐν τῷ ἄνω ἢ κάτω καὶ ἔμπροσθεν ἢ ὄπισθεν· ἐν τοῖς γὰρ τιμιωτέροις τὸ τιμιώτερον καθίδρυκεν ἡ φύσις, οὗ μή τι κωλύει μεῖζον.

> "Moreover, its position is at an originative place; for it is near the middle, and more above than below, and more in front than in the rear; for nature places the more valuable things in the more valuable locations, where nothing greater prevents it."[96]

The heart is the most valuable part and thus is located at the most valuable place in the whole animal body.[97] On the other hand, when a part is not found to be at the most honorable place possible in the animal, this calls for an explanation in terms of 'something greater that prevented it'. Such an explanation is given for the 'deviating' distribution of hair in four-footed blooded animals as compared to human beings (*PA*.II.14, 658a18-24):

> Σκέπης γὰρ χάριν αἱ τρίχες ὑπάρχουσι τοῖς ἔχουσιν· τοῖς μὲν οὖν τετράποσι τὰ πρανῆ δεῖται μᾶλλον τῆς σκέπης, τὰ δὲ πρόσθια τιμιώτερα μέν, ἀλλ' ἀλεάζει διὰ τὴν κάμψιν· τοῖς δ' ἀνθρώποις ἐπεὶ ἐξ ἴσου διὰ τὴν ὀρθότητα τὰ πρόσθια τοῖς ὀπισθίοις, τοῖς τιμιωτέροις ὑπέγραψεν ἡ φύσις τὴν βοήθειαν· ἀεὶ γὰρ ἐκ τῶν ἐνδεχομένων αἰτία τοῦ βελτίονός ἐστιν.
>
> "Hair is present in those that have it for the sake of covering. Now in four-footed animals the backs have a greater need for covering, and *though* their fronts are more valuable, they are *nevertheless* hairless because they are bent over. But in human beings, since on account of their upright posture their fronts and backs are on equal terms, nature adds this protection to the more valuable parts; for it is always a cause of the better among the possibilities."

Here the greater functional need of hair at another location in the four-footed blooded animals prevents nature from placing the part at the most valuable location; here 'for the better' means 'the most valuable location'.

Aristotle does not decide randomly what is to be the most valuable position, nor do the notion of the 'valuable' express ethical or esthetic prejudice. Instead, Aristotle derives the positions that are the most valuable in an animal's body empirically from those locations where the origins of the most important and necessary functions can be found; the valuable is thus intrinsically connected to function (see *IA*.IV, 705a31-32: διείληπται δ' ἔργῳ; "this distinction is one of

[96] Cf. *PA*.III.3, 665a23-26: "And generally, where nothing greater impedes, what is better and more valuable is always, in the case of above and below, present more in things that are above; in the case of front and rear, more in things in front; and in the case of right and left, more in things on the right."
[97] Cf. also Aristotle's explanations of the locations of parts in *PA*.III.10, 672b19-24; *GA*.I.8, 718b25-b29; *GA*.I.11, 719a13-15; and *GA*.II.1, 732a3-8.

function").[98] The place where the function of sight originates, Aristotle calls the front; the place where the function of nourishment originates, is the up; and the place where the function of locomotion originates, is the right; because these three functions originate in these locations, the three dimensions that follow from them are the most honorable.[99] The up, the right, and the front, together with the down, the left, and the back constitute the six dimensions of the body, which are themselves explicitly posited as principles by Aristotle (*IA*.II, 704b18-22):

> ἔτι τὰς διαστάσεις τοῦ μεγέθους, πόσαι καὶ ποῖαι ποίοις ὑπάρχουσι, δεῖ λαβεῖν. εἰσὶ γὰρ διαστάσεις μὲν ἕξ, συζυγίαι δὲ τρεῖς, μία μὲν τὸ ἄνω καὶ τὸ κάτω, δευτέρα δὲ τὸ ἔμπροσθεν καὶ τὸ ὄπισθεν, τρίτη δὲ τὸ δεξιὸν καὶ τὸ ἀριστερόν.
>
> "Further, we must posit [as a principle that we are accustomed constantly to use for our scientific investigation of nature; see 704b11-12] the dimensions of magnitude in the size and quality in which they are present in various objects. For there are six dimensions grouped in three pairs: the first being the upper and the lower; the second the front and the back; and the third the right and the left."[100]

These dimensions divide the body up in two parts along three different dimensions, and nature follows these divisions in distributing the different parts of the animal, being careful not to disturb the balance between the two halves.[101]

A second principle of this category refers explicitly to the preservation of balance. Aristotle uses it, for instance, to explain the location and doubleness of the sense organs (*PA*.II.10, 656b27-657a12):

> Τέτακται δὲ τὸν τρόπον τοῦτον τὰ αἰσθητήρια τῇ φύσει καλῶς, (...). Διπλοῦν μὲν γάρ ἐστιν ἕκαστον τῶν αἰσθητηρίων διὰ τὸ διπλοῦν εἶναι τὸ σῶμα, τὸ μὲν δεξιὸν τὸ δ' ἀριστερόν.
>
> "As to the position of the sense-organs, all the organs of sense have been ordered by nature in a good way (…). For because the body is double, one part the right, the other the left, each of the organs of sense is double (…)."[102]

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[98] Balme (1987), 277; Cf. Lennox (2001a, 266-272) on this type of principles and its ties to biological functions.

[99] *PA*.II.10, 656b22-25; *PA*.III.3, 665a13-15; *PA*.IV.7, 683b19-24; *IA*.IV, 705a29-b5, *IA*.IV, 706a21-25, *IA*.V, 706b12-16.

[100] *PA*.III.7, 669b19-20; cf. *Cael*.II.2, 284b10; *Cael*.II.2, 285a11; *Cael*.III.4, 303b2: "shapes must have principles."

[101] *PA*.III.7, 669b18-26, *PA*.III.7, 670a5, *PA*.IV.11, 691a28-b4.

[102] Aristotle uses similar explanations for the viscera (*PA*.III.7, 670a4-7: "So a cause of the nature of the viscera being double is, as we said, the duality of the right and the left") and for the presence of the spleen (*PA*.III.7, 669b36-670a1: "and it is on account of the liver being positioned more on the right that the nature of the spleen has developed" – the 'function' of the spleen is to counterbalance the liver). Cf. also

In sum, by positing that in distributing parts over the animal body nature always, unless something greater prevents it, follows the natural divisions of the body and chooses the most valuable location possible (where the valuable coincides with the places where the functions of sight, nourishment, and locomotion originate), Aristotle is able to give a rationale for the distribution of parts actually found. Parts are generally placed as close to the valuable locations as possible, unless something greater prevents it. Aristotle's explanatory strategy in these cases is to establish the biological optimality of a certain location for the placement of a part relative to this part's functional importance; the principle helps him to do so.

### *3.3.1.b Principles of 'economical assignment'*

The principles of 'economical assignment' I call those principles that concern the number of parts assigned to an animal, given what is both necessary and sufficient for its functioning. Aristotle posits that formal natures (like a good housekeeper) always or for the most part assign functions to parts and parts to animals in an 'economical' way: if possible, animals have one part for the performance of each function (and not more), while they only receive those parts that they are able to use, and never get more than is sufficient for them. The actions the formal nature is said to perform according to these principles are mainly described in terms of 'giving' and 'providing'. The principles that belong to this category are closely related to the principle that 'nature does nothing in vain', which will be discussed more extensively below in 3.3.1.c. For here it suffices to say that whatever is 'too much', 'wasteful', or 'unusable' is biologically speaking 'in vain' for Aristotle. The teleology of nature causes animals to be adapted to their environment and to be able to survive in an optimal way: nature does what is best, given the possibilities, and nothing less or more.

The most economical assignment of functions to parts and parts to animals seems to be to assign one part for the performance of each function. Nature never assigns more parts to an animal for the sake of the performance of one function, but where necessary and possible will use one part for the sake of multiple functions.

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*PA*.II.7, 652a30-33 and *PA*.IV.12, 695a9-13 (695a12: ὅπως ἰσορρόπου ὄντος τοῦ βάρους ἔνθεν καὶ ἔνθεν; "with an equal distribution of weight on either side").

Nature thus never saves on functions, but only on parts. Aristotle explains the principle of 'economical assignment' in an illuminating simile (*PA*.IV.6, 683a19-25):

> Βέλτιον δ' ἐνδεχομένου μὴ ταὐτὸ ὄργανον ἐπὶ ἀνομοίας ἔχειν χρήσεις, ἀλλὰ τὸ μὲν ἀμυντικὸν ὀξύτατον, τὸ δὲ γλωττικὸν σομφὸν καὶ σπαστικὸν τῆς τροφῆς. Ὅπου γὰρ ἐνδέχεται χρῆσθαι δυσὶν ἐπὶ δύ' ἔργα καὶ μὴ ἐμποδίζειν πρὸς ἕτερον, οὐδὲν ἡ φύσις εἴωθε ποιεῖν ὥσπερ ἡ χαλκευτικὴ πρὸς εὐτέλειαν ὀβελισκολύχνιον. Ἀλλ' ὅπου μὴ ἐνδέχεται, καταχρῆται τῷ αὐτῷ ἐπὶ πλείω ἔργα.
>
> "And it is better, where possible, not to have the same instrument for dissimilar uses, but the one that is defensive most sharp, and the one that is to be a tongue spongy and able to draw in nourishment. For where it is possible for two things to be used for two functions without impeding each other, nature is unaccustomed to making things as does the coppersmith who, to economize, makes a spit-and-lampstand; but where this is not possible, nature makes use of the same thing for multiple functions."[103]

While two-winged insects on account of their weakness and smallness only have one part for the sake of drawing in nourishment and for the sake of defence, insects with many wings have both stings and tongues. Aristotle's claim is here that while it is certainly possible for nature to 'cut down' the number of parts assigned to many-winged insects, this is not its custom. Nature usually makes one part for the sake of one function,[104] and only if this is not possible, and only if this second function will not negatively affect the performance of the first and principal function, will it use one part for the sake of multiple functions. This principle is also in the background of Aristotle's explanation of the differentiations of some of the common parts (*PA*.III.1, 662a18-24):

> Ἡ γὰρ φύσις αὐτὴ καθ' αὑτήν, ὥσπερ εἴπομεν, τοῖς κοινοῖς πάντων μορίοις εἰς πολλὰ τῶν ἰδίων καταχρῆται, οἷον καὶ ἐπὶ τοῦ στόματος ἡ μὲν τροφὴ πάντων κοινόν, ἡ δ' ἀλκή τινων ἴδιον καὶ ὁ λόγος ἑτέρων, ἔτι δὲ τὸ ἀναπνεῖν οὐ πάντων κοινόν. Ἡ δὲ φύσις ἅπαντα συνήγαγεν εἰς ἕν, ποιοῦσα διαφορὰν αὐτοῦ τοῦ μορίου πρὸς τὰς τῆς ἐργασίας διαφοράς.
>
> "For nature, in virtue of itself, as we said, puts the parts common to all animals to many distinctive uses; for example, in the case of the mouth nourishment is

[103] Cf. *PA*.II.16, 659a20-22; *GA*.I.1, 716a24-27.

[104] Parts such as eyes, ears, lungs, and kidneys are no exception to this rule: these parts are one in form, but double in structure because of the doubleness of the body. See *PA*.II.10, 656b32-657a10; Lennox (2001b), 227.

> common to all, while strength is distinctive to some and speech to others, and again breathing is not common to all. But nature has collected all these uses together in one, producing a differentiation of this part for the differences of its operation."

The reason why nature in these cases does assign multiple functions to the same part seems to be that the second functions are all non-necessary ones, and that their activities are close enough to the primary function so that the part only needs to be differentiated in order to accommodate the second function.[105]

While nature may sometimes use one part for more functions, it will never produce more parts for one function. For one principle posits that nature never assigns more parts to an animal than that is sufficient for the sake of the performance of a certain function.[106] For instance, Aristotle argues that animals for which it is possible to receive a means of defense only receive *one* means for the sake of this function. That is, nature gives horns to some animals, spurs to others, and to again others for instance the capacity to emit some kind of excrement, but (*PA*.III.2, 663a17-18):

> Ἅμα δ' ἱκανὰς καὶ πλείους βοηθείας οὐ δέδωκεν ἡ φύσις τοῖς αὐτοῖς.
> "Nature has not provided modes of protection to the same animals that are at once sufficient and more than sufficient."

In other words, if the performance of a certain function is necessary or for the better for a certain animal, the animal receives only as many parts as are sufficient for the performance of that function. Formal natures do not give more than is sufficient, but, on the other hand, they also do not give less. For instance, while living beings that are immobile need and receive only few parts (as they need to perform only a few actions; cf. *PA*.II.10, 656a1-3), animals that are mobile, need – and hence receive – more parts than immobile animals (*PA*.IV.7, 683b5-7):

> Τῶν δὲ ὀστρακοδέρμων οὐκ ἔστι τὸ σῶμα πολυμερές. Τούτου δ' αἴτιον τὸ μόνιμον αὐτῶν εἶναι τὴν φύσιν· πολυμερέστερα γὰρ ἀναγκαῖον εἶναι τῶν ζῴων τὰ κινητικὰ διὰ τὸ εἶναι αὐτῶν πράξεις· ὀργάνων γὰρ δεῖται πλειόνων τὰ πλειόνων μετέχοντα κινήσεων.
> "The body of the hard-shelled animals does not have many parts. The cause of this is that their nature is sessile; for to have more parts is necessary for those animals

[105] *PA*.IV.10, 689a4-15.
[106] Aristotle's remark with regard to the heart that "wherever possible, one origin is better than many" in *PA*.III.4, 665b14-15 (cf. *PA*.III.4, 665b28-31) might be interpreted as referring to the same parsimony of nature: since one origin is sufficient, and it is possible to have only one origin, it is better to have only one.

> that are mobile, because of their activities; for those partaking of more motions are in need of more organs."

Another principle posits that formal natures always assign parts exclusively or largely to those animals that are able to use them. This principle provides the framework within which in particular the distributions of non-necessary, luxury parts can be explained (*PA*.III.1, 661b28-31):

> Τῶν τε γὰρ πρὸς ἀλκὴν τε καὶ βοήθειαν ὀργανικῶν μορίων ἕκαστα ἀποδίδωσιν ἡ φύσις τοῖς δυναμένοις χρῆσθαι μόνοις ἢ μᾶλλον, μάλιστα δὲ τῷ μάλιστα, οἷον κέντρον, πλῆκτρον, κέρατα, χαυλιόδοντας καὶ εἴ τι τοιοῦτον ἕτερον. Ἐπεὶ δὲ τὸ ἄρρεν ἰσχυρότερον καὶ θυμικώτερον, τὰ μὲν μόνα τὰ δὲ μᾶλλον ἔχει τὰ τοιαῦτα τῶν μορίων. Ὅσα μὲν γὰρ ἀναγκαῖον καὶ τοῖς θήλεσιν ἔχειν, οἷον τὰ πρὸς τὴν τροφήν, ἔχουσι μὲν ἧττον δ' ἔχουσιν, ὅσα δὲ πρὸς μηδὲν τῶν ἀναγκαίων, οὐκ ἔχουσιν.
>
> "Of the instrumental parts that are for strength and protection, nature provides each of them only, or especially, to those animals that are able to use them, and especially to the animals able to use them most, [parts] such as sting, spur, horns, tusks, and if there is another such part. And since the male is stronger and more spirited, in some cases he alone has such parts, in other cases he has more than the female. For those parts which it is necessary for females to have as well, e.g. parts related to nourishment, they have, but they have less; while those related to none of the necessities, they do not have."[107]

All animals, both male and female, by necessity have all parts that are present for the sake of the performance of the essential or vital functions; the usability principle[108] obtains to a lesser degree since, presumably, females too must be able to use their necessary parts sufficiently enough to be able to survive and reproduce. The absence of the defensive parts in females is thus explained by their inability to use them. These principles are evidently related to the principle that 'nature does nothing in vain',[109] which will be discussed below: nature does not assign parts to animals that cannot (optimally) use them, or parts that are more than sufficient for an animal's needs, as in those cases the parts would be in vain.

In sum, the principle of economical assignment is used to set the framework within which it is possible to explain the ratios between parts and

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[107] Cf. *PA*.IV.8, 684a27-30, *PA*.IV.10, 687a10-12.
[108] Cf. *PA*.IV.10, 687a10-15.
[109] Cf. Lennox (2001a), 189 and 203n.16.

functions present in the animals that have them. Nature always provides what is sufficient, and never less than is needed.

### *3.3.1.c Principles of 'optimal production'*

Thirdly, there are principles that posit the goal-directedness of the actions of the formal natures in '*making*' or '*producing*' natural beings, such as animals, their parts, and their differentiations. In some sense, these principles are the most important ones, because they pertain directly to the coming to be and presence of parts and their differentiations.

One such principle posits that nature does everything either because it is necessary, or because it is better. This principle pertains to the status of parts and their differentiations, and hence to the causal patterns underlying their presence – the principle helps to find the function of structures. For it is posited with regard to all parts that (at least for the most part) their presence is either necessary, *or* for the better (the two options are mutually exclusive – if the part is not necessary, then it must be for the better). Parts are necessary for an animal when it cannot do without those parts (the animal would either not be able to survive or not be the kind of animal it is); the presence of the part is thus conditionally necessary for the performance of a necessary function. Parts are for the better for an animal, when the animal strictly speaking could do without them (it would not die or loose its identity), but would be less well off; the part is present for the sake of some subsidiary or luxurious function or good. The principle also pertains to the status of differentiations: differentiations of parts are also either necessary for an animal given its specific way of life and/or its dimensions (which are included in the definition of its substantial being), or are 'merely' for the better in case the animal could do without the differentiation, but would be less well off. As we have seen previously in 3.2.4 that the 'for the better'-part of the principle is often used in conjunction with references to material necessity as the cause of the coming to be of the material used in the differentiation.

Aristotle invokes the principle most explicitly in a passage in *GA* (*GA*.I.4, 717a12-31):[110]

> Περὶ δὲ τῆς ἐν τοῖς ἄρρεσι διαφορᾶς τῶν σπερματικῶν ὀργάνων εἴ τις μέλλει θεωρήσειν τὰς αἰτίας δι' ἃς εἰσιν, ἀνάγκη λαβεῖν πρῶτον τίνος ἕνεκεν ἡ τῶν ὄρχεών ἐστι σύστασις. εἰ δὴ πᾶν ἡ φύσις ἢ διὰ τὸ ἀναγκαῖον ποιεῖ ἢ διὰ τὸ βέλτιον, κἂν τοῦτο τὸ μόριον εἴη διὰ τούτων θάτερον. ὅτι μὲν τοίνυν οὐκ ἀναγκαῖον πρὸς τὴν γένεσιν φανερὸν πᾶσι γὰρ ἂν ὑπῆρχε τοῖς γεννῶσι, νῦν δ' οὔθ' οἱ ὄφεις ἔχουσιν ὄρχεις οὔθ' οἱ ἰχθύες ὠμμένοι γὰρ εἰσι συνδυαζόμενοι καὶ πλήρεις ἔχοντες θοροῦ τοὺς πόρους. λείπεται τοίνυν βελτίονός τινος χάριν. (...) οἱ δ' ὄρχεις εἰσὶ πρὸς τοῦτο μεμηχανημένοι· τοῦ γὰρ σπερματικοῦ περιττώματος στασιμωτέραν ποιοῦσι τὴν κίνησιν (...).
>
> "With regard to the differentiation of spermatic organs in males, if one is to search for the explanations of why they are there, one must first grasp the end for which testes are constituted. Now if nature does everything either because it is necessary or because it is better, then this part too must be because of one or the other. That it is not necessary for generation is evident: for it would be present in all that generate, but as it is neither the snake nor the fish have testes (for they have been seen coupling and with the channels full of semen). It remains then that it is for the better in some way. (...) The testes are contrived for this; for they make the movement of the spermatic secretion steadier (...)."

The passage is illuminating, for it demonstrates how Aristotle employs the principle in the practice of explaining biological phenomena. The question to be answered is why there is a differentiation of spermatic organs in males, and a first step in finding the explanation for this phenomenon is to grasp the function of testes (which must have something to do with generation). First, the principle is used as a heuristic: if parts are either necessary or for the better, and if it can be observed that not all animals that need the function (and all animals necessarily need to generate) have the part, then the only option that is left is that testes are for the better, and therefore must perform some contributory function. Next, Aristotle is able to present an explanation: in some animals a steadier emission of seed is better (because of their hot-tempered character), and it is because this is better that the animals that have testes have them. In this particular case, the use of the principle helps to solve the puzzle of why not all animals that need to perform a certain function have all the

[110] For examples of the use of this principle in *PA* see *PA*.III.7, 670a23-29 (the heart and liver are necessary parts), *PA*.III.7, 670b23-27 (the presence of the kidneys is not necessary, but for the better). Cf. also *GA*.V.8, 788b20-25.

parts that are associated with this function: while some parts are necessary for this function, others are 'merely' contributory to it.[111]

Another principle posits that 'nature does nothing in vain, but always, given the possibilities, does what is best for the substantial being of each kind of animal.'[112] What is among the possibilities for nature to produce is established inductively through observation: what is *possible* for a certain animal kind to have is in fact what can be observed to be *realized* in other animals that belong to the same wider kind (the possibilities are thus natural possibilities). The features do not have to be generic as such, but they do have to be present among at least some members of the group of animals in question.

In accordance with the line of interpretation proposed by Lennox,[113] I believe that whenever Aristotle refers to the 'nature does nothing in vain'-part of the principle, he invokes it in order to set the framework within which it is possible to explain the absence of a part that could reasonably have been expected to be present in a certain kind of animal.[114] Starting from this principle, Aristotle offers the counterfactual argument that if the formal nature of this particular animal had equipped the animal with the part in question, the part would have been in vain. (The part would have been in vain either because: (i) the animal would not have been able to use it, either at all or properly; or because (ii) the part would have been superfluous as the animal already possesses another part performing the same function for which the other part would come to be; (iii) the part would perform a function the animal does not actually require; (iv) the part would have to come to be

[111] The function of spermatic generation is in some animals performed by channels, in others by channels and internal testes, in again others by channels, external testes and a penis. This differentiation among parts present for the sake of spermatic generation can be explained by reference to the hierarchy of parts: the presence of channels is necessary for generation (as they are present in all animals that generate), while the presence of internal/external testes and a penis must be for the better (as certain animals, like birds and footless animals, lack testes (and a penis) because they lack the proper place for it; *GA*.I.5, 717b14-19). The remainders of the chapters *GA*.I.4-7 set out how the presence testes and a penis contribute to the function of generation as they ensure the semen to be in the optimal state of concoction and heat when it enters the female body.

[112] See mainly *IA*.II, 704b12-18 and *IA*.XII, 711a18-29.

[113] See Lennox (2001a), 205-223; I disagree, however, with Lennox's claim that the principle is used as a premise in the explanation (2001a, 212), and with his interpretation of the use of the second part of the principle.

[114] I have found only one exception to this 'rule', namely in *IA*.XII, 711a18-29 ("The reason is that nature never does anything without a purpose, as has been said before, but creates all things with a view to what is best among the possibilities"), where the full principle is invoked to explain the differentiation between parts (i.e. the differentiation between ways of bending legs, shoulders and hips), rather than the absence of parts; it seems that in this case, the second part of the principle is operative.

at a non-suitable place). Once it has been established that the presence of the part would be in vain, the principle allows the inference that that is in fact the reason why it is absent: nature never produces parts that are in vain (the principle validates the kind of counterfactual reasoning used). In any case, the part would be in vain in this particular animal, and as nature never does anything in vain, this explains why this part is lacking in this particular animal. This type of reasoning reflects what Aristotle elsewhere calls a 'syllogism from a hypothesis'.[115]

For instance, Aristotle uses the principle to explain the absence of feet in snakes (*IA.*VIII, 708a9-20):

> τοῖς δ' ὄφεσιν αἴτιον τῆς ἀποδίας τό τε τὴν φύσιν μηθὲν ποιεῖν μάτην, ἀλλὰ πάντα πρὸς τὸ ἄριστον ἀποβλέπουσαν ἑκάστῳ <ἐκ> τῶν ἐνδεχομένων, διασώζουσαν ἑκάστου τὴν ἰδίαν οὐσίαν καὶ τὸ τί ἦν αὐτῷ εἶναι· ἔτι δὲ καὶ τὸ πρότερον ἡμῖν εἰρημένον, τὸ τῶν ἐναίμων μηθὲν οἷόν τ' εἶναι πλείοσι κινεῖσθαι σημείοις ἢ τέτταρσιν. ἐκ τούτων γὰρ φανερὸν ὅτι τῶν ἐναίμων ὅσα κατὰ τὸ μῆκος ἀσύμμετρά ἐστι πρὸς τὴν ἄλλην τοῦ σώματος φύσιν, καθάπερ οἱ ὄφεις, οὐθὲν αὐτῶν οἷόν θ' ὑπόπουν εἶναι. πλείους μὲν γὰρ τεττάρων οὐχ οἷόν τε αὐτὰ πόδας ἔχειν (ἄναιμα γὰρ ἂν ἦν), ἔχοντα δὲ δύο πόδας ἢ τέτταρας σχεδὸν ἦν ἂν ἀκίνητα πάμπαν· οὕτω βραδεῖαν ἀναγκαῖον εἶναι καὶ ἀνωφελῆ τὴν κίνησιν.
>
> "The cause of why snakes are footless is, both, that nature does nothing in vain, but always with a view to what is best for each thing within the bounds of possibility, preserving the specific substantial being and essence of each, and, in addition, that which we stated before, namely that no blooded animal can move itself at more than four points. From those things it is evident that blooded animals whose length is out of proportion to the rest of their dimensions, like snakes, cannot possibly have limbs. For they cannot have more than four feet (or they would be bloodless), and if they had two feet or four they would be practically stationary: so slow and unprofitable would their movement necessarily be."[116]

All blooded land-dwellers possess four feet, and thus is it remarkable that snakes, who are also blooded and land-dwellers, do not have any feet. The explanation Aristotle gives for the absence of feet in snakes starts by establishing the futility of a snake having four feet: given that a snake can only possess a maximum of four feet, those four feet would not enable it to move swiftly at all. If the possession of four

[115] See Bobzien (2002), 365.
[116] Cf. *IA.*II, 704b12-18, which will be discussed in 3.3.2.

feet is in vain for snakes, then that is why nature did not generate them in snakes (cf. *PA*.IV.13, 696a10-15).[117]

The second part of the principle is used to set the framework for explanations of the presence of parts[118] and of their differentiations in those cases where observation shows that there are several means for nature to fulfill a certain functional need. For instance, Aristotle invokes the second part of the principle in order to be able to explain why human beings have hands instead of forelimbs like all other blooded, viviparous land-dwellers (*PA*.IV.10, 687a15-18):

> Ὀρθῷ δ' ὄντι τὴν φύσιν οὐδεμία χρεία σκελῶν τῶν ἐμπροσθίων, ἀλλ' ἀντὶ τούτων βραχίονας καὶ χεῖρας ἀποδέδωκεν ἡ φύσις. (...) Εἰ οὖν οὕτως βέλτιον, ἡ δὲ φύσις ἐκ τῶν ἐνδεχομένων ποιεῖ τὸ βέλτιστον, οὐ διὰ τὰς χεῖράς ἐστιν ὁ ἄνθρωπος φρονιμώτατος, ἀλλὰ διὰ τὸ φρονιμώτατον εἶναι τῶν ζῴων ἔχει χεῖρας.
>
> "And being upright in nature, mankind has no use for forelimbs, and instead of these, nature provides arms and hands. (...) So if it is better thus, and nature does, among the possibilities, what is best, it is not because they have hands that human beings are most intelligent, but because they are the most intelligent of animals that they have hands."

The explanation Aristotle provides is quite complicated, and draws on several principles at the same time, but what is clear is that, after having established that having hands is better for human beings as opposed to having forelimbs, the principle allows the inference that because having hands is best for human beings (because they are most intelligent they are most able to use them), that that is why human beings have hands. Compare in this context also *PA*.IV.9, 685b12-16, where Aristotle states that the presence of one row of suckers in one kind of octopus is not because it is best, but because it is necessary: observation shows that octopuses can either have one or two rows of suckers, but the differentiation is unrelated to what is best (rather, the differentiation is necessary given differences in dimensions between different kinds of octopuses).

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[117] See above in 3.2.4, pattern T3, for more examples of the use of the principle that nature does nothing in vain.

[118] It is hard to find examples where Aristotle uses the whole principle or only the second part; the two examples Lennox (2001a, 216-18; 220-221n.4) gives in support of his interpretation that the complete principle is used to account for the presence of parts I find unconvincing: it seems to me that they rather explain the absence of parts (*IA*.VIII, 708a9-20: absence of feet in snakes – see my discussion of this example above; *PA*.IV.13, 695b17-27: absence of distinct limbs in fish), and only in one of them Aristotle actually invokes the complete principle (i.e. in the example from *IA*).

In sum, these principles set the framework within which it is possible to explain the presence and absence and differentiations of parts in those animals that have them, by positing various teleological patterns of causality underlying these 'productions'. Parts and features that are necessary for an animal come to be by conditional necessity and are present as a result of primary teleology. What is for the better for an animal comes to be either as a result of conditional necessity and primary teleology on a secondary level (the presence of the part is conditional upon the presence of another part), or as a result of material necessity and is present due to secondary teleology. Whatever is absent in an animal must have been in vain, and whatever feature the animal has from among the possible features shared by its wider kind is what is best for this particular kind of substantial being.

All three principles discussed above build upon the general supposition that all animal development is carried out by the goal-directed actions of the formal natures in interaction with material nature. The results of natural generation are either necessary (in which case the discovery of the final cause should be straightforward, given the correlations mapped out in *HA*), or for the better (in which case the discovery of the cause is a little more difficult, and the use of the principle is necessary also by way of a heuristic), but in both cases due to some kind of teleology. In this way, the principles also function as limits: they eliminate possible materialist or 'spontaneity-theory' type explanations and restrict the possible explanations to teleological ones.

### *3.3.2 The scientific status of teleological principles*

In the sections above, I have identified the teleological principles as suppositions or hypotheses: they posit or assume the goal-directedness of the actions of formal natures. This interpretation is based on two passages in the biological works,[119] in which Aristotle makes explicit comments on the status and the philosophical justification of the principles (since they are first principles, they cannot be

[119] This interpretation is introduced and defended by Lennox (2001a), 206-211; my account is largely in agreement with his, except that I do not believe that the teleological principles are supposed to figure as premises in the explanation, but rather as heuristics that lie behind teleological explanations in cases where the final causes are not immediately discernable.

demonstrated in a deductive manner within the science of nature, but they can be shown to be philosophically reasonable).[120] The first passage is taken from *IA* (*IA*.II.704b12-705a2):

> Ἀρχὴ δὲ τῆς σκέψεως ὑποθεμένοις οἷς εἰώθαμεν χρῆσθαι πολλάκις πρὸς τὴν μέθοδον τὴν φυσικήν, λαβόντες τὰ τοῦτον ἔχοντα τὸν τρόπον ἐν πᾶσι τοῖς τῆς φύσεως ἔργοις, τούτων δ' ἓν μέν ἐστιν ὅτι ἡ φύσις οὐθὲν ποιεῖ μάτην, ἀλλ' ἀεὶ ἐκ τῶν ἐνδεχομένων τῇ οὐσίᾳ περὶ ἕκαστον γένος ζῴου τὸ ἄριστον · διόπερ εἰ βέλτιον ὠδί, οὕτως καὶ ἔχει κατὰ φύσιν. ἔτι τὰς διαστάσεις τοῦ μεγέθους, πόσαι καὶ ποῖαι ποίοις ὑπάρχουσι, δεῖ λαβεῖν. (...) πρὸς δὲ τούτοις ὅτι τῶν κινήσεων τῶν κατὰ τόπον ἀρχαὶ ὦσις καὶ ἕλξις.
>
> "The starting point of our investigation is achieved by positing [principles] that we are accustomed constantly to use for our science of nature, assuming that this is the way in which things are in all the works of nature. One of these is that nature does nothing in vain, but always, given the possibilities, does what is best for the substantial being of each kind of animal; therefore, if it is better in a certain way, that is also how it is by nature. Next, we must posit [as a principle] the dimensions of magnitude of what size and of what kind they belong to which kinds of beings. (...) Further, [we must posit] that the sources of movements in place are thrusts and pulls. (…)."

In this chapter, Aristotle introduces three principles, which are apparently 'commonly posited as a general principle in natural science'. That they are "posited" points towards their status as suppositions, which is conform the language of *APo.*; there Aristotle defines a hypotheses as follows (*APo.*I.2, 72a19-21):

> Θέσεως δ' ἡ μὲν ὁποτερονοῦν τῶν μορίων τῆς ἀντιφάσεως λαμβάνουσα, οἷον λέγω τὸ εἶναί τι ἢ τὸ μὴ εἶναί τι, ὑπόθεσις.
>
> "A posit that assumes either of the parts of a contradictory pair, I mean that something is the case or is not the case, is a hypothesis."[121]

In *APo.*I.2, Aristotle identifies as principles (i) axioms (*axiômata*), which are general principles or propositions that need to be known in order to be able to learn anything whatsoever; and also (ii) posits (*theseis*), which are domain-specific principles or propositions, proprietary to the subject-matter being investigated. Hypotheses form a subdivision of these posits, for Aristotle divides the posits into definitions (*horismoi*) on the one hand, where definitions are posits stating what a

[120] See *APr.*II.16, 64b28-38; *APo.*I.12, 77b3-15; *Top.*I.1, 100a30-b20; *Top.*VIII.3, 158a31-b4; *Ph.*II.1, 193a2-9.
[121] Cf. also *APo.*I.10, 76a31-37; 76b3-23.

thing is (definitions thereby demarcate the subject domain of the investigation at hand), without asserting that this thing is or is not, and into hypotheses (*hypotheseis*) on the other hand. Hypotheses are posits that state that something is or is not the case. The hypotheses are thus assertions about the previously defined domain. The principles concerning the agency of the formal nature described above fit this description of a posit stating that something is the case: it is posited on the most general level that the actions of formal natures are always for the sake of something. The scope of these hypotheses is the whole science of nature; they pertain to everything that has a formal nature (and not only to living beings).

The second passage in which Aristotle refers explicitly to the status of a teleological principle is in *GA*, where Aristotle is in the midst of explaining why teeth come to be at the exact moment they do (*GA*.V.8, 788b20-25):

> ἐπεὶ δὲ τὴν φύσιν ὑποτιθέμεθα, ἐξ ὧν ὁρῶμεν ὑποτιθέμενοι, οὔτ' ἐλλείπουσαν οὔτε μάταιον οὐθὲν ποιοῦσαν τῶν ἐνδεχομένων περὶ ἕκαστον, ἀνάγκη δὲ τοῖς μέλλουσι λαμβάνειν τροφὴν μετὰ τὴν [τοῦ γάλακτος] ἀπογαλάκτισιν ἔχειν ὄργανα πρὸς τὴν ἐργασίαν τῆς τροφῆς.
>
> "But since we suppose, supposing based on the things we observe, that nature neither falls short nor produces anything pointless among the possibilities in each case, it is necessary for animals that are to take in nourishment after suckling to have instruments for the chewing of food."

Again, the principle is introduced not in terms of something that has been or can be demonstrated, or that is taken as evident *a priori*, but of something that is being supposed on the basis of empirical evidence. This observational nature of the principles is supported by another passage (*Resp.*X, 476a13):

> ἐπεὶ μάτην οὐδὲν ὁρῶμεν ποιοῦσαν τὴν φύσιν
>
> "[S]ince we *see* that nature does nothing in vain."

Elsewhere, Aristotle argues that the principles that are peculiar to each science are acquired through experience, and that in some cases this experience is observational. For instance, Aristotle argues that one's ability for laying down hypotheses correlates with the amount of experience one has with the domain of investigation, and subsequently describes experience in terms of having made observations (*GC*.I.2, 316a5-10):

> Αἴτιον δὲ τοῦ ἐπ' ἔλαττον δύνασθαι τὰ ὁμολογούμενα συνορᾶν ἡ ἀπειρία. Διὸ ὅσοι ἐνῳκήκασι μᾶλλον ἐν τοῖς φυσικοῖς μᾶλλον δύνανται ὑποτίθεσθαι τοιαύτας ἀρχὰς αἳ ἐπὶ

> πολὺ δύνανται συνείρειν· οἱ δ' ἐκ τῶν πολλῶν λόγων ἀθεώρητοι τῶν ὑπαρχόντων ὄντες, πρὸς ὀλίγα βλέψαντες, ἀποφαίνονται ῥᾷον.
>
> "And the cause of the lesser ability of taking a comprehensive view of the admitted facts is lack of experience. For that reason, all those who live in a more intimate association with natural things will be more able to lay down such principles, which can bring things together for the most part. Those people, who on the basis of many arguments are unobservant of the facts, produce [principles] too easily, having seen only a few things."

The assumption is apparently that the more empirical evidence one collects, the more easily one will produce principles, and the more these principles will be in accordance with the facts. Aristotle provides a similar argument in the following passage (*APr.*I.30, 46a17-24):

> ἴδιαι δὲ καθ' ἑκάστην αἱ πλεῖσται. διὸ τὰς μὲν ἀρχὰς τὰς περὶ ἕκαστον ἐμπειρίας ἐστὶ παραδοῦναι, λέγω δ' οἷον τὴν ἀστρολογικὴν μὲν ἐμπειρίαν τῆς ἀστρολογικῆς ἐπιστήμης (ληφθέντων γὰρ ἱκανῶς τῶν φαινομένων οὕτως εὑρέθησαν αἱ ἀστρολογικαὶ ἀποδείξεις), ὁμοίως δὲ καὶ περὶ ἄλλην ὁποιανοῦν ἔχει τέχνην τε καὶ ἐπιστήμην· ὥστ' ἐὰν ληφθῇ τὰ ὑπάρχοντα περὶ ἕκαστον, ἡμέτερον ἤδη τὰς ἀποδείξεις ἑτοίμως ἐμφανίζειν.
>
> "Most principles of each [science] are peculiar to it [i.e. posits, to which the hypotheses belong, are the most numerous]. Hence it is the task for experience to give the principles that belong to each [science]. I mean, for instance, that astronomical experience [provides the principles] of astronomical science (for once the appearances had been sufficiently grasped, the astronomical demonstrations were discovered), and the same holds for whichever other art or science. Therefore, each time when the facts about each [science] are grasped, we will immediately be well-prepared to bring out their demonstrations."

Aristotle explains the acquisition of experience in the natural sciences in terms of grasping the appearances: once the appearances are grasped, the demonstrations follow easily, presumably because of the principles discovered on the basis of the appearances (i.e. because of the generalizations over the individual observations).[122] A last passage that is relevant in this context is the following one, in which Aristotle rebukes some predecessors for having assumed principles that go against observation (*DC.*III.7, 306a5-17):

[122] Irwin (1988), 30.

> Συμβαίνει δὲ περὶ τῶν φαινομένων λέγουσι μὴ ὁμολογούμενα λέγειν τοῖς φαινομένοις. Τούτου δ' αἴτιον τὸ μὴ καλῶς λαβεῖν τὰς πρώτας ἀρχάς, ἀλλὰ πάντα βούλεσθαι πρός τινας δόξας ὡρισμένας ἀνάγειν. Δεῖ γὰρ ἴσως τῶν μὲν αἰσθητῶν αἰσθητάς, τῶν δὲ ἀϊδίων ἀϊδίους, τῶν δὲ φθαρτῶν φθαρτὰς εἶναι τὰς ἀρχάς, ὅλως δ' ὁμογενεῖς τοῖς ὑποκειμένοις. Οἱ δὲ διὰ τὴν τούτων φιλίαν ταὐτὸ ποιεῖν ἐοίκασι τοῖς τὰς θέσεις ἐν τοῖς λόγοις διαφυλάττουσιν· ἅπαν γὰρ ὑπομένουσι τὸ συμβαῖνον ὡς ἀληθεῖς ἔχοντες ἀρχάς, ὥσπερ οὐκ ἐνίας δέον κρίνειν ἐκ τῶν ἀποβαινόντων, καὶ μάλιστα ἐκ τοῦ τέλους. Τέλος δὲ τῆς μὲν ποιητικῆς ἐπιστήμης τὸ ἔργον, τῆς δὲ φυσικῆς τὸ φαινόμενον ἀεὶ κυρίως κατὰ τὴν αἴσθησιν.
>
> "The result is that though they speak about the appearances they say things that are not in agreement with the appearances. And the reason is that they assume the first principles not in the right way, but by wanting to derive everything from certain predetermined beliefs. For, presumably, the principles of perceptible things should be perceptible, and of eternal things eternal, and of perishable things perishable, and in general they should be homogeneous to their subject matter. They, because of their love for them [i.e. these beliefs] seem to do what those people do who defend their positions in argument: for they admit of every outcome thinking that their principles are true, as if some [principles] do not need to be judged from what follows from them, and especially by their end result. For the end result of productive science is the product, while that of natural science is what always appears properly in accordance with perception."

According to this passage, domain-specific principles concerning perceptible phenomena (such as for example teleological principles concerning biological phenomena) are empirical in a double sense. First, because the principles should be homogeneous with the scientific domain to which they apply, the principles themselves need to be 'perceptible', which in the light of the previous passages must mean 'to be based on perception.' Principles pertaining to perceptible phenomena are themselves derived from such phenomena. Secondly, the principles must be in agreement with the actual observations; regardless of the source of the principle, their assumption is always in some sense empirical:[123] the observations or phenomena form the 'criterion of truth' against which the principles need to be checked and judged. The implication is that if the principles cannot successfully

[123] Hankinson & Matthen (1999), 212.

account for the observations as they stand, they must have been assumed wrongly, and hence must be rejected.[124]

In sum, the teleological principles Aristotle uses in his explanations are empirical, just as the notion of teleology itself is empirical.[125] The way towards teleological principles can be described as the discovery of generalizations, inductively arrived at through observation of many, many phenomena.[126] Because for the most part, the results of the actions of formal natures can be seen to serve the (vital, essential, or 'merely' luxury) needs of a living being, the inference is justified that formal natures act for the sake of something. Using this as a starting point in the explanations of difficult cases where the final cause is not immediately evident or cannot be derived from the definition of the substantial being of the animal in question, Aristotle is able to narrow down the possible explanations. This use of the principles is heuristic: it directs us to the discovery of explanations we would otherwise have missed. This usage is not made very explicit in Aristotle's biology, but there is at least one passage that hints at it (*Resp.*III, 471b24-29):

> αἴτιον δὲ μάλιστα τοῦ μὴ λέγεσθαι περὶ αὐτῶν καλῶς τό τε τῶν μορίων ἀπείρους εἶναι τῶν ἐντός, καὶ τὸ μὴ λαμβάνειν ἕνεκά τινος τὴν φύσιν πάντα ποιεῖν· ζητοῦντες γὰρ τίνος ἕνεκα ἡ ἀναπνοὴ τοῖς ζῴοις ὑπάρχει, καὶ ἐπὶ τῶν μορίων τοῦτ' ἐπισκοποῦντες, οἷον ἐπὶ βραγχίων καὶ πνεύμονος, εὗρον ἂν θᾶττον τὴν αἰτίαν.
>
> "The main cause of why [investigators] do not speak well about these things is on the one hand that they lack experience of the internal parts, and on the other hand do not make the assumption that nature in every case acts for the sake of something; had they inquired for the sake of what respiration belongs to animals, and had they investigated this question in the presence of the parts involved, that is, the gills and lungs, they would quickly have found the explanation."

Teleological principles are thus not axiomatic in the sense of a priori postulates that cannot be refuted: teleological principles are used because they set up a framework within which inferences to the best explanation can be drawn and because they yield the phenomena in the most plausible and coherent way.[127]

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[124] Cf. *GA*III.10, 760b28-33 and *EN*.I.8, 1098b11-12: τῷ μὲν γὰρ ἀληθεῖ πάντα συνᾴδει τὰ ὑπάρχοντα, τῷ δὲ ψευδεῖ ταχὺ διαφωνεῖ τἀληθές; "if a <principle> be true, all the facts harmonize with it, but if it is false, it is quickly seen to be discordant with them."
[125] Gotthelf (1987), 214 and 229.
[126] Kullmann (1990), 338-340.
[127] Hankinson (2002-2003), 22.

## 3.4 Teleology and necessity in biological explanations

### *3.4.1 The problem of the relation between teleology and necessity*

In the previous sections, I have argued that Aristotle often refers to necessity as a cause of the coming to be of animal parts and their differentiations in addition to final causes or 'the better'. In discussing the various types of explanations, I have claimed that whenever Aristotle refers to 'from necessity' as a cause of coming to be, he means 'from material necessity', and not 'from conditional necessity' as is generally thought.[128] In doing so, I have attributed a positive role to material necessity in the generation of animal parts. The material nature of an animal does not merely constrain the realizations of form 'carried out' by the formal nature of the animal,[129] but it also generates materials that may be used by the formal nature for the formation of parts that are not necessary, but serve the well-being of the animal. In some cases, material necessity even produces structures on its own accord, while the formal nature 'merely' allows those structures to form, because they serve the well-being of the animal. The claims that there is room for material necessity in the biological realm, and that its role is not purely negative, are controversial ones and need additional argumentation, which I will provide in this section.

As I discussed in chapter 1.3, the relation between teleology and necessity is altogether a controversial and problematic one. First, there is the notorious problem of whether or not final causes are 'real causes' or rather merely 'epistemic reasons', and whether or not ultimately teleological explanations 'add' anything that is not already accounted for through material and efficient cause explanations. While most scholars hold that the identification of the end of a natural process helps to explain that process and therefore attribute explanatory force to teleological explanations, some scholars[130] think that ultimately these teleological explanations can be reduced to material and efficient cause explanations without any loss on the ontological level.

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[128] See e.g. Lennox (2001b), 233: "A single explanandum is explained both as necessary and for the sake of protection. The necessity is presumably conditional, but Aristotle does not make this obvious." My account is most congenial to that of Gill (1997), 146-147, although I do not identify material and unqualified necessity in all cases.

[129] For this 'negative' role of material necessity in the generation of animals, see Lennox (2001a), 182-204.

[130] This position, labeled as 'supererogatory compatibilism' by Bradie & Miller (1999), is defended by Wieland (1975), Nussbaum (1978), and Sorabji (1980).

Under this interpretation, there is no final causation in nature, and all natural phenomena can be accounted for by reference to material necessity. In chapter 1.1.1, I have argued against this interpretation that Aristotle conceives of final causes as real causes and of explanations as intensional in form.

Secondly, there is the problem of what I would call an 'overestimation' of the causal role of teleology among those scholars who argue for a realist interpretation of final causes, and who attribute to Aristotle the view of that teleology is ontological irreducible to the cause of necessity.[131] Although these scholars disagree about which aspect of Aristotle's philosophy best captures this irreducibility,[132] they all agree that there is no role for material necessity in the sublunary realm and argue that function is always causally prior in sublunary generation. Consequently, they have explained away all material necessity in biology;[133] reduced it to conditional necessity;[134] or assigned only a negative role to it in constraining the realizations of function.[135] Although I agree with the overall, realist interpretation of Aristotle's teleology defended by these scholars, I believe that there are two problems in their accounts.

The first problem is that many of the realist interpretations of Aristotle's teleology focus on the issue of the irreducibility of teleology in terms of material (and efficient) causation, which – as I have argued in chapter 1.3[136] – is not an issue for Aristotle. Aristotle's criticism of the materialist accounts of his predecessors rather pertains to the issue of intrinsic versus accidental causation: material causes are part of the causal story, but they are not the *whole* story. Aristotle expresses no

[131] This position, labeled as 'irreducible compatibilism' by Bradie & Miller (1990), is defended by Balme (1965, 1987), Charlton (1985), Code (1997), Cooper (1982, 1985, 1987), Gotthelf (1980, 1987), Lennox (1982). For an outline of the differences among the main defenders of this position, see the introductory pages to the subject of teleology and necessity in Gotthelf & Lennox (1987), 199-203.
[132] Balme (1965, 1987), for example, brings up the indeterminateness or imprecision of material processes, which could not by themselves produce determinate and living complexes, while Cooper (1982, 1985, 1987) rather points to the 'permanence of the species of living things,' which is only explicable on the basis of teleological principles, and to the notion of the good (material natures and processes are insufficient to explain why a certain material outcome is good for the being that possesses it). Gotthelf (1976, 1987) speaks of the natures and potentials of animals as 'irreducible potentials for form', which are actualized in teleological processes (what is being realized is the animal's form which is its final cause, as it is that which the potential being actualized is irreducibly *for*).
[133] Balme, 1987.
[134] Cooper, 1987; Johnson, 2005.
[135] Gill (1997), 147-148; Lennox (2001a), 182-204.
[136] The argument in chapter I.3 builds heavily upon the thesis defended by Sauvé Meyer (1992).

need to eliminate material causes from explanations of sublunary phenomena or to reduce them to conditional necessity in the sublunary realm.

The second problem is that in discussing the relation between teleology and necessity, scholars have concentrated mainly on Aristotle's 'theoretical' discussions of teleology and necessity,[137] while neglecting his use of these concepts in his actual explanations of nature.[138] These 'theoretical' passages supposedly rule out any role for material necessity in the sublunary realm, but I believe this interpretation to be based on a misunderstanding of the use of the notion of necessity in these texts, *and* on the mistaken identification of material necessity with unqualified necessity in all cases.[139] Moreover, Aristotle's actual teleological explanations reveal that whenever Aristotle uses the term 'necessity', which he does relatively rarely, he must mean 'material necessity', and not 'conditional necessity' which is the default in the majority of teleological explanations.

As I will explain in more detail below, in his actual explanations, Aristotle uses 'necessity' *simpliciter* to refer to the causal process of coming to be in which some outcomes are necessary, given the *material nature* of the things involved in the process. This is the type of necessity that we call 'material necessity'. In other words, within a materially necessitated causal sequence in which the prior event causes the posterior, it is the material nature of the prior, which, in the sublunary realm, for the most part, necessitates the posterior (but not always, because the occurrence of the posterior is itself not necessary without qualification). The direction of the necessitation is from the prior to the posterior. For instance, in an absence of heat, the material nature of the water in a pond will for the most part necessitate the coming to be of ice (but not always – consider the case in which the water is running continuously and does not freeze).

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[137] Our main sources for Aristotle's 'theoretical' views on the relation between teleology, material causation, and necessity are *APo.*II.11, 94b27-95a3; *Ph.*II.8-9, 198b10-199a7; *Ph.*II.8-9, 199b34-200b11; *GC.*II.11, 337a35-338b19; *PA.*I.1, 639a1-642b4, and *Met.*I.3, 983a24-984b22.

[138] With the exception of Lennox (2001a), who, based on Aristotle's actual explanations, argues that on some level material necessity plays a causal role in biology independently of conditional necessity, albeit only a negative one.

[139] For the identification of material necessity with unqualified necessity, see for instance Cooper (1987), 259-260 (also 260n.20); 266; and Gill (1997), 147 (also 147n.6).

'Conditional necessity' refers to the conditional relation between the prior and the posterior in a teleological sequence. The direction of necessity also works from the prior to the posterior (i.e. from the possession of a form in potentiality to the actualization of it), although what chronologically comes to be last is prior in explanation. In those cases where conditional necessity obtains, the coming to be or presence of the prior (e.g. stones) is necessary *only if* the posterior (e.g. house) is to be realized, and it is only because it is necessary (but not without qualification) that the posterior is realized that the prior takes place. The expression indicates, first, that the necessitation (or causation) involved in the process is due to teleology (i.e. to forms that are to be realized, and not to the material nature of the prior). Secondly, it indicates that the prior is only necessary as a necessary prerequisite or condition for the realization of the posterior, which is the end that constitutes the final cause. Moreover, it is the end to be reached that determines what kind of material has to be present first and what kind of processes it needs to undergo. Inferences in these cases are one-directional: the coming to be or presence of the prior does not always necessitate the coming to be or presence of the posterior, and hence one can only draw the inference that if the posterior has come to be or is present, than necessarily also the prior has come to be or is present.

On the other hand, Aristotle uses the expression 'unqualified necessity' to refer to the 'absolutely' necessary relation between the prior and the posterior in a causal sequence, in which the prior always, without exception, necessitates the posterior, because the occurrence of the posterior is necessary without qualification. In some cases, Aristotle also uses the expression to indicate that the necessity does not presuppose the presence of a form to be realized, and that in that sense, the necessity involved is 'simple' or 'unconditional', as opposed to 'conditional' (e.g. in *Ph.*II.9; see my discussion below). However, in most cases, Aristotle uses the expression to indicate that the prior in a causal sequence, always, without exception, necessitates the posterior: that is, the process of necessitation cannot be stopped by interference of other factors. This allows for inferences from the prior to the posterior in those cases where unqualified necessity obtains (for instance, in mathematics, or in cyclical natural processes): if the prior (e.g. clouds) comes to be, than necessarily and without exception, the posterior (e.g. rain) will come to be

too.[140] In cyclical processes, the inference works in both directions (from the prior to the posterior, but also from the posterior to the prior). Unqualified necessity, understood as a means to qualify the validity of certain inferences, cannot as easily be identified with material necessity, which indicates a type of causality. This is even more so, because materially necessitated processes in the sublunary realm allow for exceptions (the posterior need not always come about), while unqualified necessity indicates that things come to be necessarily and always. Aristotle thus uses unqualified necessity often in a modal way: it pertains to the question of whether the cause that precedes its effect in time necessitates the outcome always, or only for the most part, where 'unqualified necessity' indicates the former.[141]

These distinctions between 'causal' and 'modal' uses of necessity,[142] and between material and unqualified necessity is important, for it is only unqualified necessity in a modal sense that Aristotle denies to exist in the sublunary realm. That is, in the sublunary realm, we cannot draw inferences from the existence of the prior to the existence of the posterior.[143] The difference between the two domains is that in the eternal, unchanging realm of the heavenly bodies, the prior always necessitates the posterior (i.e. things are necessary without qualification), while in the changing, sublunary realm the prior necessitates the posterior only for the most part (either by material or by conditional necessity).

In the sections below, I will first discuss the various notions of necessity that Aristotle employs in the 'theoretical' passages on the relation between teleology and necessity, and thus offer further support for my interpretation of Aristotle's notions of material, conditional, and unqualified necessity. The theoretical passages in the first book of *PA* will hereby serve as a point of reference. Next, I will offer an analysis of the interplay between necessity and teleology in the actual explanations

[140] As we would say, the prior is both necessary and sufficient for the coming to be or presence of the posterior.
[141] In *Met.*V.5, Aristotle lists as one of the five types of necessity 'that which cannot be otherwise' (*Met.*V.5, 1015a34-35: ἔτι τὸ μὴ ἐνδεχόμενον ἄλλως ἔχειν ἀναγκαῖόν φαμεν οὕτως ἔχειν); I submit that this refers to unqualified necessity in a modal sense, and not to a type of causality. Hence, pace Gill (1997), 146-147 and Cooper (1987, 260n.20), material necessity cannot be identified with or subsumed under unqualified necessity in this text, although the two do coincide in materially necessitated processes that take place in the heavenly realm.
[142] For the distinction, see Kupreeva (2007).
[143] Cf. Charles (1988), 7-8.

Aristotle offers in *PA*.II-IV, which will complement the general framework of types of explanations as set out in 3.2.

### *3.4.2 Theoretical discussions of teleology and necessity*

The first chapter of *PA*.I is the lengthiest and perhaps also the most complex chapter of the first book. It discusses a great variety of principles, methodological issues, and the types of causes involved in the study of nature. In these discussions, Aristotle refers mainly to teleology and necessity as the causes that are operative in nature, whereby teleology has priority over necessity (I will argue below that the priority Aristotle assigns to final causes is that of explanation, not of causation). However, in setting out the relation between teleology and necessity Aristotle employs at least four different notions of necessity: material (or natural) necessity, conditional necessity, unqualified necessity, and enforced necessity, all of which are related to teleology in different ways. In the sections below, I will first discuss briefly a passage in *GC*.II.11, which I believe illustrates the difference between unqualified and conditional necessity in a manner that is more lucid than Aristotle's account in *PA*.I.1. Next, I will offer an analysis of the passages in *PA*.I.1 that concern the relationship between teleology and different types of necessity,[144] while connecting them to other passages in the Aristotelian corpus that offer 'theoretical' treatments of the issue.

#### *3.4.2.a Four types of necessity: unqualified, conditional, material, and enforced*

In *GC*.II.11, Aristotle addresses explicitly the issue of causal sequences in natural processes, that is, of natural processes in which one state of affairs can be observed to come to be after another in a continuous (συνεχῶς) sequence (*GC*.II.11, 337a34-b1). He then raises the question of whether things always come to be necessarily, or whether their generation is contingent (*GC*.II.11, 337b1-3):

> σκεπτέον πότερον ἔστι τι ὃ ἐξ ἀνάγκης ἔσται, ἢ οὐδέν, ἀλλὰ πάντα ἐνδέχεται μὴ γενέσθαι.
>
> "We should investigate whether there is anything that will necessarily exist, or whether everything may fail to come to be."

[144] The relevant passages are: *PA*.I.1, 639b20-29; 640a1-9; 640a33-b3; 640b4-641a17; 642a1-13; 642a13-15; and 642a32-642b2.

Aristotle reformulates the first alternative as the question whether for some things that come to be it is necessary without qualification to come to be (*GC*.II.11, 337b10-11: ἀλλ' ἔνια ἀναγκαῖον ἁπλῶς γίνεσθαι). The question Aristotle sets out to answer in this chapter is thus the following: Are there only things of which the coming to be is 'merely' for the most part (but not always, because the causal sequence may be interrupted by external factors)? Alternatively, are there also things of which the coming to be is necessary without qualification (because the causal sequence cannot be interrupted by external factors)?

In the remainder of the chapter, Aristotle explains the differences in the relation between the prior and the posterior in the two types of causal sequences of generation (*GC*.II.11, 337b14-25):

> Εἰ δὴ τὸ πρότερον ἀνάγκη γενέσθαι, εἰ τὸ ὕστερον ἔσται, οἷον εἰ οἰκία, θεμέλιον, εἰ δὲ τοῦτο, πηλόν, ἆρ' οὖν καὶ εἰ θεμέλιος γέγονεν, ἀνάγκη οἰκίαν γενέσθαι; ἢ οὐκέτι, εἰ μὴ κἀκεῖνο ἀνάγκη γενέσθαι ἁπλῶς· εἰ δὲ τοῦτο, ἀνάγκη καὶ θεμελίου γενομένου γενέσθαι οἰκίαν· οὕτω γὰρ ἦν τὸ πρότερον ἔχον πρὸς τὸ ὕστερον, ὥστ' εἰ ἐκεῖνο ἔσται, ἀνάγκη ἐκεῖνο πρότερον. Εἰ τοίνυν ἀνάγκη γενέσθαι τὸ ὕστερον, καὶ τὸ πρότερον ἀνάγκη· καὶ εἰ τὸ πρότερον, καὶ τὸ ὕστερον τοίνυν ἀνάγκη, ἀλλ' οὐ δι' ἐκεῖνο, ἀλλ' ὅτι ὑπέκειτο ἐξ ἀνάγκης ἐσόμενον. Ἐν οἷς ἄρα τὸ ὕστερον ἀνάγκη εἶναι, ἐν τούτοις ἀντιστρέφει, καὶ ἀεὶ τοῦ προτέρου γενομένου ἀνάγκη γενέσθαι τὸ ὕστερον.
>
> "If it is the case that the coming to be of something earlier is necessary if a later thing is to be, e.g. if a house, then foundations, and if foundations, then clay, does it follow that if there have come to be foundations a house must necessarily come to be? Or can we not yet say this, unless it is necessary without qualification that the latter itself come to be? In this case, if foundations have come to be, it is also necessary that a house come to be; for such was the relationship of the earlier thing to the later, namely, that if there is to be the latter, necessarily there will be the former, earlier thing. If, accordingly, it is necessary for the later one to come to be, it is necessary also for the earlier one, and if the earlier one comes to be, it is accordingly necessary for the later one to do so – but not because of the earlier one, but because it was assumed that it was necessary it should exist. So in those cases where it is necessary for the later one to exist, there is conversion, and it is always necessary, if the earlier has come to be, that the later should also come to be."

The distinction Aristotle draws is this: in the case of conditionally necessitated processes, such as house-building, the coming to be of the prior (i.e. the foundations) is necessary *if* the posterior (i.e. the house) is to be, but it is not the case

that once the prior has come to be, the posterior necessarily will come to be. For the coming to be of the posterior depends upon the realization of the prior, but the prior does not without exception necessitate the coming to be of the posterior; the process may be interrupted by external factors. Only if a process of coming to be is absolutely necessary (i.e. when the process of necessitation cannot be interrupted), it is true to say that if the prior has come to be, the posterior necessarily will come to be, and vice versa if the causal nexus is reciprocal.[145] The example of house-building is a stock example illustrating conditional necessity. However, what is at stake here is not just the conditional relation between the prior and the posterior, but much more the type of inference one is allowed to make in conditionally necessitated processes. The issue Aristotle raises here is that in conditionally necessitated natural processes, the causal sequence of generation is not always continuous. Similarly, the notion of unqualified necessity used in this passage does not pertain to the type of causality involved in the coming to be of things; Aristotle does not speak of final causation versus material causation in this context. He is rather interested in the relation between the prior and the posterior in a particular type of a causal sequence of coming to be. In things for which it is absolutely necessary to come to be, the prior necessitates the posterior always and without exception. The expression 'unqualified necessity' indicates that if the prior is present, there will *always* be the posterior.

In sum, the difference between unqualified and conditional necessity Aristotle sketches here pertains not primarily to the type of causality that is involved in a natural process, but rather to the relation between the prior and the posterior in such a process and the types of inferences that are possible. In natural processes to which unqualified necessity pertains, it is necessary for the posterior to exist, and hence it is possible to draw inferences from the existence of the prior to the posterior. In conditionally necessitated natural processes, it is not necessary for the posterior to come to be after the prior has come to be, and hence it is not possible to draw inferences from the existence of the prior to the posterior.

I believe that Aristotle refers to this particular distinction between the necessity holding between the prior and the posterior in causal sequences also in the passage

[145] Cf. Charles (1988), 14-17.

about teleology and necessity in *PA*.I.1 (*PA*.I.1, 639b20-29), to which I will turn now. In this passage, Aristotle criticizes his materialist predecessors, not for giving explanations in terms of material causes rather than in terms of final causes as some scholars hold,[146] but for being mistaken about the kind of necessity that holds between the prior and the posterior in natural generated processes.

The discussion in *PA*.I.1 starts with a series of methodological dilemmas, the third of which pertains immediately to the relationship between teleology and necessity. Aristotle states that, given that we perceive that several types of explanations apply to natural generation – i.e. teleological and efficient causal explanation – we need to determine which of the two is first, and which one is second (*PA*.I.1, 639b11-14). Aristotle solves this dilemma by pointing to the fact that the goal of something is given with its *logos*. Because a *logos* is a starting point – either as the form and the definition of the substantial being in nature, or as the definition in art – explanations that state that for the sake of which have priority over explanations that state the efficient cause.[147] Because I take the passage to be about explanations,[148] rather than about causality, I take it that the priority of teleology at stake here is epistemological or explanatory priority, rather than causal priority. In both art and nature, it is the *definition* of the end to be achieved or the *form* to be realized that causally precedes and determines the process realizing the goal that constitutes the final cause. However, a search for the way in which things come to be and for the reason why they come to be presupposes *an earlier understanding of the end*.[149]

This discussion about explanation in natural generation leads to a discussion about explanation in terms of necessity, for it is to necessity that Aristotle claims his predecessors attempted to trace back all their explanations (*PA*.I.1, 639b21: εἰς ὃ πειρῶνται πάντες σχεδὸν τοὺς λόγους ἀνάγειν). The problem Aristotle finds with the materialist explanations of his predecessors is not so much that this type of explanation is wrong or insufficient, but that his predecessors had not made

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[146] Gotthelf (1987), 188; Cooper (1987), 259.
[147] *PA*.I.1, 639b14-19; see also my analysis of this difficult passage above, in 3.1.2.
[148] See in particular *PA*.I.1, 639b18-19: "they give the accounts and the explanations of each of the things they produce" (ἀποδιδόασι τοὺς λόγους καὶ τὰς αἰτίας οὗ ποιοῦσιν ἑκάστου); Aristotle picks up on the issue of explanation in the following lines (i.e. *PA*.I.1, 639b21, cited above).
[149] Cf. Code (1997), 137; Bolton, in an unpublished paper on the primacy of final causes in Aristotle, argues for a similar interpretation of this passage; see also, ibidem (1997), 118-119.

the right distinctions between the ways in which necessity in nature is spoken of (*PA*.I.1, 639b22: οὐ διελόμενοι ποσαχῶς λέγεται τὸ ἀναγκαῖον). The two types of necessity belonging to natural things that Aristotle puts forward for discussion here are 'unqualified necessity' and 'conditional necessity' (*PA*.I.1, 639b22-29):

> Ὑπάρχει δὲ τὸ μὲν ἁπλῶς τοῖς ἀϊδίοις, τὸ δ' ἐξ ὑποθέσεως καὶ τοῖς ἐν γενέσει πᾶσιν, ὥσπερ ἐν τοῖς τεχναστοῖς, οἷον οἰκίᾳ καὶ τῶν ἄλλων ὁτῳοῦν τῶν τοιούτων. Ἀνάγκη δὲ τοιάνδε τὴν ὕλην ὑπάρξαι, εἰ ἔσται οἰκία ἢ ἄλλο τι τέλος· καὶ γενέσθαι τε καὶ κινηθῆναι δεῖ τόδε πρῶτον, εἶτα τόδε, καὶ τοῦτον δὴ τὸν τρόπον ἐφεξῆς μέχρι τοῦ τέλους καὶ οὗ ἕνεκα γίνεται ἕκαστον καὶ ἔστιν. Ὡσαύτως δὲ καὶ ἐν τοῖς φύσει γιγνομένοις.
>
> "The [necessity] that is unqualified belongs to the eternal things, and the one that is conditional also belongs to all things that come to be, as well as to things produced, such as to a house and to any other such thing. For it is necessary that such material is present, if there is to be a house or any other end: and it is necessary that first this comes to be and is changed, and next that, and so step by step up to the end and that for the sake of which each thing comes to be and is. It is the same way too for things that come to be by nature."

In this passage, Aristotle differentiates the domains of the natural world[150] according to the type of necessity that pertains to it, and thereby introduces a special type of necessity into the domain of generated natural beings. While unqualified necessity holds of the eternal, natural realm of the heavenly bodies, among the *generated* natural beings there is *also* a kind of necessity present, namely conditional necessity (this is what I take to be the most natural reading of the particle *kai* in *PA*.I.1, 639b23).[151] Aristotle then gives a characterization of conditional necessity in terms of the material that has to be present first, and the changes that have to take place first, if some (natural or artificial) end is to be realized.

The purport of this passage is not a denial of the existence of material necessity in the sublunary realm, but an introduction of a special kind of necessity in

[150] Pace Gotthelf (1987; 170-171), I believe the contrast between the eternal and the generated to be a contrast *within* the realm of the natural, and not between mathematics and the science of nature; this is clear from the introduction of the issue (*PA*.I.1, 639b20: Τὸ δ' ἐξ ἀνάγκης οὐ πᾶσιν ὑπάρχει τοῖς κατὰ φύσιν ὁμοίως).

[151] Lennox (2001b), 128 discusses three different readings of *kai*: first, its connotation is 'in addition' and it is used to include conditional necessity in addition to unqualified necessity among the natural things that are generated; secondly, its connotation is 'in addition' and it is used to attribute another type of necessity to natural things that are generated; thirdly, its connotation is 'actually' and it is used to emphasize the presence of conditional necessity among natural things that are generated. This last reading is defended by Balme (1992), 84. Lennox does not point out which interpretation he thinks is most plausible in this context.

that realm, which is conditional, and which involves a special form of causal inference. The addition of an explication of conditional necessity (in *PA*.I.1, 639b26-30) is important in this passage, because it makes explicit what Aristotle takes to be the causal sequence and the type of inference belonging to (non-cyclical) generations of sublunary natural things. For he takes the end as a starting point, and then deduces from this end the consecutive steps leading up to its realization. The 'mistake' Aristotle's predecessors have made is to have neglected the conditionality of necessity pertaining to all generated things, both natural and artificial. Thus, when giving explanations in terms of necessity with regard to (non-cyclical) *generated* natural things, one should not make the mistake of thinking that the necessity of the causal sequence is absolute (as is the case in eternal natural processes). That is, one should not think that the prior *necessitates without exception* the coming to be of the posterior, but rather acknowledge the fact that the prior is merely a necessary precondition of the posterior.

Aristotle illustrates this distinction between the causal sequences of processes in the natural sublunary world and of processes in the natural eternal world of the heavens more clearly in the remainder of *GC*.II.11. First, Aristotle attributes unqualified necessity to all natural processes that are eternal and cyclical (*GC*.II.11, 337b35-338a5):

> τὸ γὰρ ἐξ ἀνάγκης καὶ ἀεὶ ἅμα· ὃ γὰρ εἶναι ἀνάγκη οὐχ οἷόν τε μὴ εἶναι· ὥστ' εἰ ἔστιν ἐξ ἀνάγκης, ἀίδιόν ἐστι, καὶ εἰ ἀίδιον, ἐξ ἀνάγκης. Καὶ εἰ ἡ γένεσις τοίνυν ἐξ ἀνάγκης, ἀίδιος ἡ γένεσις τούτου, καὶ εἰ ἀίδιος, ἐξ ἀνάγκης. Εἰ ἄρα τινὸς ἐξ ἀνάγκης ἁπλῶς ἡ γένεσις, ἀνάγκη ἀνακυκλεῖν καὶ ἀνακάμπτειν.
>
> "For what is of necessity coincides with what is always, because that which must be cannot not be. Hence a thing is eternal if it is of necessity; and if it is eternal, it is of necessity. And if, therefore, the coming to be of a thing is necessary, its coming to be is eternal; and if eternal, necessary. It follows that the coming to be of anything, *if it is necessary without qualification*, must be cyclical and must return upon itself."

As examples of such phenomena that are necessary without qualification Aristotle names the movement of the heavens, the evaporation-cycle, and the cycle of air (*GC*.II.11, 338a18-19: ἡ κύκλῳ κίνησις καὶ ἡ τοῦ οὐρανοῦ; *GC*.II.11, 338b6: ὕδατα καὶ ἀὴρ). Aristotle then contrasts these phenomena with the generations of human

beings and animals, which are sublunary processes of beings whose substances are perishable. The necessity involved in these processes 'does not return upon itself' but is conditional (*GC*.II.11, 338b6-11):

> Τί οὖν δή ποτε τὰ μὲν οὕτω φαίνεται, οἷον ὕδατα καὶ ἀὴρ κύκλῳ γινόμενα, καὶ εἰ μὲν νέφος ἔσται, δεῖ ὗσαι, καὶ εἰ ὕσει γε, δεῖ καὶ νέφος εἶναι, ἄνθρωποι δὲ καὶ ζῷα οὐκ ἀνακάμπτουσιν εἰς αὑτοὺς ὥστε πάλιν γίνεσθαι τὸν αὐτόν· οὐ γὰρ ἀνάγκη, εἰ ὁ πατὴρ ἐγένετο, σὲ γενέσθαι· ἀλλ' εἰ σύ, ἐκεῖνον. Εἰς εὐθὺ δὲ ἔοικεν εἶναι αὕτη ἡ γένεσις.
>
> "Then why do some things seem to be such, as for instance rain and air that come to be cyclically, namely that if there is a cloud, it is necessary that it rains, and if there is rain, it is also necessary that there is a cloud, but human beings and animals do not return to themselves such that the same thing comes to be again. For it is not necessary if your father came to be, that you come to be, but if you came to be, then he came to be. And it seems that this coming to be is rectilinear."

The coming to be of the posterior in the causal sequence entails the necessity of the prior having occurred first, but not the other way around. This rectilinearity of the sequence of conditional necessitated events was also brought up by Aristotle in the description of conditional necessity in *PA*.I.1, 639b28-29. This indicates that Aristotle's focus in these texts is on the nature of the causal sequence, and not primarily on the type of causality involved.

In sum, Aristotle's denial of the existence of unqualified necessity in the realm of natural beings that are perishable (and not eternal), and whose coming to be is rectilinear (and not cyclical), does not have to imply a denial of the operation of independent material causation and necessity in that realm. Aristotle's prime concern in both *PA*.I.1, 639b22-29 and *GC*.II.11 is not causation as such but the relation of necessity between the prior and the posterior in causal sequences. Aristotle believes it to be important to shed clarity on this relation, because the validity of demonstrations in both the natural and the theoretical sciences depends on the correct representation in those demonstrations of the necessary relation between items in a causal sequence.

The passage in *PA* in which Aristotle discusses the different modes of necessity in demonstrations of the natural sciences and of the theoretical sciences is complicated, so let me quote it in full (*PA*.I.1, 639b29-640a9):

> Ἀλλ' ὁ τρόπος τῆς ἀποδείξεως καὶ τῆς ἀνάγκης ἕτερος ἐπί τε τῆς φυσικῆς καὶ τῶν θεωρητικῶν ἐπιστημῶν. Εἴρηται δ' ἐν ἑτέροις περὶ τούτων. Ἡ γὰρ ἀρχὴ τοῖς μὲν τὸ ὄν, τοῖς δὲ τὸ ἐσόμενον· ἐπεὶ γὰρ τοιόνδε ἐστὶν ἡ ὑγίεια ἢ ὁ ἄνθρωπος, ἀνάγκη τόδ' εἶναι ἢ γενέσθαι, ἀλλ' οὐκ ἐπεὶ τόδ' ἐστὶν ἢ γέγονεν, ἐκεῖνο ἐξ ἀνάγκης ἐστὶν ἢ ἔσται. Οὐδ' ἔστιν εἰς ἄϊδιον συναρτῆσαι τῆς τοιαύτης ἀποδείξεως τὴν ἀνάγκην, ὥστε εἰπεῖν, ἐπεὶ τόδε ἐστίν, ὅτι τόδε ἐστίν. Διώρισται δὲ καὶ περὶ τούτων ἐν ἑτέροις, καὶ ποίοις ὑπάρχει καὶ ποῖα ἀντιστρέφει καὶ διὰ τίν' αἰτίαν.
>
> "However, the mode of demonstration and of necessity is different in the natural and the theoretical sciences. These have been discussed elsewhere. For the starting point is, in the latter cases, what is, in the former, what will be. So: 'since health or man is such, it is necessary that this is or comes to be', but not 'since this is or has come to be, that of necessity is or will be.' For it is also not possible to connect the necessity in such a demonstration to eternity, so as to say, 'since this is, therefore that is'. These matters too have been determined elsewhere, namely in what sorts of things [this kind of necessity] is present, what kind of processes convert and because of what cause."

Before turning to an analysis of the different modes of demonstration and necessity, I first need to say a few words about the distinction Aristotle draws here between the natural and the theoretical sciences. Usually, Aristotle depicts natural science as being itself one of the theoretical sciences,[152] and distinguishes the theoretical sciences from the practical and productive ones. In this passage, however, Aristotle singles out that part of the science of being that is concerned with *generated* things from that which is concerned with *eternal* things.[153] Natural science would then have to be understood in the narrow sense of the science that deals with natural beings whose substances are perishable. The theoretical sciences would be those sciences that deal with substances that are imperishable and eternal.

Again it seems that what is at stake here in this passage about demonstration is the relation of necessity between the prior and the posterior in a causal sequence, and the inferences one can draw from them, rather than differences in types of causality.[154] Aristotle illustrates that in the case of most generated natural

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[152] Lennox (2001b), 129; *Met.*E.1, 1025b18-1026a23 and *PA*.I.1, 641b11 (*hê physikê theôrêtikê*).

[153] I believe that this reading is most consistent with the preceding distinctions between the natural generated beings on the one hand and the eternal (natural) beings on the other. For alternative interpretations, see Lloyd (1996), 29, and Johnson (2005), 162-163.

[154] Although, of course, the fact that generated natural beings come to be (largely) by conditional necessity explains why their coming to be is not necessary without qualification in a modal sense.

beings, the causal sequence from prior to posterior might be interrupted (for the necessity is not connected to eternity), and that hence one can only draw inferences from what is posterior to what is prior. The starting point of the demonstration is therefore the posterior, or the end to be realized, and from there one reasons back to the necessary prerequisites that have to be realized if the end is to be realized. On the other hand, in cases where the necessity can be connected to eternity and where the sequences of causes convert, the inferences work in two directions: if this, therefore that is, and if the prior has come to be, the posterior will also come to be. Perhaps the mistake Aristotle thinks his predecessors have made was that they thought that in all causal chains the prior predetermines and necessitates the posterior, while that is only true in some cases. What Aristotle points out here is that in his demonstrations in the natural sciences, the 'direction' of the inference has to be captured in the right way, that is, from the posterior to the prior. At the end of the passage, Aristotle refers to other determinations made elsewhere; presumably, the reference is to *GC*.II.11 (discussed above), where necessity is claimed to convert only when the substantial being to which it belongs is imperishable and when the sequence of events is cyclical.

The upshot of this passage is that demonstration in the natural sciences, and hence demonstrations of biological phenomena, take the end or the final cause as a starting point (for these can be observed to have been realized), and then work back from this end to the conditionally necessary antecedents that have to come to be first and which the realization of this end demands. Because what is prior in a causal sequence in the case of most natural generated things does not necessarily determine or necessitate the coming to be of the posterior without qualification, the inference in natural demonstrations is one-directional from end to the preconditions of the end.

Another passage that might shed light on the distinction between inferences about natural, generated phenomena, and inferences about eternal phenomena is Aristotle's discussion of inferences about mathematical objects in the *Physica* (*Ph.*II.9, 200a15-22):

> ἔστι δὲ τὸ ἀναγκαῖον ἔν τε τοῖς μαθήμασι καὶ ἐν τοῖς κατὰ φύσιν γιγνομένοις τρόπον τινὰ παραπλησίως· ἐπεὶ γὰρ τὸ εὐθὺ τοδί ἐστιν, ἀνάγκη τὸ τρίγωνον δύο ὀρθαῖς ἴσας

> ἔχειν· ἀλλ' οὐκ ἐπεὶ τοῦτο, ἐκεῖνο· ἀλλ' εἴ γε τοῦτο μὴ ἔστιν, οὐδὲ τὸ εὐθὺ ἔστιν. ἐν δὲ τοῖς γιγνομένοις ἕνεκά του ἀνάπαλιν, εἰ τὸ τέλος ἔσται ἢ ἔστι, καὶ τὸ ἔμπροσθεν ἔσται ἢ ἔστιν· εἰ δὲ μή, ὥσπερ ἐκεῖ μὴ ὄντος τοῦ συμπεράσματος ἡ ἀρχὴ οὐκ ἔσται, καὶ ἐνταῦθα τὸ τέλος καὶ τὸ οὗ ἕνεκα.
>
> "There is necessity among the mathematical things and among things that come to be by nature in a way that is somewhat similar. For 'since the straight is such, it is necessary that the triangle has [angles] equal to two rights'; but not 'since that, the former', but rather 'if that is not the case, then neither the straight is the case. Among things that come to be for the sake of something it is reversed, namely 'if the end will be or is, then also that which precedes it will be or is'; and if not, just as there [in the case of mathematical things] if the conclusion is not present there will not be the starting point, so here there will not be the end and that for the sake of which."

In this passage, too, Aristotle discusses the validity of inferences from the prior to the posterior (and the other way around) in different causal sequences. In some sense, inferences pertaining to mathematical objects are *similar* to inferences pertaining to natural, generated things: in both cases, the causal sequence and the necessitation are linear and one-directional, and hence the inference works in one direction only. In mathematics, the inference from the prior to the posterior is valid: if this is the straight, then the triangle will have angles equal to two rights. However, the inference does not work in the other direction: it does not follow from the triangle having angles equal to two rights that the straight is such. At most, one can say that if the triangle does not have angles equal to two rights, that the straight is not such. In natural generation, the inference from the posterior to the prior is valid: if there is or will be a house, then what precedes it (e.g. bricks and stones) is or will be too. Again, the inference does not work in the other direction: it does not follow from the presence of bricks and stones that there will be a house. At most, one can say that if there are no bricks and stones, then there will also not be a house. What is *different* in the two cases is that the starting point and end point of the inference are reversed (this is also what the different uses in tense point to):[155] in mathematics, the inference is from the prior to the posterior, while in natural generation the inference is from the posterior to the prior.

[155] Cf. Gotthelf (1987), 197-198.

Again, the necessity Aristotle is talking about here is the necessity pertaining to the relationship between items in a causal sequence: this is why he can call them 'about the same, but reversed'. The relationship of necessity between items in the causal sequence of natural generation is not one of unqualified necessity, because the prior does not always necessitate the posterior and because the posterior does not always come about. This is due to the 'for the most part' character of the realm of perishable beings, not to the types of causes that are operative in the sublunary realm *as such*. It is my opinion that, in the sublunary realm, the outcomes of *all* processes of natural generation that are non-cyclical, whether they occur because of material causation or final causation or both, are never necessary without qualification.

The types of causation that are operative in nature and art are discussed in the preceding paragraphs leading up to this discussion of necessity in mathematics. There Aristotle tries to answer the question what the role of material nature is in the explanation of generation (of either natural beings or artifacts), given that he previously concluded that nature always acts for the sake of something (*Ph.*II.9, 199b34-200a15):

> Τὸ δ' ἐξ ἀνάγκης πότερον ἐξ ὑποθέσεως ὑπάρχει ἢ καὶ ἁπλῶς; νῦν μὲν γὰρ οἴονται τὸ ἐξ ἀνάγκης εἶναι ἐν τῇ γενέσει ὥσπερ ἂν εἴ τις τὸν τοῖχον ἐξ ἀνάγκης γεγενῆσθαι νομίζοι, ὅτι τὰ μὲν βαρέα κάτω πέφυκε φέρεσθαι τὰ δὲ κοῦφα ἐπιπολῆς, διὸ οἱ λίθοι μὲν κάτω καὶ τὰ θεμέλια, ἡ δὲ γῆ ἄνω διὰ κουφότητα, ἐπιπολῆς δὲ μάλιστα τὰ ξύλα· κουφότατα γάρ. ἀλλ' ὅμως οὐκ ἄνευ μὲν τούτων γέγονεν, οὐ μέντοι διὰ ταῦτα πλὴν ὡς δι' ὕλην, ἀλλ' ἕνεκα τοῦ κρύπτειν ἄττα καὶ σώζειν. ὁμοίως δὲ καὶ ἐν τοῖς ἄλλοις πᾶσιν, ἐν ὅσοις τὸ ἕνεκά του ἔστιν, οὐκ ἄνευ μὲν τῶν ἀναγκαίαν ἐχόντων τὴν φύσιν, οὐ μέντοι γε διὰ ταῦτα ἀλλ' ἢ ὡς ὕλην, ἀλλ' ἕνεκά του, οἷον διὰ τί ὁ πρίων τοιοσδί; ὅπως τοδὶ καὶ ἕνεκα τουδί. τοῦτο μέντοι τὸ οὗ ἕνεκα ἀδύνατον γενέσθαι, ἂν μὴ σιδηροῦς ᾖ· ἀνάγκη ἄρα σιδηροῦν εἶναι, εἰ πρίων ἔσται καὶ τὸ ἔργον αὐτοῦ. ἐξ ὑποθέσεως δὴ τὸ ἀναγκαῖον, ἀλλ' οὐχ ὡς τέλος· ἐν γὰρ τῇ ὕλῃ τὸ ἀναγκαῖον, τὸ δ' οὗ ἕνεκα ἐν τῷ λόγῳ.
>
> "Does necessity hold conditionally or also without qualification? For now people think that necessity is present among what comes to be, just as if someone would think that a wall comes to be of necessity, because things that are heavy are naturally carried downwards and things that are light to the top, and that therefore the stones and the foundations are at the bottom, and earth above because it is lighter, and on the very top wood, because it is the lightest. But surely even though the wall did not come to be without those, it did not come to be because of them except as by

> means of the material, but rather for the sake of enclosing and protecting certain things. And it is the same way in all other things, in as many are for the sake of something, that they on the one hand cannot be without things that have a necessary nature, but they are not because of these, except as by means of material, but for the sake of something, such as for instance: on account of what is a saw like this? That this may be, and for this. It is impossible, however, that this for the sake of which should come to be, unless it is made of iron. It is necessary, then, that it should be made of iron, if there is to be a saw, and its work to be done. The necessary, then, is necessary on some condition, and not as an end: the necessary is in the matter, the 'that for the sake of which' in the account."

In this passage, Aristotle distinguishes between the necessity governing materials that presupposes the operation of final causality, and the necessity that is 'unqualified'. This latter type of necessity is the necessity that does not presuppose the operation of final causality, but is rather associated with matter acting according to its own material potentials (note that in the following lines, Aristotle simply speaks of 'necessity' and not of 'unqualified necessity'). Aristotle's basic claim here is that, although material causation does play a role in the generation of natural and artificial things, it usually operates within the context of final causality. Ultimately, final causality is responsible for the generation of complex wholes (i.e. the presence of formal natures that operate as an internal goal-directed source of change). Materials acting on their own necessitate outcomes only qua material, while the materially causal processes themselves can only fully be explained by reference to the goals that need to be realized. On the level of complex generated beings, the necessity residing in matter operates *for the most part* on the condition of ends that need to be realized, and not simply on its own.

This does not mean that Aristotle rejects the necessity of material causes in generation altogether. As Cooper points out, the question Aristotle addresses is not whether there is such thing as material necessity in generation, but rather how it operates in nature (cf. *Ph.*II.8, 198b11-12: ἔπειτα περὶ τοῦ ἀναγκαίου, πῶς ἔχει ἐν τοῖς φυσικοῖς).[156] The passage is part of a larger argument for the existence of natural teleology and for the assumption of forms and ends to explain the regular generation of complex wholes (see chapter 1.3). For the most part, the presence of a form

[156] Cooper (1987), 262.

precedes the coming to be of a complex natural whole, and in those cases material necessity is always subordinate to and conditional upon the operation of teleology (i.e. upon the goal-directed actions of the formal nature). However, in the example of the coming to be of teeth, Aristotle left open the possibility for material causation to operate on its own. In some cases, the goal-directed actions of the formal natures come in at a second stage. The passage as I read it thus argues for the overarching operation of final causation, while retaining the causal power of material necessity as an incidental source of the coming to be of materials on its own accord.

In the discussion in *PA*.I.1 about the nature of the two types of explanations that the student of nature should produce, Aristotle refers to two *other* modes of necessity, which he claims he has discussed in another treatise (*PA*.I.1, 642a1-7):

> Εἰσὶν ἄρα δύ' αἰτίαι αὗται, τό θ' οὗ ἕνεκα καὶ τὸ ἐξ ἀνάγκης· πολλὰ γὰρ γίνεται, ὅτι ἀνάγκη. Ἴσως δ' ἄν τις ἀπορήσειε ποίαν λέγουσιν ἀνάγκην οἱ λέγοντες ἐξ ἀνάγκης· τῶν μὲν γὰρ δύο τρόπων οὐδέτερον οἷόν τε ὑπάρχειν, τῶν διωρισμένων ἐν τοῖς κατὰ φιλοσοφίαν. Ἔστι δ' ἕν γε τοῖς ἔχουσι γένεσιν ἡ τρίτη·
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> "Clearly, then, there are these two explanations, that stating the for the sake of which and that stating the 'from necessity'; for many things come to be because it is a necessity. One might perhaps be puzzled about what sort of necessity those who speak of 'from necessity' mean; for it cannot be either of the two modes defined in our philosophical discussions. There is a third mode among the things that partake of generation."

The third mode of necessity Aristotle mentions here is most likely to be *conditional* necessity: among things that partake of generation, this is the predominant form of necessity. Aristotle illustrates this type of necessity with an example (*PA*.I.1, 642a7-12):

> λέγομεν γὰρ τὴν τροφὴν ἀναγκαῖόν τι κατ' οὐδέτερον τούτων τῶν τρόπων, ἀλλ' ὅτι οὐχ οἷόν τ' ἄνευ ταύτης εἶναι. Τοῦτο δ' ἐστὶν ὥσπερ ἐξ ὑποθέσεως· ὥσπερ γὰρ ἐπεὶ δεῖ σχίζειν τῷ πελέκει, ἀνάγκη σκληρὸν εἶναι, εἰ δὲ σκληρόν, χαλκοῦν ἢ σιδηροῦν, οὕτως καὶ ἐπεὶ τὸ σῶμα ὄργανον (ἕνεκά τινος γὰρ ἕκαστον τῶν μορίων, ὁμοίως δὲ καὶ τὸ ὅλον), ἀνάγκη ἄρα τοιονδὶ εἶναι καὶ ἐκ τοιωνδί, εἰ ἐκεῖνο ἔσται.
>
> "For we say nourishment is something necessary according to neither of those two modes of necessity, but because it is not possible to be without it. And this is as in the conditional type. For just as – since the axe must split – it is a necessity that it be

> hard, and if hard, then made of bronze or iron, so too since the body is an instrument (for each of the parts is for the sake of something, and likewise also the whole), it is therefore a necessity that it be of such a character and constituted from such things, if that is to be."

Conditional necessity thus pertains to the materials and the material potentials necessary for the realization of some functional whole, whether it is a living being or artifact. 'Necessary' in this context means that it cannot be without it. Aristotle calls the necessary relation between materials and parts on the one hand and wholes on the other hand 'like' necessity on a condition, presumably because he is talking in the first place about relations between two things, and only on a secondary level about the type of causation involved. However, the implication is also that whatever is necessary for a living being in the sense that it cannot be without it, must come to be as a result of (primary) teleology and 'conditional' necessity. If something is necessary on a condition, the necessity imparted in a material process is imparted by a final cause.

The other two types of necessity that are defined "in our philosophical discussions," but which are not typically part of the explanations a student of nature should produce, are probably the two that Aristotle distinguishes in *APo.*II.11, 94b37-95a2.[157] The first is the necessity that is "in accordance with nature and impulse" (*APo.*II.11, 94b37-95a1: ἡ μὲν γὰρ κατὰ φύσιν καὶ τὴν ὁρμήν), usually interpreted as material or natural necessity.[158] The second is the type of necessity "that is by force and contrary to impulse" (*APo.*II.11, 95a1-2: ἡ δὲ βίᾳ ἡ παρὰ τὴν ὁρμήν) or 'enforced necessity'. A stone, for instance, which has an earthy constitution, moves downwards because of material or natural necessity, and upwards only because of enforced necessity.

Interestingly, Aristotle connects these two types of necessity with teleology in *APo.*II.11, without introducing his notion of conditional necessity yet. Aristotle provides two examples, illustrating how "it is possible for the same thing to be both for the sake of something and from necessity" (*APo.*II.11, 94b27-28: Ἐνδέχεται δὲ

[157] Rather than the five different meanings of necessity discussed in *Met.*V.5, *pace* Charles (1988), 8-10 and Cooper (1987), 259n.19.
[158] Or: 'pre-conditional necessity' as Lennox (2001a), 187, calls it.

τὸ αὐτὸ καὶ ἕνεκά τινος εἶναι καὶ ἐξ ἀνάγκης). Both examples concern phenomena (i.e. light shining through lanterns and thunder)[159] in which the necessity involved is material necessity (which is not conditional upon the end for the sake of which the phenomenon is said to occur), and in which the proclaimed purposes of the phenomena do not seem to be the *proper* ends or final causes of these phenomena.[160] At least in this context, Aristotle allows material necessity to operate on its own, and at the same time to serve some (secondary) purpose.

Aristotle's claim in *PA*.I.1 that there is a *third* type of necessity present in things that partake of generation therefore does not exclude the presence of the two other types of necessity in nature,[161] nor does it reduce all necessity in nature conditional necessity.[162] All that Aristotle needs to be saying here is that it must be this third type of necessity that is meant by "those who speak of 'from necessity'". Both the discussion in *APo*.II.11[163] and the example of a biological explanation Aristotle present at the very end of *PA*.I.1 give evidence for the fact that Aristotle counts material and enforced necessity as causes in natural generation. The example pertains to the circulation of air during breathing runs like follows (*PA*.I.1, 642a32-642b2):

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[159] Aristotle gives two examples of phenomena that can be explained both teleologically and of necessity, one of 'being', i.e. the fact that light shines through a lantern (*APo*.II.11, 94b28-31), and one of 'coming to be', i.e. the occurrence of thunder (*APo*.II.11, 94b31-32). The phenomenon of light shining through a lantern is said to be due to necessity, for 'being a fine body' holds of all 'light', and 'passing through a larger body' holds of all 'finer bodies' (and a lantern is a larger body than light). This is one explanation of why all light passes through lanterns, the other is because it is for the sake of something: namely, that we may not stumble. So, too, the occurrence of thunder is said to be due to necessity, because 'noise' holds of all 'extinguishing of fire', and 'extinguishing of fire' holds of all 'thunder', which is why 'noise' 'holds of all thunder.' Thunder is also explained as occurring for the sake of something, namely "to threaten the denizens of Tartarus in order to make them afraid."

[160] That is, unless we accept the awkward consequence of denying that light still shines through lanterns the moment we stumble or of denying that thunder is still what it is (in reality and not homonymously; cf. *PA*.I.1, 640b29-641a5) the moment the denizens of Tartarus are no longer threatened by it. On the contrary, light will still shine through a lantern even if this would not have any function, because that is what finer bodies naturally do – they pass through larger bodies. The examples are examples of secondary teleology, in which the function or uses are imposed by human beings or Zeus on things that happen of material necessity.

[161] Lennox's translations of this passage (Lennox (2001b), 7: "but it is especially in things that…"; (2001a), 186: but the third sort *is* present in those things which come to be") are misleading as they suggest that the two types of necessity mentioned first do not exist in things that partake of generation. The Greek, on the other hand, does not exclude this possibility, but rather emphasizes that in things that partake of generation there is a *third* type of necessity.

[162] As Balme (1972), 76-84; 100 and (1987), 283-5 holds.

[163] One could object that Aristotle never uses the notion of conditional necessity in *APo*., and that the *PA* text is a revision of an earlier statement contrasting teleology with material necessity; however, Aristotle does not explicitly revoke his statements on the presence of material necessity in nature in *PA*.

> Δεικτέον δ' οὕτως, οἷον ὅτι ἔστι μὲν ἡ ἀναπνοὴ τουδὶ χάριν, τοῦτο δὲ γίγνεται διὰ τάδε ἐξ ἀνάγκης. Ἡ δ' ἀνάγκη ὁτὲ μὲν σημαίνει ὅτι εἰ ἐκεῖνο ἔσται τὸ οὗ ἕνεκα, ταῦτα ἀνάγκη ἐστὶν ἔχειν, ὁτὲ δ' ὅτι ἔστιν οὕτως ἔχοντα καὶ πεφυκότα. Τὸ θερμὸν γὰρ ἀναγκαῖον ἐξιέναι καὶ πάλιν εἰσιέναι ἀντικροῦον, τὸν δ' ἀέρα εἰσρεῖν. Τοῦτο δ' ἤδη ἀναγκαῖόν ἐστιν. Τοῦ ἐντὸς δὲ θερμοῦ ἀντικόπτοντος, ἐν τῇ ψύξει τοῦ θύραθεν ἀέρος ἡ εἴσοδος.
>
> "One should give demonstrations in the following way, for example, breathing *exists* for the sake of this, while it [i.e. breathing] *comes to be* from necessity because of these. But 'necessity' sometimes means that if this is to be that for the sake of which, then these must be so [i.e. by conditional necessity]; but at other times it means that things are so in respect of their character and nature [i.e. by material or natural necessity]. For it is necessary for the hot to go out and come in again upon meeting resistance, and for the air to flow in – that is already necessary. But because the heat meets internally with resistance, the reason of the entrance and the exit [of the air] is in the cooling."

In his example, Aristotle acknowledges the explanatory power of references to both conditional necessity and a type of necessity rooted in the material nature of elements. Breathing is for the sake of something, namely cooling, and an animal will have to be able to cool itself if it is to live (cf. *PA*.III.6, 669a11-13; 669a12-13: ὥστ' ἐν τῷ πνεύματι αὐτῶν εἶναι τὸ τέλος τοῦ ζῆν); hence the organs for cooling come to be by conditional necessity. However, some things occur because of the material nature of bodies involved in the cooling process: the circulation of air itself does not occur for the sake of something, nor is it conditional upon some end,[164] but it happens in accordance with and due to the element's natures and powers. As Aristotle puts it: the circulation of air is immediately (i.e. not conditionally) necessary (*PA*.I.1, 642a36: ἤδη ἀναγκαῖόν). If Aristotle's own example[165] of an explanation of a natural

[164] Pace Lennox (2001b), 152, who thinks that the 'mechanics' of breathing should be viewed as embedded within a demonstration that this process of breathing is necessary for a certain end. The mechanics described, however, do not refer to breathing as such but to the circulation of air, occurring due to certain 'natural laws', which might as well take place outside an animal's lung.

[165] However, as Lennox (2001b), 151, points out, this example does not exactly represent Aristotle's own account of the mechanics of breathing as he describes it in *Juv.*27, 480a25-b4. Of course, it is not uncommon for Aristotle to use examples that draw from common beliefs, rather than from his own theories (cf. Balme (1972), 101), but this does not mean that Aristotle is not committed to the general pattern of explanation – especially since he is giving an example of good practice.

A.P. Bos, in private correspondence, suggests that the main subtext for Aristotle's example is Plato's account of respiration in Pl.*Tim.*78D and 79D. He proposes the following translation and interpretation: "One should demonstrate in the following way, for example, breathing exists for the sake of this [i.e. cooling], and this [i.e. cooling] comes to be from necessity because of these. But 'necessity'

phenomenon refers to both conditional and material necessity, we should expect his actual explanations also to refer to material necessity in at least some cases.[166]

In sum, in the majority of the passages discussed above, Aristotle contrasts unqualified and conditional necessity in terms of the relation of necessity between the prior and the posterior in a causal sequence. In natural (and artistic) generative processes, the coming to be of the conditionally necessary prerequisites do not guarantee the coming to be of the end, and therefore in demonstrations and explanations alike, we need to start from the end, and reason our way back to the prerequisites. Inferences from the prior to the posterior in nature are only possible with regard eternal, cyclical processes, where the necessity converts. There is no 'unqualified necessity' in this modal sense in the sublunary natural realm.

In the passages in which Aristotle is concerned with causation, Aristotle argues that material necessity in natural generation is subordinated to teleological processes and thus conditional upon the presence of some form. Material causation necessitates the coming to be of certain materials on its own accord, but in most cases the material process itself only takes place because some end needs to be realized. Hence, the student of nature should refer to both teleology and conditional necessity in explaining the phenomena. However, Aristotle does not claim that every aspect of a complex whole needs to be conditionally necessitated. In nature, material necessity sometimes operates on its own, in that it acts independently of forms and ends.

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sometimes means that (a) if this is to be that for the sake of which, then it has to possess these things of necessity, but at other times it means that (b) things are thus and they are thus by nature. For [according to an explanation according to b] it is necessary for the hot to go out and come in again upon meeting resistance, and for the air to flow in. That [is the theory of Plato, see *Tim.*78D; cf. 79D, and that] is indeed necessary. But [in that explanation Plato does not account for the purpose of respiration, which is cooling; therefore we have to say that] because the vital heat meets with resistance internally, the reason of the entrance and the exit of the external air is in the cooling [for this use of *en* compare *Ph.*IV.3, 210a21]." The final sentence of this passage is obscure; I follow Bos in my translation above, because his reading seems to make the most sense of the text. Under this interpretation, Aristotle acknowledges the causal influence of necessity in the process of respiration as described by Plato, but corrects him for having neglected teleology: ultimately, it is the function of cooling that explains why breathing takes place.

[166] Cf. Cooper (1987), 257-258.

*3.4.2.b Aristotle's criticism of his materialist predecessors*

In the former sections, I have argued that Aristotle criticizes his materialist predecessors for not acknowledging the operation of final causation in addition to material causation and for misunderstanding the type of necessitation involved in materially caused processes. In this section, I will present a brief overview of Aristotle's critique of his predecessors as presented in *PA*.I.1, 640b4-641a17 to complement these earlier arguments and my interpretation of Aristotle's defense of natural teleology in *Ph*.II.8 (see chapter 1.3).

Aristotle's more extensive critical evaluation of the views of his materialist predecessors follows upon his remarks about how those materialists failed to make the right distinctions concerning the type of necessity involved in different realms of nature, and about the structure of demonstration in the natural sciences.

The first issue Aristotle brings up is that in investigating nature, one should take into account that generation is for the sake of being, and not being for the sake of generation. Generation should thus be understood in terms of being, i.e. in terms of the finished product that results from the process of generation, rather than that the result should be understood in terms of the processes of generation that lead up to its coming to be. According to Aristotle, Empedocles got this priority relation wrong, and because of that gave the wrong explanation of natural phenomena (*PA*.I.1, 640a19-24):

> Διόπερ Ἐμπεδοκλῆς οὐκ ὀρθῶς εἴρηκε λέγων ὑπάρχειν πολλὰ τοῖς ζῴοις διὰ τὸ συμβῆναι οὕτως ἐν τῇ γενέσει, οἷον καὶ τὴν ῥάχιν τοιαύτην ἔχειν, ὅτι στραφέντος καταχθῆναι συνέβη, ἀγνοῶν πρῶτον μὲν ὅτι δεῖ τὸ σπέρμα τὸ συνιστὰν ὑπάρχειν τοιαύτην ἔχον δύναμιν, εἶτα ὅτι τὸ ποιῆσαν πρότερον ὑπῆρχεν οὐ μόνον τῷ λόγῳ ἀλλὰ καὶ τῷ χρόνῳ·
>
> "For this reason Empedocles did not speak accurately when he said that many things belong to animals because things turned out that way during generation, for instance also that the backbone is such, because it happened to get broken by being twisted. He did not know, first, that the sperm that puts it together must be present already having such a potential, and second, that the producer was prior not only in definition but also in time."

Aristotle's argument against Empedocles here is similar to that in *Ph*.II.8 concerning the generation of teeth (see chapter 1.3.1.b). Animals and their parts are not the way

they are because that is how they 'happened' to 'turn out' during the process of generation. Rather, they are the way they are because of formal and final causation. The form is present in the seed (and thus precedes the process of generation), and the fully realized end which constitutes the final cause is present in the father, who transmits the seed to the female, who contributes the matter to the process of generation. The main point of disagreement between Aristotle and Empedocles is that the latter turns the outcomes of natural processes into mere matters of luck, while for Aristotle these outcomes are the result of intrinsic causation,[167] and therefore have to be explained primarily in terms of these intrinsic causes (i.e. formal and final causation).[168]

This argument in favor of the priority of being is related to Aristotle's later criticism of the 'ancients who first began philosophizing about nature' (*PA*.I.1, 640b4). In Aristotle's view, their accounts of natural phenomena in terms of the material constitution of things are not enough (*PA*.I.1, 640b22: Οὐ γὰρ ἱκανὸν) for the purposes of determining the full explanation of something. As Aristotle points out, when talking about artifacts such as beds, we would rather try to define their form, rather than their matter, or at least talk about the composite of matter and shape. Form or configuration are much more important (*PA*.I.1, 640b28: κυριωτέρα) according to Aristotle, simply because they are more 'informative' – they tell us what things are. Explanations of phenomena that refer only to the constitutive material lack informative content.

Next, Aristotle focuses specifically on Democritus, who appears to have thought that things are what they are in virtue of their configuration and color. Against this theory, Aristotle claims that although, for instance, a corpse has the same shape as a human being, we would not call a corpse a human being, except

[167] Cf. Sauvé Meyer (1992), 794-795.

[168] For a similar criticism, see also *Met*.I.3, 983a24-984b. There Aristotle argues that: "it is not likely either that fire or earth or any such element should be the reason why things manifest goodness and beauty both in their being and in their coming to be, or that those thinkers should have supposed it was; nor again could it be right to entrust so great a matter to spontaneity and chance. When one man said, then, that mind was present – as in animals so throughout all of nature – as the cause of order and of all arrangement, he seemed like a sober man in contrast with the random talk of his predecessors (*Met*.I.3, 984b11-18)." The upshot of this critique is that according to Aristotle, phenomena exhibiting properties like goodness and beauty, order and arrangement, cannot be the result of accidental material causation, spontaneity, or chance.

homonymously, because it cannot perform the function that belongs to it.[169] The same holds for bronze or wooden hands, a drawing of a physician, or a flute made of stone: we do not call them a hand, a physician, or a flute, because they cannot perform their proper functions (*PA*.I.1, 640b29-641a5). Aristotle thus stresses that what something is, is ultimately determined by the function(s) it performs. In Aristotle's view, Democritus' theory is not specific enough or "too simple" (*PA*.I.1, 641a5: Λίαν οὖν ἁπλῶς εἴρηται), because he failed to connect form to essential functions.

Finally, Aristotle indicates that he also thinks that "the way in which the natural philosophers speak of the generations and causes of configuration" is too unspecified, as well (*PA*.I.1, 641a7-8: Οὕτως γὰρ καὶ οἱ φυσιολόγοι τὰς γενέσεις καὶ τὰς αἰτίας τοῦ σχήματος λέγουσιν). When asked "by what powers" something is crafted, they respond in terms of the nature of the elements. Aristotle then argues that a carpenter will be able to give a better response, by pointing to the tools by which something came to be, and ultimately by stating the reason why the tools were used in the way they were and for the sake of what they were used (*PA*.I.1, 641a8-13). The deficiency in the account of the philosophers is thus that they fail to explain why the elements move the way they do – they fail to state the 'that for the sake of which'. This is why Aristotle concludes that these natural philosophers "did not speak correctly" (*PA*.I.1, 641a14: ὅτι οὐκ ὀρθῶς λέγουσι).

In short, Aristotle points out the deficiencies of materialistic explanations mainly by showing how the inclusion of formal and final causes render a much better and fuller understanding of what a thing is and of why it is present or has come to be. Aristotle argues that explanations only in terms of material causes are not informative enough, or too simple *relative to* other types of explanation. The upshot of the whole discussion is thus not to argue for the *exclusion* of explanations in terms of material causes and necessity, but to stress the importance of the *inclusion* of formal and final causes into the study of nature. Natural phenomena are most

[169] For Aristotle's principle of homonymy, see chapter 2.1.2.c.

completely explained by explanations that refer to the ends of those phenomena, and not only to their material constitutions.[170]

### *3.4.3 Teleology and necessity in the biological explanations of PA.II-IV*

In this section, I will turn to an analysis of Aristotle's use of teleology, conditional necessity, and material necessity in the actual explanations of biological phenomena in *PA.*II-IV.

#### *3.4.3.a Necessity is spoken of in many ways*

Aristotle indicates in his theoretical introduction to the science of nature in *PA.*I.1 that necessity is among those things that are "spoken of in many ways" (*PA.*I.1, 639b23: ποσαχῶς λέγεται τὸ ἀναγκαῖον; cf. *Met.*V.5). Unfortunately, this is not only true for his predecessors, but also for Aristotle himself, because he never makes explicit which of the four types of necessity he means when he uses the term in his actual explanations. There are, however, some slight differences in his references to necessity on a linguistic level, and I believe that these differences make it possible to distinguish references to conditional necessity from those to material necessity.

In both *PA.*II-IV and *GA.*I-V, we find two kinds of expressions involving necessity.[171] First, Aristotle uses necessity as a relational term, indicating that something is necessary for another thing.[172] Usually, Aristotle indicates that certain parts are necessary for certain functions, or that certain functions are necessary for certain animals. I take it that these expressions indicate that some structure is conditionally necessary for some end, and that hence that structure will have to

[170] This, then, is also the conclusion Aristotle reaches near the end of the our chapter dealing with proper method of the science of nature (*PA.*I.1, 642a13-15): "clearly, then, there are two sorts of cause [i.e. necessity and teleology], and first and foremost one should succeed in stating both, but failing that, at least attempt to do so; and clearly all who do not state this say virtually nothing about nature."

[171] There is a third kind of expression, which I will not discuss further in this chapter, in which necessity refers to the notion of logical implication or consequence, indicating the conclusion of an account. See, for instance the following two passages: "And further, since none of the bloodless parts, nor the blood, is perceptive, it is clear that the first thing that holds it as in a vessel must be its origin (*anagkaion einai*). That it appears to be this way not only accords with our account, but with perception as well (*PA.*III.4, 666a16-19)" and "So since it is necessary (*anagkê einai*) for one or the other of these to be an origin, and it is not the liver, it is necessary (*anagkê einai*) that the heart should also be the origin of the blood (*PA.*III.4, 666a31-33)." In both examples, Aristotle rules out all other possibilities, after which only one option remains, which then must 'of necessity' be the right option.

[172] In these cases, Aristotle uses formulations like 'it is necessary for x to be y' or 'it is necessary for x to have y' (*anagkê/anagkaion einai/echein, anagkaios/ex anagkês einai*).

come to be by conditional necessity and will be present as a result of primary teleology (i.e. of the goal-directed actions of the soul or formal nature of the animal).

Secondly, Aristotle uses expressions that refer to necessity to indicate the cause of something's coming into being, often in contrast to or in concomitance with a final cause.[173] Usually, these expressions pertain to the coming to be of parts or residues. I take these expressions to refer to material necessity, as Aristotle usually explicates the necessity involved in terms of the material natures of the elements.

Let me give an example of these two uses of necessity. Aristotle states that the two parts by which nourishment enters and residue exists are "most necessary" in all complete animals (*PA*.II.10, 655b28-32; 655b30: δύο τὰ ἀναγκαιότατα μόριά ἐστιν). The reason for this is that it is not possible to be or to grow without nourishment: the two parts are necessary for the realization of the function of nourishment, and the parts are most necessary because without nourishment, the animal will not be able to survive or to grow. The coming to be of these parts must therefore be due to conditional necessity and primary teleology. However, Aristotle explains the coming to be of the omentum as follows (*PA*.IV.3, 677b22-29):

> Ἡ μὲν οὖν γένεσις ἐξ ἀνάγκης συμβαίνει τοιαύτη τοῦ μορίου τούτου· ξηροῦ γὰρ καὶ ὑγροῦ μίγματος θερμαινομένου τὸ ἔσχατον ἀεὶ δερματῶδες γίνεται καὶ ὑμενῶδες, ὁ δὲ τόπος οὗτος τοιαύτης πλήρης ἐστὶ τροφῆς. Ἔτι δὲ διὰ πυκνότητα τοῦ ὑμένος τὸ διηθούμενον τῆς αἱματώδους τροφῆς ἀναγκαῖον λιπαρὸν εἶναι (τοῦτο γὰρ λεπτότατον) καὶ διὰ τὴν θερμότητα τὴν περὶ τὸν τόπον συμπεττόμενον ἀντὶ σαρκώδους καὶ αἱματώδους συστάσεως στέαρ γίνεσθαι καὶ πιμελήν.
>
> "The generation of that part happens of necessity in the following way: when a mixture of dry and moist is heated, the surface always becomes skin-like and membranous, and this location is full of such nutrient. And further, on account of the thickness of the membrane, it is necessary for the filtrate of the bloody nourishment to be fatty (for this is thinnest), and to become hard or soft fat rather than a fleshy and bloody composition when it undergoes concoction owing to the heat in this region."

The omentum comes to be as the result of the necessity residing in the character and the potentials of the elements present in a certain region of the body, i.e. as the result of the processes of solidification and concoction. Later (in *PA*.IV.3, 677b30-

[173] In these cases, Aristotle uses formulations like 'x exists of necessity' (*einai ex anagkês*) or 'x comes to be of necessity' (*gignesthai/sumbainei ex anagkês*).

32) Aristotle explains how nature then *uses* the membrane for the sake of the proper concoction of the nourishment, but this function is secondary upon the coming to be of the part itself.

Outside *PA,* there is only one passage (namely *GA*.V.1) where Aristotle discusses the different operations of the two types of necessity, while at the same time giving actual explanations of natural phenomena. The context is a discussion of the *pathêmata*. These 'affections' are the characteristics shared by either the complete animal kind or all animals in general, or the characteristics that are present incidentally in some individuals belonging to one kind, but not in others of the same kind. It is here that Aristotle distinguishes between phenomena like that of the eye and that of the blueness of an eye (*GA*.V.1, 778a29-b19). The first category of phenomena that are like the eye *are* for the sake of something, or at least *come to be* for the sake of something *and* through material and efficient causes (the teleology operative is primary). These are phenomena that (i.) are included in the definition of animals; (ii.) are for the sake of some end; or (iii.) are ends in themselves (*GA*.V.1, 778b12-13: ὅσαπερ ἐν τῷ λόγῳ ἐνυπάρχει τῷ ἑκάστου ἢ ἐστιν ἕνεκά του ἢ οὗ ἕνεκα). The second category consists of those phenomena that do not come to be by final causation but by necessity only, because "they are not the product of nature in general nor yet characteristic of each separate kind (*GA*.V.1, 778a30-31: ὅσα γὰρ μὴ τῆς φύσεως ἔργα κοινῇ μηδ' ἴδια τοῦ γένους ἑκάστου)." Aristotle explains the difference between generic characteristics and individual ones as follows (*GA*.V.1, 778b15-19):

> ὀφθαλμὸν μὲν γὰρ ἐξ ἀνάγκης ἕξει (τοιόνδε γὰρ ζῷον ὑπόκειται ὄν), τοιόνδε δὲ ὀφθαλμὸν ἐξ ἀνάγκης μέν, οὐ τοιαύτης δ' ἀνάγκης ἀλλ' ἄλλον τρόπον, ὅτι τοιονδὶ ἢ τοιονδὶ ποιεῖν πέφυκε καὶ πάσχειν.
>
> "An animal must of necessity have an eye (for an animal is supposed to be of such a sort), but it will have an eye of a particular kind of necessity in another sense, not the sense mentioned above, because it is its nature to act or to be acted on in this or that way."

The two types of necessity referred to here are conditional and material necessity. An animal has eyes because it is by definition a perceptive being; perceiving is an essential function, and therefore animals must – by conditional necessity – have eyes

for the performance of that function. On the other hand, animals have blue (or brown, etc.) eyes because of material necessity: the color of the eye is incidental to the function for the sake of which the eye has come to be.[174] The individual differences between the material elements constituting eyes cause the differences in color on their own accord.

Interestingly, according to *GA*.V.1, teleological explanations of the *presence* of parts refer typically only to the proper function those parts perform, while their *coming to be* and their material constitution[175] is explained by reference to both their function and the material and efficient causes that are at work (i.e. conditional necessity). Features of animals that are not present for the sake of something, and that are unrelated to their essence (*GA*.V.1, 778b1), are explained as being the result of material necessity alone. As Aristotle puts it (*GA*.V.1, 778b14-16):

> ἤδη τούτων τὸ αἴτιον ἐν τῇ κινήσει δεῖ καὶ τῇ γενέσει ζητεῖν ὡς ἐν αὐτῇ τῇ συστάσει τὴν διαφορὰν λαμβανόντων.
>
> "The cause of them must be sought in the movement or process of coming into being, because they receive the difference in the actual formation."

This text gives room to material necessity, even if only at a very limited level, in the coming to be of the *pathêmata* or the individual differences between animals, such as the color of their eyes, the pitch of their voice, skin color, and the color of their hair or feathers (*GA*.V.1, 778a18-20).

However, some scholars[176] hold that the process of an eye becoming blue is – although perhaps indirectly – still ultimately conditional upon the coming to be of an eye. Because the coming to be of the eye is conditionally necessitated by its function of sight, the color of the eye (since "an eye has to have some color")[177] must be conditionally necessitated, too. This, however, need not be true. Ultimately, of course, all the materials that are present in a living being are present as the result

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[174] For *pathêmata* that do contribute to the purpose of the eye, see *PA*.II.2, 648a14-15.

[175] For other explicit references to the conditionality of the material constitutions of parts on the function they need to perform, see: *PA*.II.16, 660a8-10; *PA*.IV.7, 683b4-7; *PA*.IV.10, 687b27-29; *PA*.IV.10, 689a19-21; *PA*.IV.11, 691b9-16.

[176] Cooper (1987), 263-9; 267: "But, secondly, where material necessity does function – in forming the membrane round an animal fetus, in making an eye blue or brown, and so on – it is on Aristotle's view at best a proximate cause of the necessitated feature. That a blue eye is produced depends upon the properties of the material and their materially necessary interactions as the eye is being formed; but it is not, on Aristotle's theory, by material necessity that those materials, with their necessitating properties, are present in the first place." Cf. Lennox (2001a), 194-5; Liatsi (2000), 42; and Kullmann (1974), 295.

[177] Liatsi (2000), 85.

of conditionally necessitated processes, but that does not mean that they are all conditionally necessitated themselves. Given all the conditionally necessitated material processes taking place in the body of a living being, it must be the case that the interaction between these processes gives rise to incidental coming into beings of new materials, or that there remain residues that are then left by the formal nature of an animal to act according to their own natures. As we have seen above, Aristotle draws a clear distinction between matter that has come to be by conditional necessity for the sake of realizing some part, and between matter that has come to be by material necessity. The latter type of matter has not come to be for the sake of a 'predetermined' function (that is, there is no form necessitating the coming into being of this matter), but it may or may not be used by the formal nature of the animal for the sake of something good. Because the materials that cause the blueness of eyes have not come to be for the sake of making the eyes blue (and that is because a particular eye color does not serve a particular function according to Aristotle), they are not conditionally necessitated in a strict sense. Instead, as Aristotle points out himself, they are due to the material and efficient causal processes that take place during generation itself. Presumably, because they do the individual animal no harm, the formal nature does nothing to redirect or to dispose of these materials.

In sum, one could say that according to Aristotle teleology and necessity are related to each other in the three following ways. First, things that come to be and are present for the sake of something, and are part of the essence of an animal, come to be by conditional necessity and are present by primary teleology. Second, things that come to be of material necessity, and are not part of the essence of an animal, but are used by the formal nature of some animal for some good purpose, come to be by material necessity, and are present by secondary teleology. Third, things that come to be of material necessity, and are either irregular or particular for some individual animal, and are not used by the formal nature of some animal for some good, come to be and are present simply by material necessity. In the following subsections, I will briefly show how each of these possible relations between necessity and teleology are played out in the actual explanations Aristotle provides in *PA*.

*3.4.3.b Primary teleology and conditional necessity*

Primary teleology and conditional necessity play a causal role at different levels in the coming to be of the living organism. Usually, Aristotle explains his notion of conditional necessity in terms of *matter* having to come to be first if there is to be a certain end-product with a certain function (e.g. if there is to be a wall for the sake of protection, there first have to be stones and wood). In the biological context, however, conditional necessity describes causal relations at three levels. First, conditional necessity characterizes the relation between matter and parts that perform necessary functions for which that matter comes to be. Second, conditional necessity characterizes the relation between those parts and the necessary functions they perform. Thirds, conditional necessity characterizes the relation between necessary differentiations of parts and the optimalization of the function for which they come to be. The type of teleology involved in these cases is primary teleology.

The first level at which primary teleology and conditional necessity are picked out by Aristotle is in the explanations of the coming to be and the presence of certain materials. In these cases, it is the function that conditionally necessitates the coming to be of the materials constituting the part that performs that function (*PA*.IV.10, 689a20-21):

> Ὅτι δ' ἔχει καὶ τὰ σχήματα τῶν μορίων τούτων πρὸς τὴν ἐργασίαν ἀναγκαίως, οὐκ ἄδηλον.
>
> "But that the configuration[178] of these parts is necessarily for their operation is not hard to see."

As I argued in 2.1.2.d, the function a part should perform does not determine what kind of matter should be present first, but it rather determines what kind of *potentials* the matter that has to be present first should have. As Aristotle explains in *PA*.II.1, it is better to speak of composite matter in terms of the primary contrary potentials (cold/moist; hot/moist; cold/dry; hot/dry), rather than in terms of the elements themselves (*PA*.II.1, 646a14-20):

> Ἔτι δὲ βέλτιον ἴσως ἐκ τῶν δυνάμεων λέγειν, καὶ τούτων οὐκ ἐξ ἁπασῶν, ἀλλ' ὥσπερ ἐν ἑτέροις εἴρηται καὶ πρότερον. Ὑγρὸν γὰρ καὶ ξηρὸν καὶ θερμὸν καὶ ψυχρὸν ὕλη τῶν συνθέτων σωμάτων ἐστίν· αἱ δ' ἄλλαι διαφοραὶ ταύταις ἀκολουθοῦσιν, οἷον βάρος καὶ

[178] That *schêma* here means more than just the physical or visible shape of the part, is clear from the next passage in which Aristotle picks up this phrase, but now refers to the natural constitution (*sunestêke tên phusin*) of the part which gives it its necessary abilities to perform its function (*PA*.IV.10, 689a27-30).

> κουφότης καὶ πυκνότης καὶ μανότης καὶ τραχύτης καὶ λειότης καὶ τἆλλα τὰ τοιαῦτα πάθη τῶν σωμάτων.
>
> "And yet, perhaps it is better to speak of composition from the potentials, and not from all of them, but as stated previously in other works. That is, moist, dry, hot and cold are matter of the composite bodies, while the other differences, e.g. heaviness and lightness, density and rarity, roughness and smoothness, and the other bodily affections of this sort, follow these."

The four potentials are primary to the elements and the uniform parts that are constituted from the elements (and to the non-uniform parts that are constituted from the uniform parts), and they form the basis of material explanation.[179] The function a part needs to perform thus determines the complex combination of potentials the part needs to have, although it does not fully determine the exact material constitution of it (much of that will depend upon the kind of animal in which the function is being realized). In addition, the material nature of the animal in which the function is realized plays a role in limiting the kinds of material in which the necessary functions can be realized.[180]

The second level at which conditional necessity and primary teleology play are picked out in explanations is in the explanation of the coming to be of both necessary parts and of non-necessary parts as being for the sake of the performance of necessary functions.[181] That is, conditional necessity characterizes the relation between a part and the necessary function for the performance of which it came to be, but also the relation between a part and the necessary function to which its coming to be contributes.

Functions are necessary when they are either of vital or of essential importance for the animal, and are therefore part of the animal's substantial being. Vital functions are those functions that are necessary for the existence or the survival of an animal; without the ability to perform its vital functions the animal would die immediately. For this reason, the liver is a necessary part, because it performs the

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[179] See Lennox (2001b), 180-181.
[180] Cf. Lennox (2001a), 196-199.
[181] Parts that serve non-necessary functions (that is, functions that are not of vital of essential importance to the animal), but merely serve 'luxurious' functions that contribute to the animal's well-being, never come to be as a result of conditional necessity, but are always the result of material necessity and secondary teleology. These parts will be discussed below in 3.4.3.c.

vital function of food concoction in all the blooded animals (this is also why its material constitution affects the life-span of the animal; *PA*.IV.2, 677a36-b5):

> Εὔλογον γὰρ τὴν τοῦ ἥπατος φύσιν ἐπίκαιρον οὖσαν, καὶ ἀναγκαίαν πᾶσι τοῖς ἐναίμοις ζῴοις αἰτίαν εἶναι, ποιάν τιν' οὖσαν, τοῦ ζῆν ἐλάττω ἢ πλείω χρόνον. (...) τῶν δ' ἄλλων οὐδὲν σπλάγχνων ἀναγκαῖόν ἐστι τοῖς ζῴοις, τὸ δ' ἧπαρ μόνον·
>
> "In fact it is reasonable, that since the nature of the liver is vital, and necessary to all the blooded animals, its being of a certain character is a cause of living a shorter or longer time. (…), and none of the other viscera is necessary to these animals, but only the liver."[182]

Essential functions are those functions that are specific for and proper to the whole animal-kind or a subspecies thereof; without the ability to perform its essential functions the animal would either not be an animal at all, or not be the kind of animal it is supposed to be. For instance, without perception, an animal would not be an animal anymore (*PA*.II.2, 647a20).[183] The essential functions and the parts required to perform these functions are all picked out by the definition of the substantial being or by the form[184] of the animal. The parts and characteristics that are conditionally necessitated by these essential functions constitute the basic features of animals, that is, they do not need any further explanation, but instead other parts and characteristics are explained in terms of them.[185] Note that not only functions are picked out by the definition of an animal, but also other essential features, such as whether or not an animal is blooded (see *PA*.IV.5, 678a26-34;

[182] Examples of other vital functions with their respective parts are, for all animals: the function of heating, performed through the heart or its analogue (*PA*.II.3, 650a6-8; *PA*.II.7, 652b15; *PA*.III.4, 665b10-15; *PA*.III.4, 666a22-24); the function of receiving nourishment, performed through the mouth and stomach (*PA*.II.10, 655b28-31; *PA*.IV.5, 681b13-16; *PA*.III.14, 674a13-19); the function of excreting residue, performed through the intestines (*PA*.II.10, 655b28-31; *PA*.IV.5, 681b13-16; *PA*.III.14, 674a13-19); the function of reproduction, performed through a variety of reproductive parts (*GA*.I.2-8, 716a18-718b28); for blooded animals: the function of cooling the heat performed by the brain (*PA*.IV.10, 686a5-7) and the lung (*PA*.III.6, 668b33-35). Limbs, evidently, are not vital for an animal to have (*PA*.III.4, 665b21-27): "the limbs, however, by nature develop differently in different animals, and are not among the necessities of life, which is why even when they are removed an animal continues living (οὐκ ἔστι τῶν πρὸς τὸ ζῆν ἀναγκαίων, διὸ καὶ ἀφαιρουμένων ζῶσιν); and it is clear that adding limbs would not destroy it."

[183] Examples of other essential functions are, of all animals: sensation (*PA*.II.8, 653b19-23; *GA*.V.1, 32-34) and perception (*PA*.II.2, 647a20-23; *PA*.IV.5, 681b13-16), and reproduction (*GA*.I.23, 731b5-8); of blooded animals: respiration (performed by the lung; *PA*.III.6, 669b8-12); of birds: flying (*PA*.IV.12, 693b2-13); of fish: swimming (*PA*.IV.13, 695b17-25).

[184] For the identification of the form with the definition of the substantial being, see *GC*.II.9, 335b6-7.

[185] Cf. Gotthelf (1987), 189-192.

*PA*.IV.12, 693b2-13; *PA*.IV.13, 695b17-25; cf. *PA*.II.2, 648a20),[186] or what its dimensions are.[187]

Parts that are not necessary for necessary functions, but rather contribute to the performance of that function by some other part, also come to be by conditional necessity. However, these parts come to be at a later stage during the generative process, and only come to be if it is possible for the animal to process the amounts of food necessary for the production of these parts, and if it is on the whole possible for the animal to have the part. For instance, in order for an animal to be able to have a penis and testes (which are non-necessary parts for a necessary function) in addition to ducts for semen (which are necessary parts for a necessary function), it has to have at least two legs.

The third level at which Aristotle picks out conditional necessity and primary teleology in explanations, is in the explanation of the coming to be of the differentiations in the bodily affections or material constitutions between parts that bear the same name and perform the same (primary and proper) function. These differentiations are conditionally necessary for the part to perform its function better. This is perhaps the most important level of explanation in Aristotle's biology, for it is here that the specific formal and material nature of each kind of animal needs to be taken into account. Parts and the materials from which they are constituted always come to be for the sake of the performance of a certain necessary function *in a particular kind of animal*. It are the material and formal nature of this animal and its main differentiae that ultimately determine the exact material constitution of its parts.

The differentiae, of which the main four are the animal's life, dispositions, activities and the (other) parts it has, put extra requirements on how the necessary function should be performed by a particular kind of animal, or cause the need for one part to perform multiple functions. The differentiae cause a refinement of the 'job-descriptions' of the parts an animal has, and these functional refinements conditionally necessitate a particular differentiation of the material constitution or of

[186] Other non-functional essential characteristics are, of all animals: being male or female (*GA*.I.20, 729a22-33; *GA*.II.1, 731b18-20); of insects: being segmented into parts (*PA*.IV.6, 682b27-29); of lobsters: having claws (*PA*.IV.8, 684a32-b1); of mankind: standing upright (*PA*.IV.10, 686a25-31).
[187] For example, the length and thinness in a certain kind of octopus; see *PA*.IV.9, 685b12-15; cf. *IA*.8, 708a9-20.

the location of the parts (relative to similar parts in other animals). The functional differentiations of similar parts in different kinds of animals are thus the causes of the material differentiations among them.[188] The same holds for those cases in which a part needs to perform a second necessary function in addition to its primary and proper function. The second function conditionally necessitates the material differentiation of the part relative to the parts that perform the same primary function in other animals (and relative to how that part would have been realized in that animal if it only had to perform its primary function).

In sum, necessary functions conditionally necessitate the coming to be of parts, both at the level of the material and material potentials the parts need to have in order to perform their functions well enough for the animal to survive and to be what it is, and on the level of their specific material differentiations in each particular kind of animal.

### *3.4.3.c Secondary teleology and material necessity*

I have defined secondary teleology as the goal-directed actions of the formal nature of an animal that are undertaken with regard to matter or even complete parts that are already present (because they came to be by material necessity[189] or by conditional necessity for the sake of some other function).[190] As we have seen above, in some cases, the *coming to be* of the part or the materials out of which the

[188] Some clear examples where differentiae cause functional refinements can be seen in *PA*.III.1, 662b5-16; *PA*.III.4, 665b1-5; *PA*.III.6, 669a24-b7; and *PA*.IV.12, 693a10-16; clear examples of where the need to perform a second function causes a functional refinement can be seen in *PA*.III.1, 661a36-b6 and *PA*.IV.10, 688a19-25.

[189] For some explicit examples, see *PA*.IV.3, 677b22-29 (677b22: *hê genesis ex anagkês sumbainei*) and *PA*.IV.4, 678a3-10 (678a3: *tên genesin ex anagkês ousan*).

[190] In using the term 'secondary teleology' in this chapter, I have relied on Lennox's brief analysis of 'indirect teleology' in Lennox (2001b), 248-249. There are, however, some important differences. Unlike Lennox, I opt to speak of secondary teleology not in each case in which the formal nature is said to 'use' or 'make use' of materials for various ends, but only in those cases where (i) the materials are claimed to be present of necessity (these are usually the residues or other excessive materials); or (ii) where an existing part is made use of for another function *without* the formal nature adapting that part for the performance of this second function. I agree with Lennox (2001b, 249) that these instances are "contrasted with the production of the principal organs of biological functions, for which the uniform parts come to be." However, I would like to add that the production of these principal organs, that is, of the parts performing vital or essential functions, is always due to conditional necessity (the materials and parts are generated for the sake of the function they perform), and that those parts are always constituted from concocted nourishments, while non-necessary parts seem mostly to be constituted from 'left-over' or 'spontaneously' produced materials. Rather than there being merely a 'contrast' between two types of production of parts, Aristotle is actually laying out two different causal stories in the coming to be of parts (cf. *GA*.II.6, 744b12-27).

part is constituted is non-conditional upon the use to which it is put, but is the result of material necessity. The function the formal nature then attributes to this part or matter explains why the part or matter is present in the animal. It seems that in cases like these, the formal nature is quite literally 'confronted' with the presence of some materials or even of a fully developed structure (such as eyebrows), which it did not conditionally necessitate. Sometimes, the formal nature excretes the extra materials, but usually, it uses them for the sake of something good; the characteristic activity of nature in these cases is that of *using*. In short, the generative processes of these phenomena are not the result of primary teleology (and hence the explanation of their *coming to be* does not include references to the functions to which they are put), but their presence, organization, or distribution in an animal's body *is*. Therefore, their presence needs to be explained in terms of the function they serve.

Let me give a more detailed sketch of the types of phenomena that Aristotle explains by reference to secondary teleology and material necessity, and of the extent to which material necessity plays a role in the generation of these phenomena.

First there are parts that have come to be for the sake of some other (i.e. their primary and proper) function, and which are then put to a second use by the formal nature of the animal, but without conditionally necessitating any material adaptations of that part.[191] For instance, the elephant's trunk, which is a special kind of nostril, has come to be and is present for the sake of breathing and has the material constitution and dimensions it has (softness, the ability to bend, and extraordinary length) for the sake of this function. However, the trunk is also put to a second use, namely grasping, to make up for the uselessness of the elephant's feet in this respect. Aristotle explains that (*PA*.II.16, 659a20-23):

> ὑπάρξαντος οὖν τοιούτου τοῦ μυκτῆρος, ἡ φύσις παρακαταχρῆται, καθάπερ εἴωθεν, ἐπὶ πλείονα τοῖς αὐτοῖς μορίοις, ἀντὶ τῆς τῶν προσθίων ποδῶν χρείας.
>
> "Since it [i.e. the trunk] is such,[192] nature, as usual, turns the same part to more than one use, here using the trunk in place of the front feet."

[191] Aristotle uses the verb (*para*)*katachrêsthai* in these cases; see for example *PA*.IV.6, 683a19-25, *PA*.II.16, 659a21 and 659a35, and *PA*.IV.10, 690a1.

[192] Lennox's translation (2001b), 42, "since it is present" glosses over *toioutou*; it is because the trunk already has the material disposition it has – that it is of *such* a material nature – that it can be used for grasping, too.

This means that in this case, exactly because the trunk has been constituted from materials that have potentials that make it fit for breathing, those very same potentials also allow the elephant to use the trunk for grasping. The use to which nature puts the part thus follows the potentials that are already present in the part. The coming to be of the trunk and of its constitutive materials is conditionally necessitated by its primary function of breathing. The second function of grasping is not part of the explanation of its generation (– the potentials required to perform this second function are already available),[193] but only of the explanation of the trunk's *presence*. Only the potentials that facilitate breathing, so to speak, are conditionally necessitated in a strict sense, while the fact that they also facilitate the function of grasping is incidental. The type of necessity operative in this type of biological phenomenon, however, is not easy to determine. Because of the accidental nature of the presence of the 'right' potentials, it seems right to say that the necessity involved is material, although, *de facto* there are no materials or potentials present in the trunk that did *not* come to be as a result of conditional necessity, albeit in an indirect way.

Secondly, there are parts that are formed by the formal nature from the material that is already present in the animal as a result of material necessity (in the form of a residual surplus, secretion, sediment, or excess);[194] the formal nature puts these materials or parts to some good use in accordance with the potentials the available material has. In general, these are parts that perform non-necessary, 'luxurious' functions, which contribute to the well-being of an animal. I have found one example, however, in which processes that take place of material necessity are used by the formal nature to realize the necessary function of reproduction. This is the use of the female menses for the development of the embryo (*GA*.II.4, 738a33-b5):

> Ἐξ ἀνάγκης μὲν οὖν ἡ περίττωσις αὕτη γίγνεται τοῖς θήλεσι διὰ τὰς εἰρημένας αἰτίας· μὴ δυναμένης τε γὰρ πέττειν τῆς φύσεως ἀνάγκη περίττωμα γίγνεσθαι μὴ μόνον τῆς ἀχρήστου τροφῆς ἀλλὰ καὶ <τοῦ αἵματος> ἐν ταῖς φλεψίν, ὑπερβάλλειν τε πληθύοντα

[193] Cf. *PA*.IV.9, 685a27-29: "Accordingly [i.e. because their trunk is small and their feet are long], in the octopuses the feet are not only useful for swimming, but also for walking, while in the other two groups [i.e. the cuttlefish and the squid] they are useless for this; for their feet are small, while they have a large trunk."

[194] *PA*.II.7, 653b10-11 (*hupostêma*); *PA*.II.9, 655a23-27 (*huperochên*); *GA*.II.6, 744b12-27 (*hupoleimmata kai perittômata*); *PA*.II.2, 647b27-28 (*hupostasis*); *PA*.IV.10, 690a6-9 (*apokrisis*).

> κατὰ τὰς λεπτοτάτας φλέβας. ἕνεκα δὲ τοῦ βελτίονος καὶ τοῦ τέλους ἡ φύσις καταχρῆται πρὸς τὸν τόπον τοῦτον τῆς γενέσεως χάριν ὅπως οἷον ἔμελλε τοιοῦτον γένηται ἕτερον· ἤδη γὰρ ὑπάρχει δυνάμει γε ὂν τοιοῦτον οἵουπερ ἐστι σώματος ἀπόκρισις. Τοῖς μὲν οὖν θήλεσιν ἅπασιν ἀναγκαῖον γίγνεσθαι περίττωμα (...).
>
> "Thus the coming to be of this residue [i.e. the menstrual discharges] among females is the result of necessity because of the causes mentioned. Because her nature is not capable of concoction, it is necessary that residue must come to be, not only from the useless nourishment, but also in the blood-vessels, and that they must overflow, when there is a full complement of it in those very fine blood-vessels. And nature uses it for the sake of the better and the end for this place, for the sake of generation, in order that it may become another creature of the same kind as it would have become. For, even as it is, it is in potentiality the same in character as the body of which it is the secretion. In all female animals, then, some residue must of necessity be formed."

Material necessity is the cause of the coming to be of the female menses, but nature then uses it for the better (namely for generation), because the menses are in potentiality the same in character as the body from which it is secreted. That is, the matter the female contributes to reproduction is usable for the generation of a living being of the same kind, because this matter has the right potentials for it. In a similar way, in many animals material necessity causes the coming to be of an earthen effluence, which is then used by the formal nature of animals to produce 'luxury' parts for defense, *because* it has a defensive potential.[195] Examples of such parts are teeth, tusks, and horns in the four-footed animals;[196] hard and large beaks, spurs or claws in the birds;[197] more hair in human beings;[198] and ink in sepia.[199] The material

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[195] Pace Lennox (2001a), 194-195, who holds that "such material is present for the sake of constituting parts which must have a material propensity suitable for defense." I believe the order of causation is rather the other way around. It is because a certain type of material (i.e. earthen material) is available that happens to have a defensive potential, that nature can use it to create defensive parts. This is what Aristotle explains in the following passage (*PA*.II.9, 655b4-12): "All these <uniform parts> the animals have for the sake of protection; for the whole <organs> constituted from these <uniform parts>, and synonymous with them, e.g., the whole hoof and whole horn, have been constructed for the safety of each of these animals (…). *Of necessity all of these parts have an earthen and hard nature; for this is the defensive potential.*"

[196] *PA*.III.2, 663b31-35: "for nature uses the residual surplus of such a body, being present in the larger of the animals, for protection and advantage, and the surplus, which flows of necessity to the upper region, it distributes in some cases to teeth and tusks, in other cases to horns."

[197] *PA*.IV.12, 694a22-27.

[198] *PA*.II.14, 658b3-5.

[199] *PA*.IV.5, 679a28-30.

used by the formal nature to produce these parts did not come to be because of its defensive potential – it is only used in that way because of that potential.[200]

In his explanations of the coming to be of such parts, Aristotle provides ample descriptions of the processes of materials acting according to their elemental natures that are the causes of their formation. It is of material necessity, for example, that the extreme surface of a thing solidifies when heated as well as when cooled,[201] or that each time a mixture of dry and moist is heated, the surface becomes skin-like and membranous.[202] That these material processes are not directly or at all conditional upon some end, can be inferred also from the names Aristotle uses to indicate the materials resulting from these processes. The material is called a surplus (ὑπεροχή) when more matter has been produced than was conditionally necessitated by the necessary functions of that animal; the surplus material has come to be spontaneously.[203] In most cases, the material is called a residue (περίττωμα), which is literally the remnant of either useful or useless nourishment taken in by the animal for the production and maintenance of necessary parts.[204] Sometimes, this residue is useless[205] (in a double sense: it did not come to be for the sake of something, and now that it is present the formal nature cannot use it for the sake of something), and is therefore excreted by the animal.[206] In most cases, the formal nature of the animal will use the residue for something because of the material potentials it has, but, as Aristotle puts it emphatically, not *always* (*PA*.IV.2, 677a15-18):

> Κατάχρηται μὲν οὖν ἐνίοτε ἡ φύσις εἰς τὸ ὠφέλιμον καὶ τοῖς περιττώμασιν, οὐ μὴν διὰ τοῦτο δεῖ ζητεῖν πάντα ἕνεκα τίνος, ἀλλά τινων ὄντων τοιούτων ἕτερα ἐξ ἀνάγκης συμβαίνει διὰ ταῦτα πολλά.

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[200] This is also why material processes left on their own do not produce fully operative parts with functions: although material processes do produce the passive potentials such as hardness, moistness, solidness etc. which are the prerequisites for the performance of a function (cf. *GA*.II.6, 743a37-b17), the presence of these potentials as such does not determine which function eventually will be performed by the part having those potentials. The softness of flesh, for example, can be explained by reference to its material potential; what flesh does (why it is used for protection, and why and how it also is an organ of touch), however, and therefore what its definition is, is something which cannot explained without reference to teleology (often including the actions of the formal natures). For an illuminating account on this issue, see Cohen (1989).

[201] *GA*.II.4, 739b29-30; cf. the generation of the viscera in *PA*.III.10, 673a32-b1 and of hair in *PA*.II.15, 658b22-25.

[202] *PA*.IV.3, 677b22-29.

[203] Cf. *PA*.III.2, 663b25, *PA*.III.8, 671a2-3 and *GA*.II.7, 757a21-6.

[204] *GA*.I.18, 724b25-27; 725a4-5.

[205] Cf. *PA*.III.14, 674a13-19.

[206] This is what happens, for example, with bile; see *PA*.IV.2, 677a12-16.

> "Sometimes nature makes use even of residues for some benefit, yet one should not on this account search for what something is for in every case; on the contrary, when certain things are such as they are, many other such things happen from necessity because of these."

The formal nature of the animal makes use of what is present of material necessity by redirecting, distributing, and organizing the flow of extra material, or simply by leaving it alone. There may be enough material present to form multiple structures, but when the material is limited, nature has to follow a functional hierarchy in distributing the material. This is how Aristotle explains why none of the horn-bearing animals has a complete set of teeth (*PA*.III.2, 664a1-3):

> ἀφελοῦσα γὰρ ἐντεῦθεν ἡ φύσις τοῖς κέρασι προσέθηκε, καὶ ἡ διδομένη τροφὴ εἰς τοὺς ὀδόντας τούτους εἰς τὴν τῶν κεράτων αὔξησιν ἀναλίσκεται.
>
> "For taking away from there, nature adds to the horns,[207] and the nourishment given to the upper front teeth is expended in the growth of horns."

The material used by the formal nature to construct one part, cannot be used in another place, for "nature cannot distribute the same excess to many different locations simultaneously" (*PA*.II.9, 655a26-8: ἅμα δὲ τὴν αὐτὴν ὑπεροχὴν εἰς πολλοὺς τόπους ἀδυνατεῖ διανέμειν ἡ φύσις.).[208] An equal distribution is not an option, for the potentials of the residue would become weak and not be used optimally (*PA*.IV.12, 694a28-694b1):

> Ἅμα δ' ἄλλοθι καὶ ἄλλοθι ἕκαστα τούτων οὐ ποιεῖ. Διασπωμένη γὰρ ἀσθενὴς γίνεται ἡ φύσις τούτου τοῦ περιττώματος·
>
> "But it does not make each of these in different places simultaneously; for were it spread about, the nature of this residue would become weak."

In all these cases, the formal nature of the animal determines the optimal distribution and organization of the material that has come to be of material necessity during the second stage of the development of the animal, and thereby puts it to a good use.

In sum, material necessity and secondary teleology are picked out as explanations for two types of parts. First, there are parts whose coming to be and presence is

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[207] Cf. *PA*.II.14, 658a35-36, *PA*.IV.13, 695b14-17, *IA*.17, 714a14-19, and *GA*.III.1, 749b27-750a4 (750a3-4: ὃ γὰρ ἐκεῖθεν ἀφαιρεῖ ἡ φύσις προστίθησιν ἐνταῦθα).
[208] *GA*.IV.8, 777a15-21 ("if the secretion is diverted in the one direction it must cease in the other, unless some violence is done contrary to the general rule").

conditionally necessitated by their primary function, but whose material constitution has the potentials that allow the formal nature to put the part to a second use without changing the part in anyway; the second function that the part needs to perform is never an essential or vital function. Secondly, there are parts whose constitutive material has come to be of material necessity, and because of the potentials this material has, nature organizes it in such a way that it serves a good purpose. The function of the part is secondary to its coming to be, and its performance contributes to the well-being of the animal. At this level, material necessity does not limit the formal nature in realizing any (necessary) functions, but rather presents extra opportunities to the formal nature for realizing non-necessary, luxurious functions.

#### *3.4.3.d Material necessity*

A small number of biological phenomena are explained by Aristotle through reference to material necessity alone. This is because, as we have said above, nature cannot and does not make use of what has come to be of material necessity in all cases. Here I will briefly mention the four types of biological phenomena that Aristotle explains without any reference to final causes.

First, there are materials like the residues that have come to be of material necessity, but which, if nature does not use them for the production of some useful part, will be excreted soon. Homogenous parts like bile, urine, and feces belong to this group of useless residues; menses and sperm, too, if not used for generation, are excreted as useless residue.

Secondly, in very rare cases, material necessity seems to be responsible for the generation of parts that are not disposed of by the formal nature, but that also are not put to the performance of a function in the strict sense of the word. Such parts are the esophagus and the spleen (for their explanations, see 3.2.3).

Thirdly, there are the incidental characteristics or affections (the *pathêmata*) of living beings discussed above (see 3.4.3.a; *GA*.V.1, 778a18-21), such as eye color, or pitch of voice. Aristotle summarizes his discussion of these affections by emphasizing that they are not the result of (primary) teleology, but only of material necessity (*GA*.V.8, 789b18-20):

> εἴρηται δὲ καὶ περὶ τῶν ἄλλων τῶν κατὰ τὰ μόρια παθημάτων ὅσα γίγνεσθαι συμβαίνει μὴ ἕνεκά του ἀλλ' ἐξ ἀνάγκης καὶ διὰ τὴν αἰτίαν τὴν κινητικήν.
>
> "And we have spoken of the other affections of the parts which are found to occur not for any final end but of necessity and on account of the motive cause."

These features represent the individual differences between living beings of the same species that do not contribute to necessary or non-necessary functions.[209]

A fourth type of biological phenomenon that Aristotle explains by reference to material necessity is that of the so-called monsters (*GA*.IV.3, 767b13-15):

> τὸ δὲ τέρας οὐκ ἀναγκαῖον πρὸς τὴν ἕνεκά του καὶ τὴν τοῦ τέλους αἰτίαν, ἀλλὰ κατὰ συμβεβηκὸς ἀναγκαῖον.
>
> "Monsters are not necessary according to the final cause or end, but they are accidentally necessary."

Monsters come to be during the process of generation when the male sperm (or rather the movement that is imparted through the semen) is too weak to master the female matter (*GA*.IV.3, 769b12-13). If the semen fully masters the female matter, then a male offspring will be born who takes after his father; if not, then the embryo will be deficient. These deficiencies come in different degrees. The smallest deficiency is when a male offspring is born, who does not resemble his father; this is called a 'first monstrosity' (*GA*.IV.3, 767b7-8: "for in these cases nature has in a way departed from the type"). The next deficiency is the birth of a female offspring. This is a monstrosity in some sense, but also something that is "necessary by nature" (*GA*.IV.3, 767b8-9: ἀλλ' αὕτη μὲν ἀναγκαία τῇ φύσει), because the differentiation between sexes needs to be preserved for the sake of reproduction. Finally, when the formal nature is not able to master the material nature,[210] this leads to different kinds of deformations (*GA*.IV.3, 769b30: ἀναπηρία), which are departures from the form, causing, for instance, the coming to be of redundant parts. These monsters are 'against nature', but only against nature in the sense of regular nature (*GA*.IV.4, 770b9-18); monsters, just as the residues, are natural in the sense that they are the result of materials left to act on their own accord, without a formal nature strong

[209] Since there is no struggle for existence in Aristotle's conception of the living world, differences at the level of individuals do not make any biological difference.
[210] *GA*.IV.3, 768b30-32; *GA*.IV.3, 769b11-13; *GA*.IV.4, 770b17-18: ὅταν μὴ κρατήσῃ τὴν κατὰ τὴν ὕλην ἡ κατὰ τὸ εἶδος φύσις.

enough to limit or direct the flow of materials. In this sense, the coming to be of monsters is an accident (*GA*.IV.4, 770b6: τὸ σύμπτωμα), because the lapse in the 'powers' of the formal nature is accidental and not for the sake of something.

This brief overview shows that the role of material necessity in the generation of living animals is very diverse, and can be both positive and negative. In many cases, material necessity allows the coming to be of extra structures that contribute to the well-being of animals. In others, the outcomes of materially necessitated processes do not make any significant difference at all in the animal that has them. In still others, the outcomes have negative effects, because the formal nature of the animal is not able to realize the ends that need to be realized because it fails to master the materially necessitated processes.

### 3.5 Conclusion

In the sections above, we have seen that Aristotle uses a wide variety of types of explanations to account for the presence, absence, and differentiations of biological features. Aristotle uses different explanatory strategies in different contexts, but he uses them consistently, following a fixed methodology in order to determine the facts to be explained, to discover correlating features, and finally to explain those facts. The explanatory project presented in *PA* in many ways reflects and builds upon the scientific ideal as presented in *APo*.

Aristotle argues that the student of nature should give both the explanation that states the that for the sake of which and the explanation that states the cause of necessity, but stresses most of all the importance of the first. As we have seen, the importance of final causes is mainly one of explanation. In general, final causes are easiest to identify (either by observation of the feature to be explained itself, or by observation and comparison of correlating features), and from the discovery of the final cause the necessary antecedents in terms of material or efficient causation can be derived. Final causes therefore prove to be of important heuristic value, while other types of causes – such as the formal and the material cause – picked out in the same teleological explanations are causally primary. This does not mean that final causes do not play any causal role: functions are subsumed in the forms or essences

of living beings, and as such determine the direction and limits of generation and growth of the living being, and conditionally necessitate the coming to be of the materials constitutive of the functional parts. It only means that the formal cause that includes functions, or the material that has certain material potentials usable for certain functions, precede and necessitate for the most part the end that constitutes the final cause, and that it are these ends that form the starting point of explanation.

We have found that Aristotle uses two general types of teleological explanations: one that refers directly to final causes, and one that uses teleological principles to set the heuristic framework from which subsequently final causes can be derived or inferred. These two types of explanations are not used in an indifferent way, but are applied at different stages in the explanation of biological phenomena.

In those cases where the functions and ends of features are readily discernable, Aristotle refers to those functions and ends immediately to explain the presence of those features, and then determines whether their coming to be is due to conditional or material necessity. When the function that explains the presence of the feature to be explained is a necessary (i.e. vital or essential) function, the teleology operative is primary. Necessary functions are part of the form or essence of animals, and therefore conditionally necessitate the coming to be of the parts and their differentiations for the sake of the (better) performance of those functions. When the function that explains the presence of the part is non-necessary (or 'luxurious'), the teleology operative is secondary. Non-necessary functions are imparted by the formal nature of an animal upon structures that have come to be by material necessity because of the material potentials available in them. The different verbs of action ascribed to the formal nature of an animal correspond to the two causal patterns that underlie the coming to be of animals and their parts (and thus are not just mere metaphors). The description of a nature that *makes* parts for the sake of something represents primary teleology, while the description of a nature that *uses* parts or materials for the sake of something, represents secondary teleology.

Teleological principles are invoked in those rarer cases where the functions or ends of features are not readily discernible, or when the absence of features is at stake. In these special cases, generalizations over what the formal nature of living beings for the most part does or does not do determine the 'natural possibilities' or

boundaries within which the explanation ultimately should take place. Because the feature to be explained belongs to a kind of animal that shares its form with a larger group of animals, the explanation of the presence, absence, or differentiation of that feature needs to be found within the confinements of the natural possibilities (i.e. the existing, observed realizations of form) found within that group. Within this teleological framework, Aristotle draws inferences to the best explanation of the features to be explained. The two types of teleological explanations thus complement each other in accounting for as many biological phenomena as possible.

Necessity is spoken of in many ways in Aristotle, not only in his theoretical discussions of the relation between teleology and necessity, but also in his actual explanations. The main problem Aristotle finds in his materialist predecessors is that they do not take into consideration the special kind of necessitation that is imparted by material natures in the sublunary realm. While in the eternal realm of the heavens the prior in a causal sequence always and without exception necessitates the coming to be of the posterior, in the sublunary realm – that is subjected to generation and decay – the prior necessitates the posterior only for the most part, but not always. In addition, the materialist predecessors failed to see that material necessity in the sublunary realm is mostly (but not exclusively) subject to final causation: it is only on the assumption that a certain end needs to be realized that certain materials and structures come to be. The upshot is that concerning the sublunary natural phenomena one can only draw inferences from the end-result to the prior necessary prerequisites, but not the other way around; there is no unqualified necessity in a modal sense in the sublunary realm.

Complete living beings thus reflect three types of causal processes. First, primary teleology and conditional necessity are responsible for the parts performing the necessary functions, which are created first in the order of generation. On a secondary level, they are also responsible for the parts that contribute to the performance of necessary functions, which are created next. Second, secondary teleology and material necessity are responsible for the parts that perform functions that are non-necessary, but contribute to the well-being of the living being. Third, material necessity is responsible for the useless residues, for the presence of a few

parts that do not have proper functions, for the individual *pathêmata* of each living being, and sometimes for the generation of monsters.

In sum, nature is a good housekeeper, whose goal-directed actions at different stages of the living being's development produce living beings that are able to survive and reproduce, but are also able to enjoy a certain amount of well-being.

## Appendix: Typology of Parts and Explanations in *PA*

| NECESSARY PARTS AND FUNCTIONS | | NON-NECESSARY PARTS AND FUNCTIONS | | |
|---|---|---|---|---|
| I. Essential Parts (parts are included in the definition of the substantial being of the animal; their presence is necessary for the performance of a primary function) | I. Vital Parts (parts are necessary for the animal to stay alive; their presence is necessary for the performance of a primary function) | II. Subsidiary Parts (parts are not necessary for the survival or being of the animal, but they contribute its well-being; the part is for the better) | III. 'Luxurious' Parts (parts are not necessary for the animal in terms of being or survival, but they 'improve' the animal in some way) | IV. Functionless Parts (parts are not necessary for the animal in any way as they do not contribute to the animal's being, survival, or well-being) |
| Eyes – Perception (all animals)<br><br>Wings – Flying (birds)<br><br>Lungs – Cooling through air (all blooded land-dwellers & some waterdwellers)<br><br>Insected body (all insects)<br><br>Blooded/ bloodless | Reproduction<br><br>Heart - Warming<br><br>Brains – Cooling<br><br>Nutrition<br><br>Mouth – Receiving nutrition<br><br>Anus, Intestines – excretion residues<br><br>Liver – Boiling of food | Kidneys<br><br>Testicles, Penis<br><br>Lips<br><br>Veins | Horns<br><br>Spurs<br><br>Stinger<br><br>Hoofs/Nails<br><br>Teeth<br><br>Tusks<br><br>Hair<br><br>Eyebrows<br><br>Eyelids<br><br>Diaphragm | Spleen<br><br>Esophagus |
| | | EXPLANATION | | |
| Primary Teleology & Conditional Necessity; Function is the cause of the coming to be and of the presence of the part; The parts are made from nourishment. | | Primary Teleology & Conditional Necessity on a secondary level; Parts do not have a proper function of their own. | Secondary Teleology & Material Necessity; Function is the cause of the presence, not of the coming to be of the part; the parts are made from residues. | Material Necessity; No Teleology; Material Necessity is cause of the coming to be and the presence of the part; parts do not serve a proper function. |

# CHAPTER FOUR:

## MAKING SENSE OF THE HEAVENS

## THE LIMITS OF TELEOLOGICAL EXPLANATIONS IN ARISTOTLE'S *DE CAELO*

### 4.0 Introduction

As we have seen in the previous chapters, Aristotle's theory of natural teleology is crucial for the explanation of all natural phenomena: everything that exists or comes to be 'by nature' comes to be or changes, unless prevented, for a purpose and towards an end, and is present for the sake of that purpose or end. The final cause, closely related to Aristotle's concept of nature as an internal principle of movement, operates among animate beings (like plants, animals and humans) and inanimate objects (such as the elements)[1] alike, and thus finds its way also into the cosmological realm of the elements and heavenly bodies, comprising stars (*astra*), planets (*planêtes, planômena astra*), and the sun and the moon.

In *De Caelo* (*Cael.*), which contains in the first two books Aristotle's problem-steered exposition of his cosmology, traces of his teleological worldview are abundant. The nature of the elements is claimed to be such that it provides them with an immanent capacity to exercise their specific movements to reach their natural places. Left to their own devices, the four sublunary elements would naturally move to their natural places and thus constitute four separate, concentrically arranged spheres.[2] Teleology also permeates the heavenly domain, as all celestial movements are said to be trying to reach "the most divine principle" as a final cause (*Cael.*II.12, 292b20-25). Although teleology as a natural tendency is thus without doubt an important part of the make-up of Aristotle's cosmology and celestial physics, his general reliance on teleology to explain the different motions and features of the heavenly bodies seems to be limited in comparison with the other physical treatises. For the whole of *Cael.* contains only seven instances of explicit teleological explanations of cosmological phenomena, six of which are in the second book (there is only one instance of teleological explanation in book one, there are

[1] *Meteor.*IV.12.
[2] Bodnár & Pellegrin (2006), 282.

none in books three and four).[3] Moreover, with one exception (in *Cael.*II.3, 286a8-9), none of these explanations refer directly to final causes. Instead, they all proceed through the supposition of teleological principles, which (as I argued in chapter 3.3) in biology are only applied in very specific explanatory contexts, namely in those cases where the discovery of causes is relatively difficult. This suggests that teleology is not readily discernible in the case of the heavens. Aristotle's use of teleological principles is all the more remarkable, because the teleological explanations are the only fully-fledged physical explanations Aristotle offers in this treatise. By this I mean that the teleological explanations are the only explanations that address the nature and causes of the various features and movements of the heavens. The treatise mostly consists of statements of fact and mathematical arguments, addressing the shape and possible motions of the heavenly bodies.

The first group of teleological explanations contains explanations that stand on their own (i.e. they are not part of an interrelated sequence of arguments) and that set out to explain the *presence* of certain features and motions of the heavens.[4] For instance, in *Cael.*II.3, Aristotle explains the plurality of the motions of the heavens by the principle that everything that has a function is for the sake of that function, and that the function of the divine is to move in a circle for eternity; the other motions are necessary by conditional necessity if there is to be generation. In *Cael.*II.5, Aristotle concludes that the heavens must move forward (i.e. in the most honorable direction), if it is the case that nature always does what is best among the possibilities. In *Cael.*II.12, Aristotle uses the analogy of goal-directed actions performed by sublunary beings to explain the complexity of the motions of the heavens. In these cases, Aristotle tries to find an explanation for the presence of some fact on the assumption that whatever is observed to exist must serve some good.

The second group contains those explanations that form the last argument Aristotle offers after a series of mathematical arguments. While the latter point out that it is mathematically impossible for some motion or feature of the heavens to be

[3] For the teleological explanations, see *Cael.*I.4, 271a22-33; *Cael.*II.3, 286a7-9; *Cael.*II.5, 288a2-12; *Cael.*II.8, 290a29-35; *Cael.*II.9, 291a23-25; *Cael.*II.11, 291b10-15; *Cael.*II.12, 292a15-b25.

[4] Evidently there are no teleological explanations of the generation of the heavenly bodies as they are eternal and not generated. Cosmological teleological explanations are thus naturally restricted to the explanation of the features and motions belonging (or not belonging) to the eternal heavenly bodies.

present, the teleological explanation is set up to provide a counterfactual argument claiming that those phenomena in reality do not exist, because if they did they would be in vain. The teleological principle invoked to explain the *absence* of heavenly features in these cases is that nature does nothing in vain. In short, in *Cael.*I.4, Aristotle argues that there is no movement contrary to a circle, for if there were, one body performing that movement would not be able to actually perform its movement, and hence would be in vain. In *Cael.*II.8 Aristotle argues that nature did not provide organs for movements to the stars and planets, because they are not 'intended' to move on their own, and so their organs for movement would be in vain. The argument in *Cael.*II.11 is connected to the previous one, for Aristotle claims that nature gave stars and planets the shape they have (i.e. spherical), because it is the shape least fit for movement on their own. In *Cael.*II.9 Aristotle claims that because nature foresaw the negative consequences of stars and planets moving on their own (their noise would make life as we know it impossible), stars and planets do not move on their own.

In this chapter, I aim to shed light on the specific nature of the above mentioned teleological explanations in Aristotle's cosmology and on the problems related to their application within this particular branch of the science of nature. In addition, I will argue that the use of teleological principles follows from Aristotle's approach to cosmology as a natural science.

The issues I would like to discuss in this chapter have received relatively little attention in the scholarly literature on Aristotle. Scholars who have studied teleology in Aristotle's cosmology have focused almost exclusively on the role of the Prime Mover as a final cause in Aristotle's *Physics* and *Metaphysics*.[5] On the other hand, Leggatt, in his commentary on *De Caelo*, claims that Aristotle consciously played down the role of teleology in his cosmological treatise, because of his alleged dissatisfaction with the type of intentional and psychological teleological explanations deployed by Plato in the *Timaeus*.[6] Hence, Leggatt offers little analysis of the teleological explanations actually provided in this treatise, because he believes them to be of little importance.

[5] See, in particular, Kahn (1985). Other studies on cosmology have either left out the question of teleology completely (Falcon, 2005), or have subsumed it under the 'normal' use of teleology (Johnson, 2005).
[6] Leggatt (1995), 18; 36-37; 207.

My main goal will be to show that Aristotle has no reservations about using teleological explanations in cosmology, but rather attributes special explanatory force to them. In particular, I will argue that the way Aristotle uses teleological principles to explain heavenly phenomena, builds upon their – very successful – usage in biology, and is thus consistent with his physical approach to cosmology. This is an approach he shares with Plato; hence, in my view, Aristotle is not so much fighting Plato here, but rather the astronomers who approached cosmology mainly as a mathematical science.

In the first section (4.1), I will offer some further notes on the scientific status of cosmology, and argue against Leggatt's interpretation of the role of teleology in *Cael.* Next, I will present my own interpretation of the teleological explanations that address the presence of heavenly phenomena. The teleological explanations addressing the absence of heavenly phenomena will be discussed in the next and final section (4.2).

## 4.1 Teleological principles and the explanation of the presence of cosmological features

### *4.1.1 Cosmology as science of nature*

The approach to cosmology taken by Aristotle's predecessors and contemporaries, described as *astrologia* by Aristotle (corresponding to what we call 'astronomy'), had predominantly been mathematical. The homocentric theories put forward by Eudoxus and revised by Callippus were geometrical models that explained the apparent movements of the stars and planets by hypothesizing a complex system of concentric spheres. The models did not explain the physical mechanics and causes underlying those movements,[7] mainly because the astronomers were not concerned with those issues.[8] For Aristotle, however, just as for Plato, cosmology is a part of the investigation of nature, and he thus endorsed a 'physicalized' conception of the

[7] According to Aristotle, astronomy does not at all deal with perceptible magnitudes or with the heavens above: see *Met.*I.8, 989b33-990a15; *Met.*III.2, 997b16-998a1; and *Met.*XIII.2, 1076b39-1077a4.
[8] Heath (1932), xliv-xlv; however, see Wright (1973-1974), for a 'physical' interpretation of the models of Eudoxus.

science of cosmology.[9] This is evidenced, for instance, in his claim that each of the spheres in his system is corporeal, and thus not simply a mathematical construct (*Cael.*II.12, 293a7-8):

> ἑκάστη δὲ σφαῖρα σῶμά τι τυγχάνει ὄν.
>
> "For each sphere is some kind of body."

Thus, if for Aristotle cosmology is part of the science of nature, and if scientific knowledge involves the knowledge of all four causes,[10] a mathematical approach to cosmology will not be sufficient, for the following reasons. By its very nature, mathematical reasoning cannot yield understanding of final causes (there are no final causes in mathematics, because there is no change or good in that domain).[11] Hence, mathematical astronomy only yields understanding of the shape and size of the heavenly bodies, and of their distances from each other and from the earth. This gives important information about the mathematical properties of the heavenly bodies, especially if combined with arguments drawing from principles of physics, and certainly Aristotle incorporates some of the most successful astronomical theories in his own investigations.[12] However, as a natural philosopher, Aristotle is also interested in the nature of the heavenly bodies, in their material composition, and in the causes of their movements (i.e. in their material, formal, efficient, and final causes).[13] The opening words of *Cael.* are significant (*Cael.*I.1, 268a1-4):

> Ἡ περὶ φύσεως ἐπιστήμη σχεδὸν ἡ πλείστη φαίνεται περί τε σώματα καὶ μεγέθη καὶ τὰ τούτων οὖσα πάθη καὶ τὰς κινήσεις, ἔτι δὲ περὶ τὰς ἀρχάς, ὅσαι τῆς τοιαύτης οὐσίας εἰσίν ·

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[9] Aristotle emphatically introduces his study of the heavens as a part of the study of nature: see *Cael.*I.1, 268a1: Ἡ περὶ φύσεως ἐπιστήμη; cf. *Cael.*III.1, 298b2-3: τῆς περὶ φύσεως ἱστορίας, *Meteor.*I.1, 338a20-5. Building upon these passages, one could define Aristotelian cosmology as the natural science and investigation (*hê peri phuseôs episteme*, *hê peri phuseôs historiea*) of the properties (*pathê*), motions (*kinêseis*) and functions (*erga*) of bodies (*sómata*) in the universe, that is, of both the simple bodies such as the elements and of the bodies that are composed of them (i.e. the heavens as a whole and its parts), and of their principles (*archai*).

[10] See chapter 1.1 and 5.1; cf. Falcon (2005), 15.

[11] *Met.*II.2, 996a21-b1.

[12] On Aristotle's knowledge and use of the Eudoxan theory of concentric spheres, see Mendell (2000), 78-83.

[13] See *Ph.*II.2, 193b22-194a12 and *Cael.*II.14, 297a2-4 (Μαρτυρεῖ δὲ τούτοις καὶ τὰ παρὰ τῶν μαθηματικῶν λεγόμενα περὶ τὴν ἀστρολογίαν; "what the mathematicians say in astronomy also testifies to this"); cf. Simplicius *In Ph.* 293, 7-10 and *In Ph.* 290, 20-24 on the Greek conception of astronomy as being part of mathematics, not physics; Mueller (2006), 179-181.

> "The science of nature is clearly concerned for the most with bodies and magnitudes, the affections and motions of these, and further, with the principles, as many as belong to this kind of substance."

Because the physical sciences are concerned with all four types of causes, and especially the understanding of final causes is crucial (because they are concerned with things that undergo change), Aristotle needs an additional strategy to extend scientific knowledge as he understands it to the domain of the heavens. This strategy involves the application of teleological principles, of the sort he employs in his biology (see 3.3) precisely as a heuristic for finding final causes where they are not immediately observable. In short, Aristotle uses teleological principles to discover purposes and functions among the heavenly phenomena, and thereby tries to turn cosmology into a proper physical science.

Aristotle's 'physical' approach towards cosmology also explains why the teleological explanations are mainly found in the second book of *Cael.* For it is this book that deals most specifically with the heavenly bodies qua subjects of motion, that is, with the plurality, direction, and complexity of their motions, the physical mechanisms underlying those motions, and the shape of the heavenly bodies required to perform those motions. On the other hand, we find no teleological accounts regarding Aristotle's views on the nature of the heavens as a whole (for instance, for such features as the heaven's size, uniqueness or eternity, topics that are dealt with primarily in book I), or regarding the motions and features of the four terrestrial elements (dealt with in books III and IV), which are not part of cosmology properly speaking. Aristotle's use of causal language in *Cael.* also reveals that the second book is more concerned with Aristotle's *own* attempts to provide physical explanations than any of the other books: of the 28 occurrences of the term *aition* in the whole of *Cael.*, 10 can be found in the second book (as opposed to 4 in book I; 3 in book III, and 11 in book IV), and of the 28 occurrences of the term *aitia*, 21 can be found in the second book (as opposed to none in the first and the third book, and 7 in the fourth), while the references to causes and explanations in the fourth book are often[14] – although not exclusively – used in descriptions of views entertained by Aristotle's predecessors.

[14] I.e. in *Cael.*IV.1, 308a25; *Cael.*IV.2, 309a5; *Cael.*IV.2, 309a10; *Cael.*IV.2, 309a28; *Cael.*IV.2, 310a2; *Cael.*IV.6, 313a22.

As we have seen in the previous chapter, scientific research for Aristotle comprises two stages of enquiry: first, one is to conduct systematic observations of the phenomena, and next one is to give causal explanations of these phenomena. However, as Aristotle makes clear several times in *Cael.*, it is not at all an easy undertaking to give physical explanations of cosmological phenomena. The central problem is the limitedness – or even lack – of empirical evidence: the observations of the heavens we have are too few, and the objects of observation are too far away to offer any certain evidence.[15] The only observation that seems to be rock solid is that of the rotation of the heavens (*Cael.*I.5, 272a5-6: τὸν δ' οὐρανὸν ὁρῶμεν κύκλῳ στρεφόμενον; "we see the heavens turning about in a circle"). Notwithstanding the many methodological caveats we find in *Cael.* (I will discuss them in 4.1.3 below), Aristotle remains confident that it is still possible to give explanations of cosmological phenomena that go beyond the mere fact that heavens rotate, and also beyond the conclusions mathematical reasoning yields about for instance sizes, shapes, and distances.

My contention is that Aristotle's use of teleological principles, by analogy of their use in the biological domain,[16] forms an important part of his strategy to increase the possibility of gaining scientific knowledge of the heavens. Thus, when Aristotle does proceed to give 'physical' (as opposed to mathematical) explanations, he is unremittingly teleological in his approach. The explanations thus presented will not qualify as demonstrations in a strict sense (i.e. not as demonstrations as described in the *APo.* or *PA*),[17] because they do not set out to demonstrate the truth but merely the reasonableness of certain causal scenarios. However, they go a long way in taking away some of the puzzlement pertaining to the heavenly realm and thus in making sense of the heavenly phenomena. And as Aristotle has indicated elsewhere,[18] 'making sense' in such difficult circumstances entails giving an account of the heavens that is free of impossibilities.

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[15] Cf. *Mete.*I.7 and *APr.*I.30.
[16] Pace Falcon (2005, 101), who argues that "Aristotle is reluctant to extend the results achieved in the study of plants and animals to the imperishable creatures populating the celestial world."
[17] Cf. Lloyd (1996), 182.
[18] *Mete.*I.7, 344a5-7: "We consider a satisfactory explanation of phenomena inaccessible to observation to have been given when we reduce them to what is possible (ἐπεὶ δὲ περὶ τῶν ἀφανῶν τῇ αἰσθήσει νομίζομεν ἱκανῶς ἀποδεδεῖχθαι κατὰ τὸν λόγον, ἐὰν εἰς τὸ δυνατὸν ἀναγάγωμεν)."

### *4.1.2 Leggatt on teleology in De Caelo*

Before turning to a discussion of Aristotle's actual teleological explanations in his cosmology, and to a defense of my view of the role of teleology in this particular branch of the science of nature, I would first like to review some of the remarks Leggatt makes in his commentary on Aristotle's *Cael.*, because he addresses to some extent the same question of the role of teleology in Aristotle's cosmology. Leggatt's answer is that Aristotle consciously tried to exclude teleology at certain levels of his cosmological explanation because of his dissatisfaction with Plato's teleological cosmology.[19] I find this interpretation unconvincing.

In the first place, one could object that Leggatt does not explain why Aristotle on seven occasions emphatically *does* rely on teleological principles in his explanation of various features of the cosmos. Aristotle's dissatisfaction with Plato's teleological cosmology was apparently not so great for him not to use teleology at all. In the second place, Aristotle usually never shuns to either openly or implicitly discuss or reject Platonic theories from the *Timaeus*, and there is no indication that this is different for *Cael.*[20] However, against Leggatt's interpretation, there is not a single instance in the *Cael.* (nor, remarkably enough, anywhere else in the corpus) where Aristotle criticizes Plato's conception of teleology, or addresses the subject at all. Leggatt's argument proceeds fully *ex silentio*. A third and last objection to Leggatt's interpretation is that in the few instances that Aristotle relies on teleological principles to explain certain cosmological phenomena, he does so in language that is very similar to the intentional, psychological, and providential teleological language of the *Timaeus*. Nature is personified numerous times in the treatise and is thereby portrayed as a creative, thinking, caring, and even foreseeing 'being'.[21] In *Cael.*I.4 Aristotle speaks, somewhat surprisingly, of a god next to nature

[19] Leggatt (1995), 18; 36-37; 207.
[20] Lloyd (1996), 175.
[21] See *Cael.*I.1, 268a13 ("according to the laws of nature"), *Cael.*I.1, 268a19-20 ("nature itself leads us there"), *Cael.*I.3, 270a20 ("nature seems rightly to have set"), *Cael.*I.4, 271a33 ("god and nature make nothing in vain"), *Cael.*II.5, 288a2-3 ("for if nature always produces the best of possibilities"), *Cael.*II.8, 290a30-35 ("it is would be absurd that nature gave them no organ for movement – since nature does nothing as a matter of chance – and that she should care for animals, but disregard such honorable beings; rather, it seems that she, as though deliberately, removed everything by means of which they might possibly in themselves have effected forward motion, and that she set them at the greatest distance form those things that possess organs for movement"), *Cael.*II.9, 291a24-25 ("as though nature foresaw what was going to be"), *Cael.*II.11, 291b13-14 ("since nature does nothing without reason or in vain"), *Cael.*II.12, 293a2-4 ("in this way, then, nature both balances things and produces a certain order, having

who never produces anything in vain (*Cael.*I.4, 271a33: Ὁ δὲ θεὸς καὶ ἡ φὐσις οὐδὲν μάτην ποιοῦσιν); this might of course be no more than a colloquialism, but it at least shows that Aristotle is not that concerned at all with avoiding the theological or craft-related language of the *Timaeus*, here nor in any other of his works.

In general, Aristotle's *De Caelo* is set out as treatise discussing various problems and aspects concerning the cosmos starting from Aristotle's own physical principles as set out in his *Physica.* It's main concern is not to address all the topics from Plato's *Timaeus* and to refute or criticize them,[22] but to provide an autonomous and general explanatory framework saving as much of the phenomena[23] in the heavens as possible.

### *4.1.3 Explaining what is present in an empirically underdetermined domain*

For the purpose of clarity, I will offer in this section a separate discussion of the teleological arguments in *Cael.* that are not part of a series, but rather stand on their own for the sake of explaining the presence of certain motions and features of the heavens (these are the explanations in *Cael.*II.2, *Cael.*II.5, and *Cael.*II.12). Before turning to a discussion of the use of teleological principles in these explanations, I will first say a few words about the status and supposed explanatory force of the explanations.

Aristotle is very well aware of the fact that offering explanations of what is present in the heavens is problematic and difficult given the lack of empirical evidence.[24] All three explanations that set out to explain the presence of a feature or motion of the heavenly bodies are immediately preceded by discussions of the methodological problems related to this very enterprise of providing explanations in the strong sense for phenomena at such a remove. In *Cael.*II.3, for example,

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given many bodies to a single locomotion, and many loco-motions to a single body"); *Cael.*III.8, 306b15-16 ("indeed it seems as if nature itself here shows us the truth of a conclusion to which more abstract reasoning also points").

[22] Cf. Solmsen (1960), 318.

[23] On Aristotle's project of 'saving the phenomena', see Kosman (2000), 89-105; Owen (1961); and Nussbaum (1986), 240-263. In *Cael.*, I take *phainomena* to mean 'the way people take the heavens to be based on their observations of them', not '(theory neutral) observed facts'.

[24] Cf. Burnyeat (2004), 15-16, who observes that "*Cael.*I. contains an unusually high number of occurrences of words like *eikotôs* and *eulogon* which express epistemic modesty." I would like to add to this observation that words of 'epistemic modesty' are even more abundant in the second book of this treatise where the explanation of presence and absence of heavenly features properly speaking is at stake (I counted only two occurrences of the word *eulogon* and none of the word *eikotôs* in *Cael.*I; in *Cael.*II, I counted fifteen occurrences of the word *eulogon* and two of the word *eikotôs*).

Aristotle indicates that the examination of the question of why there are several locomotions of the heavens is complicated, but that this is no reason not at least to attempt to give an explanation (*Cael.*II.3, 286a3-7):

> Ἐπεὶ δ' οὐκ ἔστιν ἐναντία κίνησις ἡ κύκλῳ τῇ κύκλῳ, σκεπτέον διὰ τί πλείους εἰσὶ φοραί, καίπερ πόρρωθεν πειρωμένοις ποιεῖσθαι τὴν ζήτησιν, πόρρω δ' οὐχ οὕτω τῷ τόπῳ, πολὺ δὲ μᾶλλον τῷ τῶν συμβεβηκότων αὐτοῖς περὶ πάμπαν ὀλίγων ἔχειν αἴσθησιν. Ὅμως δὲ λέγωμεν. Ἡ δ' αἰτία περὶ αὐτῶν ἐνθένδε ληπτέα.
>
> "Since there is no movement in a circle contrary to movement in a circle, we must examine why there are several locomotions, though we must try to conduct the inquiry from far off – far off not so much in the sense of spatial distance, but rather by virtue of the fact that we have perception of very few of the attributes that belong to them [the heavens]. Nonetheless, let us speak of the matter. The explanation concerning these things must be grasped from the following [considerations]."

The problem Aristotle signals with regard to a scientific investigation of the heavens is not just that we are too far removed from the objects of inquiry in distance, but also that the type of observation available to us is limited – we cannot dissect the heavenly bodies for instance. It is significant that Aristotle nevertheless is confident that there is a way of answering this particular question, and that this answer follows from *teleological* considerations. For the consideration 'from which the explanation must be grasped' is the supposition of the teleological principle that everything that has a function must exist for the sake of that function. We will analyze Aristotle's explanation for the existence of several motions of the heavens below, but for now it is important to note that Aristotle thinks that the use of teleological principles can contribute to the project of gaining knowledge of the heavens. By positing a teleological principle, and hence by setting the framework within which one can search for the possible functions of those very features that have been observed, one might be able to grasp the explanation of why those features are present. On the other hand, the implication also seems to be that this kind of knowledge cannot be gained by other means: observation is certainly ruled out (observation in this case will only yield knowledge of the fact that there are several movement, not of the reason why), but also mathematical arguments are not what is called for in these situations (for reasons that I will discuss below in 4.1.4.a).

The situation is comparable in *Cael.*II.5, where Aristotle attempts to resolve the problem of why the heavens move in the direction they do, as circular motion has – mathematically speaking – two possible directions. That the heavens move in one direction rather than in the other one must have an explanation, for "either this must be a principle or there has to be a principle of it" (*Cael.*II.5, 287b28). This means that the direction of the movements must either be a brute fact of the universe as it is (i.e. there is no explanation to be given), or it is dependent on something else, in which case it must be possible to give an explanation of it. Before presenting his explanation, set out explicitly in teleological terms, Aristotle refers first to the difficulty of the subject matter and the limited level of security and plausibility attainable in this case (*Cael.*II.5, 287b29-288a2):

> Ἴσως μὲν οὖν τὸ περὶ ἑνίων ἀποφαίνεσθαί τι πειρᾶσθαι καὶ τὸ περὶ πάντων καὶ τὸ παριέναι μηθὲν τάχ' ἂν δόξειεν εἶναι σημεῖον ἢ πολλῆς εὐηθείας ἢ πολλῆς προθυμίας. Οὐ μὴν δίκαιόν γε πᾶσιν ὁμοίως ἐπιτιμᾶν, ἀλλ' ὁρᾶν δεῖ τὴν αἰτίαν τοῦ λέγειν τίς ἐστιν, ἔτι δὲ πῶς ἔχων τῷ πιστεύειν, πότερον ἀνθρωπίνως ἢ καρτερώτερον. Τὰς μὲν οὖν ἀκριβεστέρας ἀνάγκας, ὅταν τις ἐπιτύχῃ, τότε χάριν ἔχειν δεῖ τοῖς εὑρίσκουσι, νῦν δὲ τὸ φαινόμενον ῥητέον.
>
> "Perhaps, then, the attempt to make some statement about some matters, and indeed on all matters, and to omit nothing, may well seem to be a mark of great simple-mindedness or of much zeal. Yet it is by no means right to censure all people alike, but one should consider what their reason is for speaking – what it is – and, in addition, the sort of conviction involved in it, whether it is suited to man[25] or something stronger. As to more accurate necessities, whenever someone hits upon them, then we should be grateful to those who found them, but for now we should state the phenomena."

Here Aristotle offers a justification for the kind of approach he takes in cosmological inquiry. People might object that the attempt to answer a particular question pertaining to the motions of the heavens is ridiculous or hubristic, but what should be censured are the intentions and the epistemic attitude of the person carrying out the attempt.[26] Aristotle readily admits that given what is known about the heavens it will not be possible (not for him at least, but, as Aristotle indicates, it

[25] Cf. *Cael.*I.3, 270a12-13: "this also emerges with sufficient assurance from perception, in a manner sufficient at least for mortal belief, so to speak."
[26] Falcon (2005), 98.

might be for somebody else) to give an explanation that 'touches upon more accurate necessities'. For now Aristotle gives what he objectively takes to be the most plausible explanation; and again this explanation is unremittingly teleological in nature.

In *Cael.*II.12, finally, Aristotle deals with two remaining difficulties concerning the movements of the stars and the planets. He introduces these two problems as follows (*Cael.*II.12, 291b24-28):

> Δυοῖν δ' ἀπορίαιν οὔσαιν, περὶ ὧν εἰκότως ἂν ὁστισοῦν ἀπορήσειε, πειρατέον λέγειν τὸ φαινόμενον, αἰδοῦς ἀξίαν εἶναι νομίζοντας τὴν προθυμίαν μᾶλλον ἢ θράσους, εἴ τις διὰ τὸ φιλοσοφίας διψῆν καὶ μικρὰς εὐπορίας ἀγαπᾷ περὶ ὧν τὰς μεγίστας ἔχομεν ἀπορίας.
>
> "Since there are two difficulties about which one might reasonably be troubled, we should try to state the phenomenon, considering the eagerness to do so a mark of modesty rather than of excessive ambition, if, out of thirst for philosophy, one is content with small solutions in things in which we have the greatest difficulties."

The issues Aristotle addresses here are familiar ones: even if the difficulties are particularly great, one should try to give the most plausible explanation one is able to offer, no matter how small the solution will be; to do so is not something excessive, but part of what philosophy or the attempt to acquire knowledge is all about. Therefore, the attempt to state the phenomenon is appropriate. Before solving the first of these two difficulties, Aristotle adds another methodological caveat and justification of the approach taken (*Cael.*II.12, 292a14-18):

> Περὶ δὴ τούτων ζητεῖν μὲν καλῶς ἔχει καὶ τὴν ἐπὶ πλεῖον σύνεσιν, καίπερ μικρὰς ἔχοντας ἀφορμὰς καὶ τοσαύτην ἀπόστασιν ἀπέχοντας τῶν περὶ αὐτὰ συμβαινόντων· ὅμως δ' ἐκ τῶν τοιούτων θεωροῦσιν οὐδὲν ἄλογον ἂν δόξειεν εἶναι τὸ νῦν ἀπορούμενον.
>
> "About these things it is worthwhile to seek more understanding, even though we have very little resources to start from and that we are at such a great distance from what is happening with them [i.e. the heavenly bodies]. Nonetheless, by beginning our study from the following [sort of consideration], the present difficulty will not appear as anything absurd."

The consideration that follows and that will render the difficulty less absurd is again teleological in nature (Aristotle uses an analogy based on the goal-directed actions of the living beings in the sublunary world). Even though we are far removed from the objects of inquiry (for this theme of us being far removed from the heavenly bodies,

see also *PA*.I.5, 644b22-645a5), Aristotle thinks it is possible to extend our understanding of the heavens by employing teleological argumentations; the *aporia* might not be solved completely, but the expectation is that teleology will at least render the phenomena less perplexing.

The tentativeness expressed in these methodological introductions is in line with Aristotle's other remarks elsewhere about what his explanations in general add up to.[27] According to these remarks Aristotle believes that his explanations amount to *pistis*, but not to *alêtheia*, and that they are reasonable (*eulogon*).[28] However, this does not mean that the explanations actually offered do not objectively speaking (and not just in Aristotle's own view) constitute the most plausible accounts of the heavenly phenomena: given the limitations, the explanations offered are the best ones possible.[29] Thus, although the observations we have are few and limited,[30] the observed phenomena can be accounted for by positing teleological principles.[31]

### *4.1.4 Stating the phenomena by the use of teleological principles*

In the previous section, I claimed that Aristotle uses teleological explanations to account for the presence of features and motions of the heavens (i.e. for the observed heavenly phenomena) that are difficult to explain otherwise, because of our limited access to the heavenly bodies. In this section, I will finally offer an

[27] E.g. in *Cael*.I.4, 270b32-3; *Cael*.II.1, 283b29-30; and *Cael*.II.11, 291b11.
[28] Cf. again Aristotle 'standards' for explanations regarding things to which we only have limited access in *Mete*.I.7, 344a5-7.
[29] Pace Guthrie (1939), 165.
[30] They are not altogether absent: we can observe for instance that the heavens have more than one motion, that they move in a certain direction, and that the planets furthest from the fixed stars undergo fewer movements than those nearer to them: see *Cael*.II.3, 286a3-6; *Cael*.II.5, 287b24-27; *Cael*.II.12, 292a3-9; cf. *Cael*.II.8, 289b1. See also Lloyd (1996), 162-163 on the observational data from which Aristotle drew.
[31] This point is also made by Lloyd (1996, 171) with regard to the explanations in *Cael*.II.5 and *Cael*.II.12: "Thus it is surely significant that both on the problem of why the heavens revolve in one direction rather than in the other – in II 5 – and on the difficulty of the complexities of the movements of the non-fixed stars – in II 12 – his positive speculations invoke teleology." I disagree, however, with Lloyd's interpretation of the significance of this connection between Aristotle's methodological disclaimers on the one hand and his use of teleology on the other: according to Lloyd (1996, 161; 173; 175; 180), Aristotle's main interest in cosmology follows from his concern to establish his teleology, and especially the orderliness of the heavens. However, I do not believe that Aristotle's epistemological hesitations are not genuine here, or that Aristotle's concern for teleology is all that prominent in *Cael.* (in comparison to the other physical treatises, there are relatively few references to teleology). On the contrary, I believe that Aristotle uses his teleology, already firmly established on the basis of the abundance of empirical evidence discussed in his biological works, to extend – where possible – his knowledge of the heavens.

analysis of the actual teleological explanations given in *Cael.*II.3, *Cael.*II.5, and *Cael.*II.12, and offer an assessment of their explanatory force.

#### *4.1.4.a Why there are several locomotions of the heavens*

In *Cael.*II.3, Aristotle states the following teleological principle from which 'the explanation of why there are several locomotions of the heavens must be grasped' (*Cael.*II.3, 286a8):

> Ἕκαστόν ἐστιν, ὧν ἐστιν ἔργον, ἕνεκα τοῦ ἔργου.
>
> "Each thing that has a function is for the sake of that function."

Through the statement of the principle (common in Aristotle's biology; see e.g. *PA.*I.5, 645b15-18) that everything that has a function is present for the sake of that function, Aristotle makes explicit that in his view teleology extends to the heavenly domain, and hence some of the puzzling phenomena can be explained by reference to teleology. Aristotle also *must* refer to teleology here, since material causes alone cannot account for the differences in locomotions in the heavens (for all spheres are made from the same material).[32] The assumption that everything that has a function is present for the sake of that function allows a series of inferences that ultimately yield (at least part of) the explanation of why there are several locomotions of the heavens. Accordingly, Aristotle continues by stating the explanation (*Cael.*II.3, 286a8-11):

> Θεοῦ δ' ἐνέργεια ἀθανασία· τοῦτο δ' ἐστὶ ζωὴ ἀΐδιος. ὥστ' ἀνάγκη τῷ θειῷ[33] κίνησιν ἀΐδιον ὑπάρχειν. Ἐπεὶ δ' ὁ οὐρανὸς τοιοῦτος (σῶμα γάρ τι θεῖον), διὰ τοῦτο ἔχει τὸ ἐγκύκλιον σῶμα, ὃ φύσει κινεῖται κύκλῳ ἀεί.
>
> The activity of god is immortality, and that is everlasting life. In consequence it is necessary that an eternal movement holds of the divine. Since the heaven is such (for it is a divine body), for that reason it has a circular body, with which it naturally moves in a circle for eternity."

The reasoning is that, if the function of the divine is immortality, and if the heaven is divine, then the function of the heaven is immortality. Furthermore, if being

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[32] Cf. Simplicius, quoting Alexander, *In Cael.* 396, 6-9: "it is not possible to make either natural or material necessity responsible for these things, since both spheres have the same matter, but it is necessary to give an account of the difference in terms of some divine governance or ordering."

[33] Here I follow Leggatt in reading θειῷ instead of θεῷ with most manuscripts; see Leggatt (1995), 227. I believe Aristotle's argument to be that the heaven partakes in a divine essence, not that the heaven itself is a god.

immortal is the defining function of the heaven, then it is a necessary prerequisite for it to possess an eternal movement. That is, for the heaven as a whole to be able to perform its defining function or its activity of being immortal, it has to perform at least one kind of eternal movement. And the only kind of motion capable of uniform eternal continuity is motion in a circle. This explanation, curious as it may sound, resembles those formal cause explanations in the biological works that take the essence (or the definition of the substantial being) as a starting point, and derive from this essence the necessary prerequisites of something being what it is. Just as birds must have wings because they are essentially flyers (and the only way for birds to perform their defining function is by using their wings), so too the heaven must have a spherical body and move eternally in a circle because it is essentially immortal. According to this argumentation, eternal movement in a circle is the proper attribute of an immortal body such as the heaven.

However, Aristotle has not yet explained why there are *several* movements; the activity of being immortal of the heaven only explains why there is a first eternal movement of the heaven. And thus Aristotle continues (*Cael.*II.3, 286a12-13):

> Διὰ τί οὖν οὐχ ὅλον τὸ σῶμα τοῦ οὐρανοῦ τοιοῦτον;
>
> "Why, then, is not the whole body of the heaven that way?"

The second part of the explanation of why there are more movements than just this one eternal movement of the heavens consists of a complicated chain of arguments, based on assumptions that are assumed for the sake of the present argument, but will be demonstrated later (*Cael.*II.3, 286a21-22: Νῦν μὲν οὖν ὑποκείσθω τοῦτο, ὕστερον δὲ δειχθήσεται περὶ αὐτοῦ; *Cael.*II.3, 286a30-31: Ὑποκείσθω δὲ καὶ τοῦτο νῦν, ὕστερον δὲ πειρατέον δεῖξαι; the demonstrations follow in *Cael.*II.13-14 and *Cael.*III-IV). These assumptions, which posit the presence of the sublunary elements and their movements, are derived from the necessity of there having to be an eternal movement of the outer sphere in order for the heaven to be immortal. The reasoning Aristotle employs is thus deductive, but the type of necessity involved is sometimes that of a necessary consequence, while at other times it is conditional.[34] Let me give a summary of the chain of arguments (*Cael.*II.3, 286a13-286b2):

[34] The formula 'ἀνάγκη ... εἶναι' is repeated six times: in *Cael.*II.3, 286a13; *Cael.*II.3, 286a20; and *Cael.*II.3, 286b2 (see i., ii., and vi. above) the necessity is conditional; in *Cael.*II.3, 286a22; *Cael.*II.3, 286a28; and *Cael.*II.3, 286a32 (see iii., iv., and v. above) the necessity indicates a necessary consequence.

i. If there is to be a body moving in a circle eternally it must have a center that remains at rest.

ii. For there to be a fixed centre, the existence of the element earth is a necessary condition (i.e. since whatever is made of aether cannot remain at rest, there must be a second element next to aether, the natural movement of which is to move towards the centre and then to remain at rest in the centre).

iii. If there is to be earth, then it is a necessary consequence that there also is fire (for earth and fire are contraries, and if the one exists, so does the other).

iv. If there is to be fire and earth, then it is a necessary consequence that the two other elements exist (for water and air are in a relation of contrariety to each of the other two elements).

v. From the existence of the four elements, it necessarily follows that there must be generation (for none of the four sublunary elements are everlasting).

vi. If there must be generation, then it is a necessary condition that there exists another movement (this must be the motion of the planets, and especially that of the sun, which is the efficient cause of life on earth).

According to this account, generation is a necessary consequence of there being sublunary elements, whose existence is a necessary condition for there to be an eternal, cyclical movement of the outermost sphere of the heavens carrying the fixed stars. However, having established that it is necessary for there to be generation (as a consequence of there being the four sublunary elements), Aristotle turns the argument around, and reasons that if there is to be generation, then it is conditionally necessary for there to be other movements, because the movements of the outermost sphere cannot cause generation. Accordingly, generation is that for the sake of which all the other movements (namely the movements of the planets) take place. This is how Aristotle summarizes the whole explanation (*Cael.*II.3, 286b6-9):

> Νῦν δὲ τοσοῦτόν ἐστι δῆλον, διὰ τίνα αἰτίαν πλείω τὰ ἐγκύκλιά ἐστι σώματα, ὅτι ἀνάγκη γένεσιν εἶναι, γένεσιν δ', εἴπερ καὶ πῦρ, τοῦτο δὲ καὶ τἆλλα, εἴπερ καὶ γῆν· ταύτην δ' ὅτι ἀνάγκη μένειν τι ἀεί, εἴπερ καὶ κινεῖσθαί τι ἀεί.
>
> "For the moment so much is clear, because of what cause there are several circular bodies, namely because it is necessary that there is generation, and generation (is

> necessary), if there also has to be fire, and that one and the others (are necessary) if there also has to be earth, and that one because it is necessary that something always remains at rest, if there has to be something that is for ever in motion."

The complete explanation of why there are several motions of the heaven is thus that there are several functions for the sake of which these motions are present. There is one eternal movement in a circle (performed by the outer sphere carrying the fixed stars) for the sake of realizing the immortality of the heaven, and there are other movements (performed by the inner spheres carrying the planets) for the sake of generation. Here, the use of the teleological principle allows Aristotle to draw an organic picture of the cosmological system in which the variety of motions that can be observed can be explained by the purpose they serve.

Admittedly, the argument is not without problems, and certainly it does not establish an explanation for *each* of the individual motions of the planets. Most problematic is perhaps Aristotle's claim for the need for there to generation. For, in the first place, Aristotle could have established the necessity of there being other movements in addition to the one of the sphere with the fixed stars solely on the basis of the existence of the four elements: if it is a necessary consequence of this first motion that there are four elements that do not partake in eternity, and if these elements have motions (cf. *Cael.*II.3, 286b1: τούτων δ' ἔστι κίνησις), then this explains why there are other motions. In the second place, Aristotle turns the necessity of generation in terms of being a necessary consequence of there being four sublunary elements, into a necessity of generation as a final cause, for which the motions of the planets are a necessary condition. Concerning generation, Aristotle states that "there will be spoken more clearly on this matter in what follows," pointing to his discussions in *GC.*II.10. There he explains that the eternal, circular motions of the sun are the efficient causes of continuous coming to be and passing away. Although it is thus clear that the motions of the sun cause generation, it is not clear that they are necessary *for the sake of* generation, or in other words, why generation is a necessary feature of the world.[35]

Presumably Aristotle is trying to unify the heavenly realm of eternal being and the sublunary realm of continuous generation (i.e. coming to be and passing

[35] This point is well brought out by Hankinson (2002-2003), 31-32; see ibidem for further criticisms of the argument.

away) by deriving them both from the immortality of the heaven, and in doing so, succeeds in giving some rationale for a phenomenon that the astronomers did not explain. The plurality of the motions of the heavenly bodies makes sense in the light of the need for the heaven as a whole to perform an eternal motion, if it is to be truly immortal, and as a corollary – of the need for there to be generation, if this eternal movement is to be at all.

#### *4.1.4.b Why the heavens move in the direction they do*

In *Cael.*II.5, Aristotle states that mathematically speaking, it is possible to move in two directions on a circle, i.e. clockwise and counterclockwise. However, the possibility of there being two directions in which bodies can move on a circle in the heavenly realm raises the following question (*Cael.*II.5, 287b24-27):

> Ἀλλ' εἰ μηδὲν ὡς ἔτυχε μηδ' ἀπὸ ταὐτομάτου ἐνδέχεται ἐν τοῖς ἀϊδίοις εἶναι, ὁ δ' οὐρανὸς ἄϊδιος καὶ ἡ κύκλῳ φορά, διὰ τίνα ποτ' αἰτίαν ἐπὶ θάτερα φέρεται, ἀλλ' οὐκ ἐπὶ θάτερα; ἀνάγκη γὰρ καὶ τοῦτο ἢ ἀρχὴν εἶναι ἢ εἶναι αὐτοῦ ἀρχήν.
>
> "But, if it is not possible for there to be anything by luck or by chance among the things that are eternal, and the heaven and its cyclical locomotion are eternal, because of what cause then are they carried in one direction, and not in the other one? For it is necessary that that is either a principle or that there is a principle of it."

While strictly speaking there is no distinction between movement in one direction and movement in the other direction, the assumption that in the heavenly realm nothing happens by chance, 'forces' Aristotle to ask the question why the heavens move in the direction they do, and also to try and answer that question teleologically.[36] For if some natural phenomenon cannot be by chance, it must have a determinate and non-incidental cause, and hence be explainable in terms of either necessity or teleology (these are the only two forms of causation possible as opposed

[36] Aristotle repeatedly offers the a fortiori argument that if one agrees that animals and plants neither come to be nor exist by spontaneity (but for the sake of something), then the claim that spontaneity is the cause of the heaven – which is most divine and exhibits the greatest order – must be absurd and that one has to conclude that final causality pertains to the heavenly realm as well. See *Ph.*II.4, 196a24-b5; *Ph.*II.6, 198a1-13, and *PA.*I.1, 641b10-23; 641b16-23: "This is why it is more likely that the heaven has been brought into being by such a cause – if it has come to be – and is due to such a cause, than that the mortal animals have been. Certainly the ordered and definite are far more apparent in the heavens than around us, while the fluctuating and random are more apparent in the mortal sphere. Yet some people say that each of the animals is and came to be by nature, while the heaven, in which there is not the slightest appearance of chance and disorder, was constituted in that way by chance and the spontaneous."

to chance and spontaneity). Since all the heavenly spheres are made from the same matter, Aristotle cannot refer to material causes to account for the direction of motion, and thus it remains to search for a teleological explanation.

This is the explanation Aristotle offers in an attempt to state the phenomenon (*Cael.*II.5, 288a2-12):

> Εἰ γὰρ ἡ φύσις ἀεὶ ποιεῖ τῶν ἐνδεχομένων τὸ βέλτιστον, ἔστι δὲ καθάπερ τῶν ἐπὶ τῆς εὐθείας φορῶν ἡ πρὸς τὸν ἄνω τόπον τιμιωτέρα (θειότερος γὰρ τόπος ὁ ἄνω τοῦ κάτω), τὸν αὐτὸν τρόπον καὶ ἡ εἰς τὸ πρόσθεν τῆς εἰς τοὔπισθεν, ἔχει, εἴπερ καὶ τὸ δεξιὸν καὶ τὸ ἀριστερόν, καθάπερ ἐλέχθη πρότερον, (καὶ μαρτυρεῖ δ' ἡ ῥηθεῖσα ἀπορία ὅτι ἔχει) τὸ πρότερον καὶ ὕστερον· αὕτη γὰρ ἡ αἰτία λύει τὴν ἀπορίαν. Εἰ γὰρ ἔχει ὡς ἐνδέχεται βέλτιστα, αὕτη ἂν εἴη αἰτία καὶ τοῦ εἰρημένου· βέλτιστον γὰρ κινεῖσθαι ἁπλῆν τε κίνησιν καὶ ἄπαυστον, καὶ ταύτην ἐπὶ τὸ τιμιώτερον.
>
> "For if nature always does what is best among the possibilities, and it is the case that, just as among the rectilinear locomotions the locomotion towards the upper location is more honorable (the location that is upper is more divine than the one that is lower), in the same way also the locomotion to the front is [more honorable] than the one to the back, then it [the heaven] has, if also the right and the left, just as was said before, (and the difficulty discussed gives evidence that it has), the prior and the posterior. For this explanation solves the difficulty. For if it is in the best way possible, then this will be the explanation also for what has been said: for it is best to move with a motion that is simple and incessant, and with one [i.e a motion] that is in the most honorable direction."

The starting point of the argument is the teleological principle that nature does always what is best among the possibilities, a principle that is well known from Aristotle's biology. In chapter 3 (see 3.3.1.c), I argued that the principle is used to set the framework for explanations of the presence of features in those cases where observation shows that there are several possibilities for nature to fulfill a particular functional need. Here the principle is used in a similar way to explain the presence of a particular motion: mathematics shows that there are two possible directions on a circle, and it is clear from observation that the heavens move only in one direction, and not in the other. Just as nature has given hands to human beings instead of forelimbs, because having hands is what is best for them among the two natural possibilities (*PA.*IV.10, 687a15-18), so, too, in the case of the heaven, Aristotle argues that nature has given it a motion in one direction, rather than one in the other

direction, because this is what is best for the heaven among the two possible motions. However, there is an important difference with the cases from biology, namely that it is not possible for Aristotle to point out why it is *functionally* more befitting for the heaven to move in one direction, rather than in the other one. In the case of human beings, Aristotle can show why it is best for human beings to have hands: because of their intelligence they are best able to use hands (and for beings with less intelligence it is best to receive forelimbs, because they would not be able to use hands). Presumably, however, the heaven would not be any less immortal if it were to move in the other direction.

This is where Aristotle brings in the analogy with dimensions in case of rectilinear motions. As we saw in 3.3.1.a, Aristotle posits dimensions as principles of the science of nature and attaches different (functional) values to different dimensions. Once it is established that the heaven has dimensions, it is possible to attach different values to those dimensions, and consequently to explain the direction of movement as what is best or most honorable. In the case of rectilinear motions, there are two possible directions of motion, but only one of them is best in terms of being more honorable: the best or most honorable direction is upwards, presumably because it is towards the divine, instead of away from it. The same holds for motions forward and backward: locomotion to the front is more honorable and hence the better of the two motions. If the heaven has the dimensions of left and right, and of prior and posterior, then that would solve the difficulty: the heaven would move in the best or the most honorable direction possible, which is forward.

Aristotle does not justify the assumption that the dimensions can be applied to the heaven, but instead refers back to earlier discussions, most likely to *Cael.*II.2. There Aristotle addressed a theory of the 'so-called Pythagoreans', claiming that the heaven has a left and a right. Aristotle accepts this theory somewhat reluctantly, and rebukes the Pythagoreans for having forgotten to apply the two most important pairs of dimensions to the heaven (i.e. up and down, front and back). The justification Aristotle gives for accepting the theory is that just as living beings, the heaven is ensouled and has a principle of movement (*Cael.*II.2, 285a27-31):

> Ἡμῖν δ' ἐπεὶ διώρισται πρότερον ὅτι ἐν τοῖς ἔχουσιν ἀρχὴν κινήσεως αἱ τοιαῦται δυνάμεις ἐνυπάρχουσιν, ὁ δ' οὐρανὸς ἔμψυχος καὶ ἔχει κινήσεως ἀρχήν, δῆλον ὅτι ἔχει καὶ τὸ ἄνω καὶ τὸ κάτω καὶ τὸ δεξιὸν καὶ τὸ ἀριστερόν.
>
> "Since we have previously determined that such capacities are present in those things that possess a principle of movement, and the heaven is ensouled and has a principle of movement, it is clear that it has the up and the down and the right and the left."

The claim that the heaven is ensouled is enigmatic. Although Aristotle never explicitly addresses the question of whether or not he believes that the heaven and heavenly bodies are alive, scholars have taken this passage as evidence for the view that Aristotle thinks they are.[37] Whatever the case may be, what is important here is that Aristotle only allows self-movers to have dimensions (as the dimensions are functionally defined partly by reference to the function of locomotion),[38] and apparently thinks that the heaven (at least in some way) is such a self-mover. However, when it comes to the actual attribution of those dimensions to the heaven, Aristotle makes clear that there is no absolute or objective point of reference;[39] the dimensions can only be attributed to the heaven through the use of analogy and thought-experiment. This points to a possible weakness in Aristotle's explanation: whatever the observed direction of the motion of the heaven is, that direction must be forward, and hence must be best and most honorable; had the heaven turned in the other direction, then Aristotle would have had to say that that direction was forward and the best (ultimately, the argument is circular). In other words, there is no supporting evidence available that corroborates Aristotle's conclusion that the heaven actually move in the best direction possible. However, in the absence of such evidence, the explanation that the heavens move in the direction they do, namely

[37] For this view, see e.g. Falcon (2005), 19; 74; and 112; Johnson (2005), 136-140; and Lloyd (1996), 171. I hesitate to draw this conclusion, because Aristotle's claim in *Cael.*II.2, 285a27-31 is that the heaven as a whole is ensouled (not that each of the heavenly bodies is), and because the references to the heavenly bodies as being alive (in *Cael.*II.12) are made as part of an analogy that is drawn for explanatory purposes. This does not necessarily mean that Aristotle also endorses this view independently of its explanatory merits; pace Falcon (2005, 74), who argues that Aristotle "presumably thinks that the explanatory benefits that depend on this assumption are also an indirect argument in support of the assumption itself."

[38] *Cael.*II.2, 284b10-284b29; *IA.*IV, 705a28-b18.

[39] *Cael.*II.2, 285a31-b8; cf. *DA.*II.4, 416a3, where Aristotle states that "up and down for all things are not what they are for the whole world."

forwards, because that is the best direction of the two possibilities, is the most plausible.[40]

#### *4.1.4.c Why the heavenly bodies move with different complexities*

The first of the two problems that are under scrutiny in *Cael.*II.12 (and it is the solution to this first problem which will have my attention here) pertains to the number of movements each of the heavenly bodies undergoes. For even though one would expect that the heavenly bodies that are nearer to the outer sphere undergo fewer motions than the ones further away, observations of some of the planets[41] and trustworthy sources (*Cael.*II.12, 292a6-8) both give evidence that there is no correlation between the distance of a heavenly body to the outer sphere and the complexity of its motions. According to these sources, the motion of the fixed stars can be accounted for by the assumption of the simple motion of one sphere. The motions of the planets close to these stars can only be accounted for by the assumption of many motions of many spheres, while the motions of the moon and the sun can be accounted for by the assumption of fewer motions by fewer spheres.[42] The earth does not move at all.

The solution Aristotle sketches here presumably draws upon some version of the theory of concentric spheres, in which the movements of the planets can be accounted for by the assumption of the motions and connections of several (mathematical) spheres. According to this theory, a planet is fixed to one sphere, the poles of which are connected to another one, and so on, sometimes leading up to as many as five spheres in Callippus' version of the theory, or nine in Aristotle's own adapted version of the theory (who added so-called unwinders to the system). Evidently, Aristotle is committed to a physical version of the theory (*Cael.*II.12, 293a7-8: ἑκάστη δὲ σφαῖρα σῶμά τι τυγχάνει ὄν; "each sphere is a body"), but the physicality of the spheres as such does not solve the problem: again, all the heavenly bodies and their spheres are made from the same matter (aether) and have the same

[40] Cf. Hankinson (1998), 185-186.
[41] *Cael.*II.12, 292a2: Δῆλον δὲ τοῦτο περὶ ἐνίων καὶ τῇ ὄψει γέγονεν; "it is clear that that happens with some of them also to observation."
[42] Modern commentators point out that Aristotle's claim in *Cael.*II.12, 291b34-292a1 that "the sun and the moon undergo fewer movements than some (ἔνια) of the planets" is problematic, since in whatever version of the theory of concentric spheres, the sun and the moon undergo fewer movements than *all* of the other planets. See Leggatt (1995), 246 for an outline of and a possible solution to this problem.

shape, and thus the differences in the complexities of their motions will have to be explained by reference to a final cause.

The considerations Aristotle offers in order to "make the thing that is puzzling us to appear as nothing absurd (*Cael.*II.12, 292a17-18)," is the application of the teleological model of action to the heavenly bodies (*Cael.*II.12, 292a18-22):

> Ἀλλ' ἡμεῖς ὡς περὶ σωμάτων αὐτῶν μόνον, καὶ μονάδων τάξιν μὲν ἐχόντων, ἀψύχων δὲ πάμπαν, διανοούμεθα· δεῖ δ' ὡς μετεχόντων ὑπολαμβάνειν πράξεως καὶ ζωῆς· οὕτω γὰρ οὐθὲν δόξει παράλογον εἶναι τὸ συμβαῖνον.
>
> "We think about them as if they are bodies only, and units with a certain order, but being altogether without soul; but it is necessary to suppose that they partake in action and life: for in that way the result will not seem to be anything absurd."

In other words, Aristotle proposes that we stop thinking of the heavenly bodies as if they are mathematical objects, and instead think of them as living beings, which move and act for the sake of ends and do so in virtue of possessing an internal principle of movement (i.e. their soul).[43]

In applying the notion of action to the heavenly bodies, Aristotle explicates two 'rules' that will be helpful in the understanding of the complexity of the heavenly bodies. In the first place, Aristotle argues that the further away one is removed from the good, the more actions are needed to attain that good; that which is in the best state already possess the good, and hence does not need to undertake any action; and for that which is too far away the good might not even be attainable (*Cael.*II.12, 292a23-28). Aristotle uses an analogy of the number of exercises a body needs to undergo to acquire a good condition to illustrate this 'rule': the one who already has a good condition does not need to exercise, while people with less good conditions have to perform one or more kinds of exercises to achieve a good condition, etc. In the second place, Aristotle makes clear – again through the use of an analogy, this time drawn from the game of knucklebones – that the more intermediate goals need to be achieved, the more difficult it will be to achieve the ultimate end (*Cael.*II.12, 292a28-b1).

These two 'rules' that set out the correlations that exist between the number of actions that are needed to reach the good and the initial distance from

[43] Aristotle usually uses analogies in the other direction: he uses what we know about higher order species to illuminate or explain features that belong to lower order species, and not the other way around; Lloyd (1983), 37-38.

this good are then applied to the motions of the heavenly bodies. Aristotle states that we should think[44] of the actions of the stars and planets as being analogous to those of living beings and plants (*Cael.*II.12, 292b1-2):

> Διὸ δεῖ νομίζειν καὶ τὴν τῶν ἄστρων πρᾶξιν εἶναι τοιαύτην οἵα περ ἡ τῶν ζώων καὶ φυτῶν.
>
> "This is why it is necessary that we consider also the action of the stars as being of the exact same sort as are the action of living beings and plants."

Subsequently, Aristotle fills in the details of this analogy. First, he describes four kinds of living beings that occupy the world around us (*Cael.*II.12, 292b2: ἐνταῦθα) and the number of actions they need in order to reach their good:

> a) human beings, who perform the most actions of all living beings;
>
> b) 'the person who is in the best state', who has no need for action;
>
> c) animals, which perform fewer actions than human beings do;
>
> d) plants, which perform only one limited mode of action.

Next, Aristotle formulates four 'patterns of activity', laying out the number of actions something needs to perform in order for it to reach the good (the smaller the number of actions is, the better it is, unless the absence of actions is due to an inability to reach the end). The patterns are then illustrated through an analogy with a person who performs actions for the sake of being healthy:

> 1) One thing already possesses and shares in the best, and therefore does not have to reach for it (some people are always healthy);
>
> 2) One thing reaches the good by performing a few actions (some people loose weight for the sake of health);
>
> 3) One thing reaches the good by performing many actions (some people loose weight and run and do something else for the sake of running, all for the sake of health);
>
> 4) One thing does not even attempt to reach it, but tries to get as close to the good as possible (some people are unable to reach a state of health, and for them running or loosing weight are goals).

The illustration of this fourth 'pattern' leads Aristotle to an explication of a third 'rule', which is that to reach the ultimate best would be the best for all, but if this is impossible, that "a thing is better the nearer it is to the best (*Cael.*II.12, 292b18-19)."

[44] For the terminology, see Bogen & McGuire (1986/7), 424-25.

Finally, Aristotle is in a position to apply those general patterns to the heavenly bodies (*Cael.*II.12, 292b18-25):

> Καὶ διὰ τοῦτο ἡ μὲν γῆ ὅλως οὐ κινεῖται, τὰ δ' ἐγγὺς ὀλίγας κινήσεις· οὐ γὰρ ἀφικνεῖται πρὸς τὸ ἔσχατον, ἀλλὰ μέχρι ὅτου δύναται τυχεῖν τῆς θειοτάτης ἀρχῆς. Ὁ δὲ πρῶτος οὐρανὸς εὐθὺς τυγχάνει διὰ μιᾶς κινήσεως. Τὰ δ' ἐν μέσῳ τοῦ πρώτου καὶ τῶν ἐσχάτων ἀφικνεῖται μέν, διὰ πλειόνων δ'ἀφικνεῖται κινήσεων.
>
> "And because of this the earth does not move at all, and the planets that are close have only few movements: for they do not reach the end, but they are able to reach the most divine principle only to a certain point. The first heaven immediately attains it immediately through one movement. The bodies in between the first and the last reach it, and they reach it through several movements."

Ultimately, Aristotle thinks that this analogical reasoning will take away the puzzlement regarding the different complexities of the heavenly bodies. In the table below, I have made an attempt to reconstruct the analogies underlying Aristotle's explanation.

| **a-d: sublunary living beings** | | **1-4: number of actions & the good** | | **Application to heavenly bodies** |
|---|---|---|---|---|
| Human beings | Many actions | Something that is able to reach the good | Needs many actions to reach the good | Other planets<br>(many movements)<br>(achieves the good) |
| Person in the best state | No actions | Something has the best | No actions | Outher sphere<br>(one movement)<br>(achieves the good) |
| Animals | Few actions | Something that is able to reach the good | Needs few actions to reach the good | Sun and Moon<br>(few movements)<br>(achieves the good to certain degree) |
| Plants | One action | Something that is unable to reach the good | Actions do not lead to achievement of the good | Earth<br>(no movement)<br>(not capable of achieving the good) |

If this reconstruction is correct, then Aristotle must have meant his analogy to work quite loosely: the earth is not really like plants, because the earth does not move at all, and the outer sphere is not really like the person who has it all, because the outer sphere does perform one (eternal) movement. At most, the teleological framework of actions that are undertaken for the sake of reaching the good makes the differences among the numbers of motions the heavenly bodies perform less perplexing or better understandable (which was of course Aristotle's goal), but it does not fully *explain* them. Here we touch upon the important problem of to what

exactly the analogy between sublunary beings and heavenly bodies amounts. Some scholars have taken the analogy quite literally as implying that the heavenly bodies are actually alive and that therefore they are actually submitted to a similar teleology of actions as the sublunary living beings are. The analogy is thus interpreted in a strongly causal sense as the mapping of the causal structure underlying one (well-known) phenomenon to another (lesser known) phenomenon.[45] However, in the light of the fact that it is not possible to map the patterns of goal-directed actions in exactly the same form to the heavenly domain, and given that Aristotle never explicitly states that the stars and planets are alive (he only states that the heaven is ensouled, and that we should think of the heavenly bodies *as* – ὡς – partaking of life), we might consider a less strong interpretation of the analogy, namely as a means to reduce puzzlement.[46] And this is, of course, exactly the way in which Aristotle himself introduces the teleological analogy: as a means to make the observed phenomena appear as "nothing absurd." For, the difference in the number of motions made by the stars, planets, sun, moon, and earth is less perplexing once one thinks of them as if similar to living beings: for, they, too, are different with regard to the number of motions that they perform and need to perform if they are to achieve their good.

In sum, in all three chapters discussed above, Aristotle uses teleological principles and models, all of which are well-known and well-established in his biology, to make sense of the presence of three heavenly phenonomena that cannot be accounted for by reference to mathematical priniciples or to material and formal causes alone. Lack of empirical evidence makes it hard to provide fully fledged physical explanations or demonstrations in these cases, but through the use of teleology Aristotle at least succeeds in taking away some of the perplexities pertaining to the heavenly phenomena.

[45] See, for instance, Johnson (2005, 139), who argues that the point of this analogy is "that the motion of the heavens is purposeful activity."
[46] For the distinction between a 'strong' and a 'weak' use of analogy, see Hankinson (1998), 22.

## 4.2 Teleological principles and the explanation of the absence of cosmological features

In this section, I will turn to the special cases where Aristotle uses some form of the teleological principle that nature does nothing in vain to explain the absence of certain motions or features of the heavens, after having already discussed these matters from a mathematical perspective. I will first discuss the two major problems pertaining to the attempt to explain what is absent in an empirically underdetermined domain such as the heavens, and secondly turn to a discussion of the explanations in *Cael.*I.4, *Cael.*II.8, *Cael.*II.9, and *Cael.*II.11 themselves.

### *4.2.1 Explaining what is absent in an empirically underdetermined domain*

In the former section, we saw that Aristotle was very much aware of the methodological problems involved in explaining the presence of heavenly phenomena. However, when it comes to the explanation of the *absence* of features and motions of the heavenly bodies, Aristotle seems less careful in his use of evidence and his reliance on teleological principles. By claiming that Aristotle is 'less careful', I mean in the first place, that Aristotle does not hedge his teleological explanations for the absence of features as he did in the other cases, nor does he provide some kind of justification indicating why the attempt to explain the absence of some feature is reasonable. In the second place, there are two possible problems in Aristotle's use of teleological principles to explain the absence of heavenly phenomena, which are less pressing in the case of explanations of what is present.

The two problems that I find in Aristotle's teleological explanations of the absence of features are the following. The first problem pertains directly to the lack of empirical evidence in cosmology: what cannot be observed might still be present (but just too far away for us to notice, just as perhaps the concentric spheres are), and what can be observed might be the result of a visual illusion. Although Aristotle was aware of these problems, in the chapters under discussion in this section Aristotle often shows himself to be very confident in deciding how much credence to attribute to the observations of the heavens. His general strategy is to explain the

phenomena and hence to save them,[47] but on occasion, especially where there are contradictory observations, the observations that conflict with the theory of the stars moving around fixed in concentric spheres are explained away.

This strategy is especially clear in *Cael.*II.8, where Aristotle addresses the movements of the stars and the heaven as a whole. As both are observed to move as a whole (and this observation remains unquestioned, although it is actually not possible to observe the movement of the spheres independently of the movement of the stars), it is necessary that the change of position either takes place with both the heavens and the stars being at rest, or with both moving, or with the one moving and the other being at rest. Aristotle rejects the first two options and then argues for the third one that the spheres or circles move and that the stars move fixed on these spheres. In support of this third option, Aristotle argues that if stars were to move on their own, they would either roll or rotate (*Cael.*II.8, 290a7-11), and neither one of these movements is observed to take place (*Cael.*II.8, 290a11: ἀλλ' οὐδετέραν φαίνεται). When Aristotle sets out to offer further empirical evidence for the absence of these movements, he explains away the observation of the apparent rotation of the sun[48] by claiming that it is caused by our distance to those heavenly phenomena and by the weakness and unsteadiness of our vision (Aristotle extends this explanation to the twinkling of the stars, which is also merely a visual illusion; the single observation of a rotating sun is not considered to be a refutation of the theory, because it is reasonable to expect all planets to make the same movement, and only the sun seems to rotate), while using the (single) observation that the moon always shows its face as evidence for the not rolling of the stars (*Cael.*II.8, 290a12-29).[49] In addition to this observational evidence (*Cael.*II.8, 290a30: *pros de toutois*),

[47] For Aristotle's concern to save the phenomena, see in particular *Cael.*I.3, 270b4-5 (Ἔοικε δ' ὅ τε λόγος τοῖς φαινομένοις μαρτυρεῖν καὶ τὰ φαινόμενα τῷ λόγῳ ; "and it seems like the argument testifies to the phenomena, and the phenomena to the argument"); *Cael.*I.5, 272a5-6; *Cael.*II.4, 287a12; *Cael.*II.6, 288b12; *Cael.*II.8, 289b10; *Cael.*II.14, 297a2-6; *Cael.*III.7, 306a5-8 (Συμβαίνει δὲ περὶ τῶν φαινομένων λέγουσι μὴ ὁμολογούμενα λέγειν τοῖς φαινομένοις.; "The result is that though they speak about the appearances they say things that are not in agreement with the appearances").

[48] Xenophanes might have observed the same phenomenon, and also explains it as a visual illusion; *DK*21A41a: δοκεῖν δὲ κυκλεῖσθαι διὰ τὴν ἀπόστασιν; "[the sun] seems to turn in a circle due to its distance." It is not clear to what kind of phenomenon Aristotle and Xenophanes are referring to; one suggestion is that it is sometimes possible to see sunspots on the sun, which are then seen to be 'moving' when the sun turns.

[49] *Cael.*II.8, 290a12-29: "In rotating they would have remained in the same place and not change their place, which is observed to be so, and everyone maintains as much (ὅπερ φαίνεταί τε καὶ πάντες φασίν). Further, it is reasonable that they all perform the same type of movement, but alone of the stars it is the

without adding any methodological caveats, Aristotle offers a further teleological argument for why it is reasonable to think that the stars move, not on their own, but by being fixed in concentric spheres. The problem thus seems to be that, where in the biological works Aristotle is very careful in dealing with cases of which the observations are inconclusive or absent,[50] in cosmology this cautiousness is less prevailing.

The second problem pertains to the 'justification' of the use of the principle that nature does nothing in vain in the heavenly domain. Prima facie, their use in the biological and in the cosmological domain is the same. As we saw in 3.3.1.c, Aristotle uses the principle that nature does nothing in vain in order to set the framework within which the absence of biological phenomena can be explained through a counterfactual argument. However, the use of this particular principle in biology is always 'prompted' through the comparison of empirical evidence. Comparative empirical research shows, for instance, that a particular kind of animals lacks a part that is present in all the animals that are related to it (e.g. the comparison of snakes with other blooded land-animals shows that snakes are the only ones to lack feet). The question of why some part is absent in a particular kind of animal is thus rational if it is based on the observation of that part's presence in other related animals. The use of the principle to explain the absence of a part is thus 'legitimate' and appropriate only if its presence could reasonably have been expected, and if its absence is 'significant' in the light of its presence in other animals. For instance, it is rational to ask why snakes have no feet, because all the other blooded animals that live on land all have feet: all these animals, snakes included, share to a certain extent the same formal nature, which explains the occurrence of certain co-extensive features, such as the possession of a maximum of four feet. The snake possesses all the other properties shared by the members of the same wider kind to which they

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sun that seems (δοκεῖ) to do this in rising and setting, and it does so not in itself but as a result of the distance from which we see it; for our vision, in being extended a long way, skews through weakness. This is also perhaps the reason for the apparent twinkling of the fixed stars, and the non-twinkling of the planets; for the planets are near, and so our vision reaches them while it is still strong; when, however, it reaches the fixed stars, it wavers due to the distance, being over-extended. Now, its wavering makes the movement seem to belong to the star, since there is no difference between the movement of our vision or of the thing seen. Yet that the stars do not roll either is evident (φανερὸν). For a thing that rolls must turn about, but the so-called face of the moon is always visible (δῆλόν ἐστι). Consequently, since it is reasonable that in moving by themselves they perform their proper movement, but they are not observed to be performing them (ταὐτας δ' οὐ φαίνεται κινούμενα), it is clear that they will not move by themselves."

[50] See, for example, *GA*.III.10, 760b28-33, *GA*.I.16, 721a12-17 and *GA*.II.5, 741a33-b1.

belong, except for feet. It is therefore rational to ask why this particular property is absent in snakes. It is not rational, however, to ask why snakes lack wings, telescopic eyes, or any other part that cannot be observed to belong to any of the members of the wider class to which snakes belong. As there is a virtual infinity of properties that any animal does not have, it only makes sense for a natural scientist to explain the absence of those properties that belong to the 'natural possibilities' of that animal. And what those natural possibilities are can be established inductively, on the basis of extensive observations and comparisons. The problem, as I see it, in the cosmological realm is that the range of natural possibilities can only partly, and only in a very indeterminate way, be established on the basis of observation. Therefore the use of the principle that nature does nothing in vain is not as firmly rooted in empirical evidence in cosmology as it is in biology.

*4.2.2 Explaining what is not there through the principle that nature does nothing in vain*

Aristotle's explanatory strategy for the explanation of the absence of heavenly phenomena is the supposition of some form of the principle that nature does nothing in vain. He then argues counterfactually that if those phenomena had been present, they would have been superfluous (in *Cael.*I.4, 271a33: μάτην; and *Cael.*II.11, 291b13-14: μάτην), or harmful (*Cael.*II.9, 291a25-28) for the heavens and its inhabitants. In one case Aristotle turns the argument around to argue for the unlikelihood that nature would purposefully have neglected honorable beings by not giving them the properties they need (*Cael.*II.8, 290a29-32: τῶν δ' οὕτω τιμίων ὑπεριδεῖν). Interestingly, all these explanations are offered *after* a series of mathematical arguments (in *Cael.*I.4) or of discussions of empirical evidence (in *Cael.*II.8 and *Cael.*II.9). The explanation in *Cael.*II.11 stands on its own, but is closely related to the explanation presented in *Cael.*II.8 (for this reason, the two explanations will be discussed together; see below 4.2.2.b). While the preceding arguments in these cases merely point out that it is mathematically impossible for some phenomenon to be present, or that its presence has not been observed, the teleological argument provides a physical explanation of why those properties 'in reality' do not exist. In this section, I will analyze the teleological explanations given

in *Cael.*I.4, *Cael.*II.8, *Cael.*II.9, and *Cael.*II.11 in full, and offer an assessment of their explanatory force.

#### *4.2.2.a Why there is no motion contrary to motion in a circle*

In *Cael.*I.4, Aristotle tries to provide plausibility (*Cael.*I.4, 270b33: ἄν τις λάβοι τὴν πίστιν) for the claim that there is no locomotion contrary to locomotion in a circle. Aristotle offers about six arguments in favor of this proposition.[51] The first five arguments are all mathematical in nature and show that motion contrary to motion in a circle is mathematically impossible. It is not until the last argument that Aristotle makes clear that he actually has a physical situation in mind.[52] He introduces the teleological principle that 'nature produces nothing in vain' and sets out to argue for the natural or physical impossibility of such a motion (*Cael.*I.4, 271a22-33):[53]

> Εἰ δὲ καὶ ἦν ἡ κύκλῳ τῇ κύκλῳ ἐναντία, μάτην ἂν ἦν ἡ ἑτέρα· * - * εἰ μὲν γὰρ ἴσαι ἦσαν, οὐκ ἂν ἦν κίνησις αὐτῶν, εἰ δ' ἡ ἑτέρα κίνησις ἐκράτει, ἡ ἑτέρα οὐκ ἂν ἦν. Ὥστ' εἰ ἀμφότερα ἦν, μάτην ἂν θάτερον ἦν σῶμα μὴ κινούμενον τὴν αὑτοῦ κίνησιν· μάτην γὰρ ὑπόδημα τοῦτο λέγομεν, οὗ μὴ ἐστιν ὑπόδεσις. Ὁ δὲ θεὸς καὶ ἡ φύσις οὐδὲν μάτην ποιοῦσιν.
>
> "Even if there were a locomotion in a circle contrary to locomotion in a circle, one of them would be in vain. For if they were equal, there would not arise a movement from them, and if one movement would prevail, the other one would not occur. As a result, if there were two, one of the two bodies would be in vain, because it would not move its proper movement: for we call that sandal in vain, of which there is no strapping. And god and nature do nothing in vain."

As usual, the argument is set out in a counterfactual way. Suppose there were a locomotion contrary to locomotion in a circle, then one of these two motions would be in vain: for to each simple movement belongs a simple body (*Cael.*I.2, 269a2-4), and if there were two bodies moving contrarily on a circle, then either no movement would happen (the collision of two bodies of equal strength would keep them at rest

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[51] Aristotle later refers back to this, and other propositions defended in the first chapters, as 'first supposition' (see *Cael.*I.7, 274a34: εἴ τις ἡμῖν ἐάσει μένειν τὰς πρώτας ὑποθέσεις), or 'suppositions concerning motion' (see *Cael.*I.8, 276b8: ἐκ τῶν περὶ τὰς κινήσεις ὑποθέσεων φανερόν).

[52] That the argument in *Cael.*I.4 pertains to the actual heavenly bodies becomes clear also from the way in which the argument ties in with the arguments in other chapters. For instance, the question of whether or not there is a motion contrary to motion in a circle is prompted by the earlier argument for the eternity of the first bodies in *Cael.*I.3, 270a19-20 in which the proposition that there is no such motion is already presupposed.

[53] I follow Leggatt in transposing *Cael.*I.4, 271a23-28 to follow *Cael.*I.4, 271a19; Leggatt (1995), 185.

for eternity), or one movement would conquer the other one (in which case the latter would not be able to perform its proper function). As Aristotle explains, a body that like a sandal can never perform the function for which it is present is in vain.[54] If, then, such a motion would be in vain, that explains why in fact there is no such body of motion. "God and nature"[55] simply do not operate in that way.

In this example, the teleological explanation not only strengthens the conclusion of the mathematical arguments for the absence of a motion contrary to motion in a circle, but also shows how it applies to the heavenly bodies. Even though there are no observations prompting the use of the principle that nature does nothing in vain, I do not find its use problematic here. As Aristotle has established firmly in his biology, nature does not produce parts that an animal is not able to use, let alone whole beings that are not able to perform their natural and proper function. The inference that there are no vain bodies in the heavenly sphere, and that therefore there is no movement contrary to movement in a circle, is *reasonable* – and that is all Aristotle is trying to establish here.

*4.2.2.b Why the heavenly bodies do not move on their own (or, why stars have no feet)*

In *Cael.*II.8, Aristotle addresses the question of whether or not the stars and planets have a movement independently of the movement of the spheres. Aristotle sketches three possible scenario's of the movements of the heavenly bodies and their spheres (*Cael.*II.8, 289b1-3): either both the heavenly bodies and the sphere are at rest; or both move; or one of the two moves while the other one stays at rest. The first two scenarios are rejected on the basis of empirical evidence (*Cael.*II.8, 289b5: οὐ γὰρ ἂν ἐγίγνετο τὰ φαινόμενα; *Cael.*II.8, 289b10: Φαίνεται). The option that the spheres are at rest while the heavenly bodies move is rejected on the basis of having absurd consequences (*Cael.*II.8, 289b27-28: τὰ αὐτὰ καὶ ὁμοίως ἔσται ἄλογα). Aristotle accepts the last possible scenario in which the spheres move and the heavenly bodies

[54] Nature does not produce something that is at the same time impossible and in vain: see *PA.*II.8, 653b26-29.

[55] Why Aristotle speaks here of "god and nature" is unclear; *kai* might be used epexegetically ("god, that is, nature"), but perhaps the divine subject matter of the argument (namely the movements of heavenly bodies) leads Aristotle to identify (on a metaphoric level) god and nature in positing the principle; cf. *GC.*II.11, 336b27-32 where Aristotle first posits the principle that nature always does what is best, and then exemplifies this by describing the actions of god (ἐπεὶ γὰρ ἐν ἅπασιν ἀεὶ τοῦ βελτίονος ὀρέγεσθαί φαμεν τὴν φύσιν, (...) τῷ λειπομένῳ τρόπῳ συνεπλήρωσε τὸ ὅλον ὁ θεός, ἐνδελεχῆ ποιήσας τὴν γένεσιν).

are at rest as being the least absurd (*Cael.*II.8, 289b34-35: μόνως γὰρ οὕτως οὐθὲν ἄλογον συμβαίνει). In favor of this scenario, Aristotle first argues that since the heavenly bodies are spherical, and since the natural movements of spherical bodies are either rotating or rolling, and neither one of these movements are observed (see the discussion of the conclusiveness of this empirical evidence above in 4.2.1), it is reasonable to conclude that they do not move on their own (*Cael.*II.8, 290a7-29). In addition to this observational evidence, Aristotle offers a final argument showing the unlikelihood of the stars and planets having a movement on their own. The argument runs as follows (*Cael.*II.8, 290a29-35):

> Πρὸς δὲ τούτοις ἄλογον τὸ μηθὲν ὄργανον αὐτοῖς ἀποδοῦναι τὴν φύσιν πρὸς τὴν κίνησιν (οὐθὲν γὰρ ὡς ἔτυχε ποιεῖ ἡ φύσις), οὐδὲ τῶν μὲν ζώων φροντίσαι, τῶν δ' οὕτω τιμίων ὑπεριδεῖν, ἀλλ' ἔοικεν ὥσπερ ἐπίτηδες ἀφελεῖν πάντα δι' ὧν ἐνεδέχετο προϊέναι καθ' αὑτά, καὶ ὅτι πλεῖστον ἀποστῆσαι τῶν ἐχόντων ὄργανα πρὸς κίνησιν.
>
> "In addition to these arguments, it would be absurd that nature gave them no organ for movement (since nature does nothing as a matter of chance), and that she should care for animals, but disregard such honorable beings; rather, it seems that nature, as though deliberately, removed everything by means of which they might possibly in themselves have effected forward motion, and that she set them at the greatest distance from those things that possess organs for movement."

The structure of this teleological argument is quite complex. In short, it consists of a *reductio ad absurdum* followed by an alternative account proclaiming the purposiveness – or perhaps even the providence – of nature. The first part of the argument builds upon the implicit counterfactual assumption that if the stars 'were intended by nature' to be moving on their own, it would be absurd for nature not to have given them organs for movement, given the fact that nature did provide such organs to 'lesser' beings. I take the expression that 'nature does nothing as a matter of chance' to be equivalent to the principle that nature does nothing in vain. Living beings always have the parts that they need, and if the heavenly bodies lack organs for movement, that lack must be for the sake of something. In other words, if the organs for movement are absent in heavenly bodies, it must be because their presence would have been in vain (they would have had no function to fulfill in this particular kind of being). The reference to the honorable status of heavenly beings

implies that Aristotle takes the teleology of nature to apply even *more* to them than to the sublunary beings.[56]

The – implicit – underlying teleological principle here is that each capacity (in this case the capacity to locomote) requires an organ[57] and that thus locomotion of the stars is possible if and only if they have organs for locomotion. The absurdity lies in the fact that nature *did* provide less honorable beings with organs for movement. We would have to conclude, were we to accept this account as true, that nature purposely neglected more honorable beings such as the stars. Since this account is of course unacceptable within Aristotle's view of the way nature operates, the opposite scenario, set out in the second part of the argument, must be the case: nature has *taken away* (*Cael.*II.8, 290a33: ἀφελεῖν) every means of locomotion, and thereby set a distance between the heavenly bodies and the sublunary beings equipped with organs for movement.[58]

The core of this teleological argument for why the heavenly bodies do not have a movement of their own, and hence must be fixed in spheres, is the assumption (presented as a fact) that heavenly bodies do not have organs for locomotion. For, if the heavenly bodies do not have organs of movement, and assumed that nature acts for the sake of something, nature must have 'designed' them not to be able to move on their own.

In a way Aristotle's explanation of the movement of the stars here parallels and criticizes that of Plato in the *Timaeus*. In this dialogue, Timaeus explains that the divine craftsman did not think it to be necessary to equip the heaven – self-sufficient and perfect as it is – with hands or feet for walking (Pl.*Tim.*33d-34a):

> ἡγήσατο γὰρ αὐτὸ ὁ συνθεὶς αὔταρκες ὂν ἄμεινον ἔσεσθαι μᾶλλον ἢ προσδεὲς ἄλλων. χειρῶν δέ, αἷς οὔτε λαβεῖν οὔτε αὖ τινα ἀμύνασθαι χρεία τις ἦν, μάτην οὐκ ᾠετο δεῖν αὐτῷ προσάπτειν, οὐδὲ ποδῶν οὐδὲ ὅλως τῆς περὶ τὴν βάσιν ὑπηρεσίας. κίνησιν γὰρ ἀπένειμεν αὐτῷ τὴν τοῦ σώματος οἰκείαν, τῶν ἑπτὰ τὴν περὶ νοῦν καὶ φρόνησιν μάλιστα οὖσαν· διὸ δὴ κατὰ ταὐτὰ ἐν τῷ αὐτῷ καὶ ἐν ἑαυτῷ περιαγαγὼν αὐτὸ ἐποίησε κύκλῳ κινεῖσθαι στρεφόμενον, τὰς δὲ ἓξ ἁπάσας κινήσεις ἀφεῖλεν καὶ ἀπλανὲς ἀπηργάσατο

[56] Cf. *PA.*I.1, 641b16-20.
[57] *GA.*I.2, 716a24-25.
[58] Aristotle considers it to be better for the superior to be separated from the inferior; cf. *GA.*II.1, 732a6-8, where Aristotle explains that it is better for the male and the female to be separated, for "it is better that the superior principle should be separated from the inferior."

> ἐκείνων. ἐπὶ δὲ τὴν περίοδον ταύτην ἄτ' οὐδὲν ποδῶν δέον ἀσκελὲς καὶ ἄπουν αὐτὸ ἐγέννησεν.
>
> "For he thought that a being which is self-sufficient would be much better than one which is in need of other things. And he did not think it was necessary to attach hands to it to no purpose – hands for which there would be no need either to grasp or to defend itself against anything; nor had it any need of feet, nor of the whole apparatus of walking. For he assigned to it the movement that is most suited to its body, [the movement] which, of the seven, is the most appropriate to mind and to thinking. And therefore he caused it to move in the same manner and on the same spot and revolving in a circle within its own limits. All other six [motions] he took away and it was made not to partake in their deviations. And as this circular movement required no feet, the universe was created without legs and without feet."

In this passage, Plato describes how the heaven was created and was given its circular movement, which is most appropriate for its spherical shape. The other types of movement – forwards/backwards, to the left/to the right, and up/down – were taken away from it (Pl.*Tim.*34a: ἀφεῖλεν). For circular movement no feet (or legs) are needed, and therefore Plato's heaven has no feet. Notwithstanding the similarities between the two accounts, Aristotle's differs in an important way from Plato's. For, while Plato holds that the spherical shape of the heaven and the absence of organs for movement make it most suitable for a rotating movement, which the heaven then performs on its own,[59] Aristotle rather uses these 'facts' to differentiate between the motions of the heaven as a whole and those of the heavenly bodies (*Cael.*II.8, 290b1-11). While the heaven, in virtue of being spherical, is most fit to move on its own (*Cael.*II.290b1-4; i.e. the heaven as a whole rotates; Aristotle agrees on this point with Plato), Aristotle holds – pace Plato – that the heavenly bodies, also in virtue of being spherical, do not rotate, and are also least fit to effect forward motion on their own (*Cael.*II.8, 290b5-8):

> πρὸς δὲ τὴν εἰς τὸ πρόσθεν ἀχρηστότατον· ἥκιστα γὰρ ὅμοιον τοῖς δι' αὑτῶν κινητικοῖς· οὐδὲν γὰρ ἀπηρτημένον ἔχει οὐδὲ προέχον, ὥσπερ τὸ εὐθύγραμμον, ἀλλὰ πλεῖστον ἀφέστηκε τῷ σχήματι τῶν πορευτικῶν σωμάτων.
>
> "[F]or forward movement it is least fit, since it is least like to those things that produce motion in themselves; for it does not have any appendage or projection, as

[59] Cornford (1975), 56-57.

> does a rectilinear figure, but stands most apart in shape from those bodies equipped for progression."

According to Aristotle, spherical bodies lack 'points of movement' and hence cannot locomote. Aristotle thus uses Plato's argument, but applies it to the heavenly bodies, and concludes that they are unfit for any type of locomotion and hence must be carried around by the spheres.

The teleological argument Aristotle offers here is in many ways similar to explanations we have seen in the biological works. In biology, Aristotle holds that all animals that are capable of locomotion must have organs for movement[60] and that animals without organs for movement are not capable of locomotion.[61] These two 'laws' are exhaustive with regard to all blooded land-walkers. The only exception is formed by the footless snake, which obviously does not have organs specifically designed for movement, but moves forward by bending itself (see also above, in 4.2.1).[62] Since the snake would move badly if it had only four feet, and given the principle that nature does nothing in vain *and* that nature cannot give snakes more than four feet (for in that case, the snake would not be bloodless), nature instead 'took those parts away.' However, the fact that snakes do not have organs for movement does not mean that they do not locomote: they move forward by bending themselves.[63] This may point to a problem for Aristotle's argument concerning the heavenly bodies: for the absence of *organs* for locomotion as such does not provide conclusive evidence that the stars in fact do not locomote. Of course, as the remainder of *Cael.*II.8 points out, Aristotle is actually committed to the stronger claim that spherical bodies do not only lack organs for movement, but also 'points of movement', which (at least given Aristotle's laws of sublunary mechanics) rules out any possible way of locomotion. However, it is not clear whether there are any *natural* limitations to the possible ways in which nature could have 'crafted' stars in order to make them able to move on their own. The absence of both organs and points for locomotion in the heavenly bodies in itself might not be enough to

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[60] *PA.*IV.10, 686a35-b1: "all (animals) that walk must have two hind feet"; *IA.*III, 705a19-22: "That which moves always makes its change of place by the employment of at least two organic parts, one as it were compressing and the other being compressed."
[61] *IA.*III, 705a23-25: "And so nothing that is without parts can move in this manner; for it does not contain in itself the distinction between what is to be passive and what is to be active".
[62] *PA.*IV.11, 690b14-18; *IA.*IV.705b25-29.
[63] *IA.*VII.707b6-131; *IA.*VIII.709a25-b4; *IA.*X.709b27-28.

establish the plausibility of the alternative theory that they do not effect any forward movement at all.

The comparison with explanations invoking the principle that nature does nothing in vain in the biological domain may point to another problem concerning its application to the cosmological domain. For, as I argued above in 4.2.1, while observations show that snakes lack feet, observational evidence of the heavens does not provide any *certainty* about the absence of feet in the heavenly bodies. For all we can tell, the heavenly bodies might be too far away for us to see their organs of movement. This difference between the reliability of observational evidence is important, because Aristotle's explanation in the case of the heavenly bodies is not prompted by the observation that they do not have organs for movement, as it is in the case of snakes. There are no observations of the heavens that would reasonably lead to the expectation of heavenly bodies having feet in the first place (one might object, however, that in this case the philosophical tradition within which Aristotle is working prompts this question).[64] Rather, Aristotle works the other way around: because he wants to present the theory that the stars do not move on their own as plausible as possible, he uses the absence of the organs of movement in the heavenly bodies to draw exactly this inference. Given the teleological framework that is posited by the principle that nature does nothing in vain, however, the inference is reasonable.[65]

The overall success of the teleological argument used in this chapter is thus difficult to determine, but at least Aristotle himself seemed to be quite pleased with it, for he repeats it in a reversed form in *Cael.*II.11.

In *Cael.*II.8, Aristotle presupposed that the heavenly bodies are spherical in shape, and argued that the absence of organs of movements in the heavenly bodies makes it all the more likely that they do not move on their own; this he considered

[64] On this tradition, see Cornford (1975), 55-6; besides Plato, Empedocles also seems to have argued for the footlessness of the heaven (fr.29, Simpl.*Ph.*1124, 1: τὴν Φιλίαν διὰ τῆς ἑνώσεως τὸν Σφαῖρον ποιοῦσαν, ὃν καὶ θεὸν ὀνομάζει, καὶ οὐδετέρως ποτὲ καλεῖ 'σφαῖρον ἔην'. οὐ γὰρ ἀπὸ νώτοιο δύο κλάδοι ἀίσσονται, οὐ πόδες, οὐ θοὰ γοῦν(α), οὐ μήδεα γεννήεντα, ἀλλὰ σφαῖρος ἦεν καὶ <πάντοθεν> ἶσος ἑαυτῷ).

[65] A third problematic aspect of Aristotle's argument (which is unrelated to the two previous ones) is perhaps that it does not provide sufficient reason to believe that the heavenly bodies in fact do not rotate, for as Aristotle must concede, their spherical shapes are fit for just that sort of movement.

to be an indication that the heavenly bodies actually are spherical (*Cael.*II.8, 290a35-b1):

> Διὸ καὶ εὐλόγως ἂν δόξειεν ὅ τε ὅλος οὐρανὸς σφαιροειδὴς εἶναι καὶ ἕκαστον τῶν ἄστρων;
>
> "Therefore it would also seem reasonable that the heaven as a whole and each of the stars is spherical."

In *Cael.*II.11, Aristotle picks up on this issue and provides two further considerations that strengthen the supposition that the heavenly bodies are spherical in shape (*Cael.*II.11, 291b10):

> Τὸ δὲ σχῆμα τῶν ἄστρων ἑκάστου σφαιροειδὲς μάλιστ' ἄν τις εὐλόγως ὑπολάβοι.
>
> "One may most reasonably assume that the shape of each of the stars is spherical."

The first of the considerations Aristotle offers in support of this assumption builds upon the teleological argument in *Cael.*II.8 (*Cael.*II.11, 291b11-17):

> Ἐπεὶ γὰρ δέδεικται ὅτι οὐ πεφύκασι κινεῖσθαι δι' αὑτῶν, ἡ δὲ φύσις οὐδὲν ἀλόγως οὐδὲ μάτην ποιεῖ, δῆλον ὅτι καὶ σχῆμα τοιοῦτον ἀπέδωκε τοῖς ἀκινήτοις ὃ ἥκιστά ἐστι κινητικόν. Ἥκιστα δὲ κινητικὸν ἡ σφαῖρα διὰ τὸ μηδὲν ἔχειν ὄργανον πρὸς τὴν κίνησιν. Ὥστε δῆλον ὅτι σφαιροειδῆ ἂν εἴη τὸν ὄγκον.
>
> "For, since it has been shown that they are by nature not such as to move by themselves, and since nature does nothing absurd or in vain, it is clear that she also gave that shape to things that are immobile that is least mobile. And the sphere is least mobile because it does not have an organ for movement. In consequence, it is clear that their masses are spherical in shape."

Here Aristotle has turned the argument around: given the conclusion of *Cael.*II.8 that the heavenly bodies do not have their own movements, and given the teleological principle that nature does nothing in vain, the inference is reasonable that the 'physical make-up' of the heavenly bodies is most appropriate for their immobility (where movement is taken in the sense of locomotion). Therefore, the heavenly bodies are spherical in shape. Subsequently, Aristotle explains the immobility of things that are spherical in terms of not having an organ for movement.

The way in which Aristotle applies the principle that nature does nothing in vain in this example is slightly different from its use in the biological works. In biology it is used to explain the absence of parts; here it is used to explain why the heavenly bodies are least 'adapted' to a function they are not supposed to perform.

That is, it is used to explain the presence of a feature (i.e. the spherical shape) in terms of it not being for the sake of a function the heavenly bodies do not need to perform (i.e. locomotion). If it is part of the nature of heavenly bodies to be immobile (in the sense of not being able to locomote on their own), then the natural bodies they have must be instrumental to this immobility, which is not to have instruments for mobility. This way of showing that features belong to a certain being by reference to a negatively defined nature is unprecedented in Aristotle's biology.[66] In the remainder of the chapter, Aristotle provides empirical evidence (*Cael.*II.11, 291b19: δείκνυται διὰ τῶν περὶ τὴν ὄψιν) concerning the waxing of the moon to strengthen the conclusion of the teleological argument,[67] and refers to evidence from the astronomers concerning the eclipse of the sun.

The success of the teleological explanation is again hard to determine. One problem is that the arguments in *Cael.*II.8 and *Cael.*II.11 are circular: their conclusions presuppose one another. In addition, Aristotle does not discuss the fact that *in some sense* the spherical shape is most fitted for movement, namely for movement in the sense of rotation; this is in fact what he argued for in *Cael.*II.8, 290b2-3:

> Πρὸς μὲν γὰρ τὴν ἐν ἑαυτῷ κίνησιν ἡ σφαῖρα τῶν σχημάτων χρησιμώτατον.
>
> "For, the sphere is the figure that is most fit for movement on itself."

In sum, in both *Cael.*II.8 and *Cael.*II.11 Aristotle goes out of his way to establish the plausibility of the assumption that the heavenly bodies do not have a movement of their own, and hence must be moving while being fixed in concentric spheres. In doing so, he combines observational evidence (for as far as available) and the teleological principle that nature does nothing in vain: if our observations of the heavens are reliable, then the presence of their spherical shape and the absence of organs of movement must be for the sake of their immobility.

[66] Although there might be hints to such an explanation in *PA.*IV.7, 683b9-14.
[67] The evidence concerning the moon and the sun is extended to the other heavenly bodies on the assumption that they are all "one and alike" (*Cael.*II.11, 291b17: ὁμοίως μὲν ἅπαντα καὶ ἕν.)

*4.2.2.c Why the absence of the harmony of the spheres shows that heavenly bodies do not move on their own*

In *Cael.*II.9, turns to the Pythagorean notion of the harmony of the spheres and uses the rejection thereof to corroborate his claim that the heavenly bodies do not move on their own.

Aristotle argues that the conclusions of *Cael.*II.8 show that the theory of the harmony of the spheres must be false (*Cael.*II.9, 290b12-15) for the following reason. Given that bodies around us produce a sound when they move through air, it seems reasonable to suppose that such enormous bodies as the heavenly bodies must produce a sound, too, when they move, and that is must be a very loud one. However, since we do not perceive such a loud noise,[68] and do not experience any effects of this sound independently of our perception (thunder, for instance, has destructive effects, and it is reasonable to expect the noise of the heavens to have far more destructive effects), Aristotle concludes that the harmony of the spheres must simply be absent. Aristotle then uses the absence of the harmony of the spheres as evidence for the theory that the heavenly bodies do not move on their own (*Cael.*II.9, 291a6-9):

> Ἅμα δ' ἐστὶ τό τ' αἴτιον τούτων δῆλον, καὶ μαρτύριον τῶν εἰρημένων ἡμῖν λόγων, ὡς εἰσιν ἀληθεῖς· τὸ γὰρ ἀπορηθὲν καὶ ποιῆσαν τοὺς Πυθαγορείους φάναι γίγνεσθαι συμφωνίαν τῶν φερομένων ἡμῖν ἐστι τεκμήριον.
>
> "At the same time that the cause of those things is clear, it is also a testimony for the arguments we have provided, namely that they are true: for that which puzzled the Pythagoreans and which made them assert that there arises a harmony from the things that move is a proof for us."

The argument runs as follows: things either move through a medium and cause noise, or they move while being fixed in something else that performs the movement, and do not cause noise. If the heavenly bodies were to move on their own through a medium, they would produce noise of an enormous magnitude, and this noise would shatter our terrestrial realm (*Cael.*II.9, 291a9-22). From these considerations, Aristotle draws a conclusion that is teleological in nature (*Cael.*II.9, 291a22-26):

[68] The Pythagoreans explain this by claiming that human beings have gotten used to the sound, since they have been hearing it since their birth.

> Ὥστ' ἐπείπερ οὐ φαίνεται τοῦτο συμβαῖνον, οὔτ' ἂν ἔμψυχον οὔτε βίαιον φέροιτο φορὰν οὐθὲν αὐτῶν, ὥσπερ τὸ μέλλον ἔσεσθαι προνοούσης τῆς φύσεως, ὅτι μὴ τοῦτον τὸν τρόπον ἐχούσης τῆς κινήσεως οὐθὲν ἂν ἦν τῶν περὶ τὸν δεῦρο τόπον ὁμοίως ἔχον.
> "Consequently, exactly since this result is not observed, none of them moves with an ensouled or forced movement, as if nature foresaw what was going to be the result, namely that if their movement were not like this nothing in the place around us would be the same."

Aristotle thus does not draw the simple conclusion that if none of the effects of the harmony of the spheres has been observed, the heavenly bodies cannot be moving on their own (i.e. if there are no effects, the causes of these effects must be absent). He rather gives a teleological or even providential twist to it: Aristotle argues that it is *for the sake of* preserving the terrestrial realm, that the heavenly bodies do not move on their own. In other words, the heavenly bodies do not just not produce such a harmony, they 'were not meant to be'; their being fixed in spheres serves a good purpose.[69] This argument draws on the principle that nature does nothing in vain: had the heavenly bodies moved on their own, their movements would have had bad consequences for our life on earth. Aristotle claims that, because nature "foresaw" these bad consequences and never does anything that is in vain (which, as we saw in the biological works, includes those things that are harmful), it did not produce the heavenly bodies in such a way that they could move on their own.

Just as in the previous explanations, Aristotle uses what has not been perceived (i.e. noise) as evidence for something's absence (i.e. for the absence of the harmony of the spheres), and uses the teleological argument that explains this absence in support of his theory of the physicality of the concentric spheres. The evidence for the absence of the harmony of the spheres is quite strong: even though our sensorial input might not be all that reliable when it concerns the heavens, the analogy with thunder and the absence of the effects caused by extremely loud noises make it reasonable to think that there really is no harmony of the spheres. The inference from the absence of bad results to the denial of heavenly bodies

[69] This is also how Simplicius reads the passage, see: *In Cael.*467, 19-27: "Secondly, he [Alexander] also correctly recognizes that on the basis of what is said here Aristotle clearly believes that there is also providence over things her, since he says that nature, foreseeing things here, made the spheres, but not the stars, move. For the efficient cause also foresees this. And it is clear that Aristotle is now calling god nature, since what he calls nature in the strict sense – the starting point of motion and rest of what it is in – is not only not strong enough to have foresight, but it is such that it does not think or understand at all, nor does it perceive since it is naturally implanted first of all in bodies which do not perceive".

performing a movement of their own is perhaps more of a stretch. The function, that is, the preservation of our world as it is, does not determine (in the sense of conditionally necessitating) the absence of the movement of the heavenly bodies, nor the presence of the heavenly spheres. A problem concerning the general theory of the argumentation is that Aristotle himself is not committed to the view that stars have to move through air or fire in case they were not fixed in a moving sphere: there are no natural elements in the region of the heavens except for *aithêr*. In addition, the explanation hints at a cosmological teleology: the heavenly bodies do not move while being fixed in concentric spheres because that is best for *them,* but because it is best for *us*. I have argued in 1.3 that Aristotle ultimately does not endorse such a cosmological view of teleology, but again, the teleological argument helps Aristotle to make as much sense of the phenomena as possible.

In sum, in all four chapters discussed above, Aristotle applies some form of the principle that nature does nothing in vain to the heavenly bodies in order to argue for the plausibility of the theory of physical concentric spheres carrying the heavenly bodies. In the biological realm, the observation of what happens always or for the most part in nature is what allows us to draw inferences about cases in which the goal-directedness is less evident. In a domain such as cosmology, which is empirically underdetermined, such inferences are necessarily of a conjectural nature. However, if teleology extends to the heavenly realm, and Aristotle assumes it does, then the use of teleological principles allows Aristotle to make the most sense of the phenomena, and to provide physical explanations, rather than only mathematical ones.

## 4.3 Conclusion

To a modern audience, Aristotle's teleological explanations of heavenly phenomena may sound rather unusual, and perhaps even a bit silly, but what I hope to have made clear in this chapter is that they make perfect sense within Aristotle's conception of natural science. If the heavens are part of nature, then we need at least to attempt to state all four causes for every heavenly phenomenon, even if the

investigation has been made difficult because of the scarcity of empirical data. Aristotle's use of teleological principles thus follows from his physical approach towards cosmology, and we have seen that this approach is especially prominent in the second book of *Cael.*, where Aristotle searches for explanations of the features and motions of the heaven as a whole and of the heavenly bodies. The scientific investigation of an empirically undetermined domain such as the heavens is difficult, and as his methodological reflections show, Aristotle is mostly well aware of all the problems involved. However, if one wants to gain knowledge of the heaven and its bodies, one has to try and give explanations that at least make the phenomena – both in terms of what can and of what cannot be observed – seem as reasonable as possible.[70]

The strategy Aristotle employs to give plausible accounts is to posit teleological principles as a way of heuristic for finding final causes in difficult cases. The principles used are not a priori axioms, but suppositions derived from empirical evidence; they are generalizations over the actions of the formal nature of beings, based on numerous observations made in the biological domain. Just as the use of these principles helped Aristotle to find final causes in cases where these were not immediate observable in biology, in the same way Aristotle hopes to find explanations for natural phenomena in the cosmological realm. This gives a very central role to Aristotle's scientific practice in biology: one could say that where Aristotle's philosophy of science as described in the *Posterior Analytics* offers the student of nature his scientific toolbox, the accessible and rich domain of biology is the student's main workplace. The experience and knowledge acquired in studying the biological phenomena may then – of course with suitable adaptations and refinements – be applied to other, less accessible domains of nature, such as that of the heavens.

The application of teleological principles to the cosmological domain is itself based on the assumption that the heaven is no less teleological – and, perhaps even more teleological – than the sublunary realm is. However, as I have pointed out above, the lack of empirical evidence in the cosmological realm also weakens to

[70] Cf. Irwin (1988), 34.

some extent the inferences Aristotle draws within this teleological framework:[71] the explanations are plausible, but not as 'conclusive' as the ones we can find in the biological works.

For *De Caelo* this means that Aristotle argues as much from as towards teleology: starting from the assumption that the heaven as a whole is goal-directed, Aristotle tries to give a coherent, plausible, and reasonable picture of the heavens in which things are present or absent for a reason. This is Aristotle's main goal in *De Caelo*: even if it is not possible to give deductions that demonstrate why the heaven and the heavenly bodies have the features they have, one can still offer plausible physical accounts or inferences to the best explanation that take away some of the puzzlement concerning the heavens.

[71] Cf. Falcon (2005), ix: "there are features of the celestial world that outrun the explanatory resources developed by Aristotle for the study of the sublunary world."

# CHAPTER FIVE:
# DEMONSTRATING TELEOLOGY
# THE THEORY OF TELEOLOGICAL EXPLANATIONS IN ARISTOTLE'S *ANALYTICA POSTERIORA*

## 5.0 Introduction[1]

In the *Posterior Analytics* (*APo.*), Aristotle discusses demonstrative knowledge. Despite the long tradition of Aristotelian scholarship on this treatise, many details concerning the nature of demonstration and its relation to explanation remain enigmatic, and are subject of much controversy.[2]

This chapter aims to shed light on Aristotle's pivotal discussion of the relation of demonstration, explanation, and scientific knowledge in *APo.*II.11, and specifically on the structure of teleological explanations as presented in this chapter. In the first two sections of this chapter (sections 5.1-5.2), I will clarify the examples Aristotle provides to illustrate his theoretical remarks about causal explanation. In particular, I hope to make sense of the teleological example of walking after dinner for the sake of health and to illuminate the explanatory role played by the final cause. In the third section of this chapter (section 5.3), I will confront these findings with conclusions from the previous four chapters concerning Aristotle's practice. In particular, I will focus on the structure of three of the most common types of teleological explanation in Aristotle's *De Partibus Animalium* (*PA*) and its relationship to the 'ideal' as described in *APo.*II.11.

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[1] A shorter version of this chapter is forthcoming as Leunissen (2007b). Previous versions of this chapter were presented to the Joint Ancient Philosophy Program at the University of Texas at Austin and the Marquette Summer Seminar in Ancient and Medieval Philosophy on the *Posterior Analytics* and Aristotelian Sciences, at Marquette University; I am grateful to all those who asked critical questions and made helpful comments. I am also indebted to the participants of the Leiden research seminar on the *Posterior Analytics*, Frans de Haas, Pieter Sjoerd Hasper and Marije Martijn, for their invaluable assistance in analyzing *APo.* II.11. For help and comments on earlier drafts of this chapter, I would like to thank Frans de Haas, Jim Hankinson, Pieter Sjoerd Hasper, Jim Lennox, and David Sedley. I thank Jeff Laux for correcting my English. The errors which remain are, of course, my responsibility, and the views expressed are not necessarily shared by those thanked above.

[2] For present purposes, I leave aside the question whether the *Posterior Analytics* is supposed to present a theory of scientific methodology and investigation or a theory of the organization and presentation of the finished scientific system. On this matter, see among others Barnes (1969) and (1993), xi-xix.

Ultimately, this will show that Aristotle's theory and practice of teleological explanation are in agreement with each other, and that both are more flexible and comprehensive than has been acknowledged so far.

## 5.1 Causes, explanations, and middle terms

*5.1.1 The problem: the middle terms of the examples in APo.II.11 do not pick out all four causes*

In *APo.*I.2 Aristotle introduces demonstrations as being syllogistic in form and causal in content. Demonstrations are thus deductive reasonings that produce scientific knowledge (*APo.*I.2, 71b17-19). For Aristotle, scientific knowledge consists ultimately in knowledge of the explanation of why things are the case (*APo.*I.2, 71b9-13):

> Ἐπίστασθαι δὲ οἰόμεθ' ἕκαστον ἁπλῶς, ἀλλὰ μὴ τὸν σοφιστικὸν τρόπον τὸν κατὰ συμβεβηκός, ὅταν τήν τ' αἰτίαν οἰώμεθα γινώσκειν δι' ἣν τὸ πρᾶγμά ἐστιν, ὅτι ἐκείνου αἰτία ἐστί, καὶ μὴ ἐνδέχεσθαι τοῦτ' ἄλλως ἔχειν. δῆλον τοίνυν ὅτι τοιοῦτόν τι τὸ ἐπίστασθαί ἐστι ·
>
> "We think we have <scientific> knowledge of each thing without qualification (and not in the sophistic way, incidentally), when we think we know the explanation because of which the state of affairs is the case, that it is its explanation, and also [when we think] that it is not possible for this to be otherwise. It is clear that something of this kind is what it is to have <scientific> knowledge."[3]

At the beginning of chapter 11 of the second book of the *Posterior Analytics*, Aristotle specifies – and, from our perspective, complicates – this assertion by introducing a 'doctrine' of four *aitiai*, which, he claims, are all to be demonstrated through the middle term (*APo.* II.11, 94a20-27):

> Ἐπεὶ δὲ ἐπίστασθαι οἰόμεθα ὅταν εἰδῶμεν τὴν αἰτίαν, αἰτίαι δὲ τέτταρες, μία μὲν τὸ τί ἦν εἶναι, μία δὲ τὸ τίνων ὄντων ἀνάγκη τοῦτ' εἶναι, ἑτέρα δὲ ἡ τί πρῶτον ἐκίνησε, τετάρτη δὲ τὸ τίνος ἕνεκα, πᾶσαι αὗται διὰ τοῦ μέσου δείκνυνται.
>
> "Since we think we have <scientific> knowledge when we know the explanation, and there are four types of explanation – one, what it is to be a thing, and another, given what things being the case it is necessary for that to hold;[4] another, what first

[3] All translations are mine, unless indicated otherwise.

[4] The expression used here to refer to material causation is puzzling; I believe Aristotle to imply that material causes for the most part necessitate their results, or that they at least did so when picked out in demonstrations. For present purposes, I shall treat the expression and the example discussed below as a

> initiated the motion; and fourth, the for the sake of what – all of them are brought out through the middle term."[5]

After this short introduction of the subject matter of this chapter, Aristotle moves on to explain how indeed each of the four *aitiai* is indeed brought out or shown through the middle term.

In contrast with the apparent clarity of structure and argument in this chapter, its content has raised many interpretative problems for modern scholars, most of which pertain to the general purpose of the chapter and to the nature of the individual syllogistic examples.

The sentence stating that "all the *aitiai* are brought out through the middle term" has traditionally been interpreted[6] as meaning that all four Aristotelian causes can or even must be picked out by the middle term in scientific demonstrations. However, under this interpretation the syllogistic examples Aristotle gives to illustrate his introductory sentence present us with two major difficulties. In the first place, contrary to the expectations of many interpreters the syllogisms posited in no way constitute typical Barbara demonstrations (the required mood for science) where the predicates hold universally and necessarily of the subjects.[7] In the second place, it is not immediately clear how the middle terms in the given examples refer to the causes in question. In particular, the section that shows how final causes are brought out through the middle term is notorious,[8] because the final cause is not picked out by the middle term, but rather by the major or predicate term.[9] Some

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'canonical' example of material explanation, taken in the broad sense as an explanation stating 'that out of which'. For the problems involved (which do not affect the interpretation presented here), see Barnes (1993), 226-7; Detel (1993), 685, 690-4; and Ross (1949), 638-42.

[5] For my translation of *APo.*II.11, 94a20-94b26, see the appendix at the end of this chapter.

[6] This interpretation ultimately goes back to Philoponus, who criticises this chapter in his commentary on *APo.* (*In APo.* 376, 12-14; 376, 16-18; 376, 31-2; 377, 21-22 and 377, 26-27). He thinks that the examples are wrong and rebukes Aristotle for having set out the syllogisms in a confused way (*In APo.* 378, 16-19; 379, 4-9; 379, 33-380, 3). In order to correct Aristotle, Philoponus rearranges the examples and thereby manoeuvres the causes into the preferred position of the middle term (*In APo.* 378, 19-22; 379, 33-380, 3; 381, 35-36). I have discussed these issues in more detail in Leunissen (2007a).

[7] Cf. Barnes (1993), xvi ("In chapters B11-12 the syllogism is, alas, a positive embarrassment and a bar to understanding.") and 228 and Ross (1949), 647 (Ross calls Aristotle's examples 'quasi-syllogisms').

[8] For the difficulties modern commentators encounter in this section, see, Ross (1949), 642; Barnes (1993), 225; 229; and Detel (1993), 695; 707.

[9] See Barnes (1993), 229ff; Detel (1993), 707ff; and Ross (1949), 642-3. The problem is expressed most emphatically in Detel (1997), 65-66: "The syllogistic reconstruction of the first of these [two teleological] examples Aristotle seems to offer in the subsequent passage (94b12-20) turns out to be, at first sight, extremely problematic, though, since he represents the aim of being healthy, not by the middle term, B, but by the major term, A. This is *clearly incompatible* with his general claim, expressed in 94a20-24, that the aim too must be proved through the middle term" (the italics are mine).

scholars have taken up Aristotle's own suggestion that things will become clearer if we 'change the *logoi*' (94b21-22: *metalambanein tous logous*), taking it to mean that we as readers are supposed to rearrange the syllogism so that the middle term picks out the final cause after all.[10] However, it is not an easy undertaking to construct such a syllogism, let alone to do so while remaining close to the Aristotelian original. On the whole, the verdict of interpreters on this chapter has been very negative.[11]

### *5.1.2 The hypothesis: the causality of the explanation vs. that of the explanatory middle term*

The hypothesis that I put forward in order to solve the problem outlined above is a fairly simple one. I submit that it is not the examples that are wrong, but rather our interpretation of what Aristotle means by saying that "all the *aitiai* are brought out through the middle term." What is crucial for the understanding of this chapter is that within an Aristotelian demonstration there can be a difference between the type of causality expressed in the *explanation* of a state of affairs (i.e. the causality expressed by the whole demonstrative syllogism), and the type of causality expressed in the middle term that picks out the *explanans* of this state of affairs. In the case of teleological explanations, I will even argue for the stronger case that the type of causality expressed by the middle term *must be* different from that expressed in the explanation. The upshot of this distinction for Aristotle's theory of demonstration is that all the four types of explanations will be brought out through the middle term, but that the middle term itself will not have to refer to the corresponding cause in all four cases.

I will give two examples to illustrate this distinction. First, consider the *dia ti* question why there is a house. In many cases,[12] Aristotle takes this to be a question about the purpose of the presence of a house. In that case, an adequate explanation

[10] Detel in particular puts much work into the rewriting and adaptation of the examples as a consequence of interpreting *metalambanein tous logous* as 'changing the terms'; see Detel (1993), 684-716 and (1997), 65-67. Recently, Johnson argued that 'changing the terms' should be read as entailing that 'health' and 'good digestion' are convertible in this explanation; see Johnson (2005), 52-55. This, however, is only possible if the terms were coextensive, which seems unlikely in this case. Bolton (1997, 115), saves the example, but suggests that ultimately what is picked out by the major term (the final cause) is "in its primitive definition" equal to what is picked out by the middle term (the material cause).

[11] This might explain why the chapter has largely been ignored by some recent studies on *APo.*; see, for instance, Goldin (1996) and McKirahan (1992).

[12] Aristotle does not offer a complete demonstration of why there is a house in *APo.*II.11, but the details might be inferred from similar examples in *Met.*Z.19, 1041a23-30, *APo.*II.12, 95b32-38, and *DA.*I.1, 403b3-7.

needs to be a teleological one: as Aristotle puts it, a house is present for the sake of protecting my belongings against wind, rain, and heat. However, this explanation as such does not make it intelligible yet why it is that protection of my belongings holds of this house, that is, we have not shown yet why this function belongs *per se* to this subject. This is where the explanatory middle term comes in: the middle term picks out the *explanans* of why a house offers protection. In this example, Aristotle thinks the middle term will be something like 'bricks, stones, and timber,' because these materials explain why a house has the protective properties it has. That is, if a house is to be protective, it is a necessity that it be solid and impenetrable by water; materials such as cloth or cardboard, unlike bricks, stones, and timber, will not have the right material potentials to do the job. The middle term thus picks out the material cause of why the function of protection belongs to a house, and thereby brings out or shows why the teleological explanation holds.

A second example is the *dia ti* question of what is ice. Aristotle takes this question to be about the essence of ice – about what ice *is* (cf. *APo.*II.12, 95a16-21). By assuming (the nominal definition) that ice is solidified water Aristotle makes a first move towards an explanation in terms of formal causation. Again, this preliminary answer does not qualify as a demonstration yet, because we do not know why it is that 'solidified' belongs to 'water', or why there is ice. The explanatory middle term that Aristotle proposes for this example is a complete cessation (*ekleipsis*) of heat: ice comes about when there is a complete cessation of heat. The middle term, which picks out the efficient cause[13] of the solidification of water, reveals the essence of ice: ice is solidified water resulting from a complete cessation of heat. While the explanation is a formal cause explanation, the middle term bringing out this explanation picks out an efficient cause.

In sum, Aristotle's claim that "all the *aitiai* are brought out through the middle term" means under this scheme that all the four types of explanations are brought out through the middle term, but that these demonstrations may proceed through middle terms that pick out causes of a different type.

### *5.1.3 The semantic distinction between hê aitia and to aition*

Within the context of the *Posterior Analytics* this philosophical distinction is supported by a semantic distinction between the term *hê aitia* (fem.; pl. *aitiai*) and the term *to aition* (neut.; pl. *aitia*). Frede has argued that the two terms were used differently in the original legal context in which they arose: *to aition* designated the agent responsible for a state of affairs, while *hê aitia* designated the accusation.[14] This distinction between *aition* as cause and *aitia* as causal account or explanation seems to be preserved in Plato's *Phaedo*,[15] and perhaps also in Chrysippus[16] and Diocles.[17]

Outside the *Posterior Analytics*, there is little or no evidence that Aristotle also endorsed this distinction, but within the *Posterior Analytics* I believe there is.[18] The semantic distinction is not crucial for the philosophical distinction, but a short sketch of the semantic distinction might help to get a clearer view of the theory Aristotle is setting out in chapter 11.

First *to aition*: usually, *to aition* is characterized as a condition for knowledge.[19] More specifically, in 'demonstrations of the reason why' the middle term must always refer to an *aition*.[20] This is what Aristotle points out at the end of the following passage (*APo.*II.2, 89b37-90a9):

> ζητοῦμεν δέ, ὅταν μὲν ζητῶμεν τὸ ὅτι ἢ τὸ εἰ ἔστιν ἁπλῶς, ἆρ' ἔστι μέσον αὐτοῦ ἢ οὐκ ἔστιν· ὅταν δὲ γνόντες ἢ τὸ ὅτι ἢ εἰ ἔστιν, ἢ τὸ ἐπὶ μέρους ἢ τὸ ἁπλῶς, πάλιν τὸ διὰ τί ζητῶμεν ἢ τὸ τί ἐστι, τότε ζητοῦμεν τί τὸ μέσον. (...) συμβαίνει ἄρα ἐν ἁπάσαις ταῖς ζητήσεσι ζητεῖν ἢ εἰ ἔστι μέσον ἢ τί ἐστι τὸ μέσον. τὸ μὲν γὰρ αἴτιον τὸ μέσον, ἐν ἅπασι δὲ τοῦτο ζητεῖται.

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[13] I here follow Charles (1999), 233-5, who identifies *ekleipsis* as a process (the suffix –*sis* indicates a *nomen actionis*) and an efficient cause.
[14] Frede (1980), 222-223.
[15] Frede (1980), 223; Lennox (2001a), 282-283; Sedley (1998), 115 and 115n1.
[16] Frede (1980), 222.
[17] Diocles, fr.176 (edition Van der Eijk (2001)).
[18] In other treatises the distinction may only be preserved in 'technical discussions' of demonstrations such as *DA.*II.2, 413a11-21; this, however, requires further research. Interpreters of *APo.* usually take the terms to be semantically equivalent, and translate them more or less randomly as cause, reason, or explanation. For instance, Barnes (1993), 89-90, "resolved to adhere to a single translation for all occurrences of the word [i.e. "*aitia* and its cognates"]; and I opted for 'explanation'."
[19] Knowing why is to know *by means* of *to aition* (75a35); this knowledge proceeds *from aitia* (76a19-20) that are primitive (78a25-26). See also 93a4-8; 93b19; 93b21-6; 95a10-12; 95a22-25; 95b14.
[20] The middle term in demonstrations of the reason why always picks out the *aition* that is immediate and primitive (89b15; 90a7-9; 93a4-8; 95a10-12; 95a17; passim in 98b17-99b13). If the deduction does *not* proceed through the *aition* but through the more familiar of the (non-explanatory) converting terms, that is, when the middle term is not an *aition*, then the demonstration that follows is not a demonstration of the reason why, but a demonstration of the fact (78a27-29; 78b4; 78b12; 78b15; 78b24; 79a4).

> "When we seek the fact or if something is without qualification, we are seeking whether or not there is a middle term for it. And when, having come to know either the fact or if it is – either partially or without qualification –, we again seek the reason why or what it is, we are then seeking what the middle term is. (…) Thus it results that in all our searches we seek either if there is a middle term or what the middle term is. For the middle term is the *aition*, and in all cases it is this which is being sought."

The middle term must pick out whatever is responsible for the connection between the two terms it mediates. In this way, the middle term clarifies the causal relation between the two terms by providing the real cause (and not merely the epistemic reason) of why the one extreme term holds of the other. I therefore translate the noun *to aition* as cause.[21]

The term *hê aitia* is used less frequently in the *Posterior Analytics*, and is usually part of the definition of scientific knowledge. Scientific knowledge is always knowledge of *hai aitiai*.[22] For instance, in *APo*.I.2, 71b20-33 Aristotle first picks up on his definition of scientific knowledge as being knowledge of the *aitia* of something, and then continues by stating that this knowledge can be reached through things that are, among other things, *aitios* of the conclusion:

> εἰ τοίνυν ἐστὶ τὸ ἐπίστασθαι οἷον ἔθεμεν, ἀνάγκη καὶ τὴν ἀποδεικτικὴν ἐπιστήμην ἐξ ἀληθῶν τ' εἶναι καὶ πρώτων καὶ ἀμέσων καὶ γνωριμωτέρων καὶ προτέρων καὶ αἰτίων τοῦ συμπεράσματος· (...) αἴτιά τε καὶ γνωριμώτερα δεῖ εἶναι καὶ πρότερα, αἴτια μὲν ὅτι τότε ἐπιστάμεθα ὅταν τὴν αἰτίαν εἰδῶμεν.
>
> "If then to have <scientific> knowledge of something is what we have posited it to be, then demonstrative knowledge in particular must proceed from [items which are] true and primitive and immediate and more familiar than and prior to and *aitios* of the conclusions. (…) They [the items that are constitutive of demonstrative understanding] must be *aitios* and more familiar and prior – *aitios* because we only understand something when we have knowledge of *hê aitia* (…)."

Other passages[23] point out that Aristotle conceives of these *aitiai* as being larger linguistic or syllogistic formulas that state the reason why in answer to the question

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[21] See, for example, 78b17; 85b22; 94b8; 94b18; 95b20; 95b28; 98a35-b3; passim in 98b17-99b13.
[22] See 71b9-13; 71b30-31; 87b40; and 94a21-7.
[23] See, for example, *APo*.I.13, 78b28-31; in this passage, Aristotle compares explanations in Camestres to explanations in which the middle terms are set too far away: "Explanations (*aitiai*) of this kind resemble *extravagant statements* (*tois kath' huperbolên eirêmenois*), i.e. when you argue by setting the middle term too far

'why' (*to dioti* or *to dia ti*).[24] At least within the *Posterior Analytics* it is thus implied that *hê aitia* itself is a kind of *logos* or *syllogismos* containing an explanatory middle term, where *to aition* is a subordinated element of *hê aitia*.[25] I therefore translate the term *hê aitia* with such terms as 'causal account' or 'explanation',[26] and the adjective *aitios* as either 'causative' or 'explanatory' depending on the context.

Assuming that this semantic distinction between *aition* and *aitia* illustrates a philosophical distinction between the type of causality that is revealed through the middle term and the type of causality picked out by the middle term, I will now present a new reading of *APo.*II.11.

## 5.2 Towards a new reading of *Posterior Analytics* II.11

### *5.2.1 Making sense of the opening statement and the examples in APo.II.11*

In his opening statement of the chapter, Aristotle first recapitulates his definition of scientific knowledge. That is, we know something when we know its explanation, which is the syllogistic formula stating the *aition* of the state of affairs to be explained. He then specifies four kinds of explanations, which are formulated as four different questions as to the reason why (formal explanation is an explanation of *what* is it to be a thing; material explanation is an explanation of *given what* things being the case it is necessary for that to hold; efficient explanation is an explanation of *what* initiated the movement; and teleological explanation is an explanation of the for the sake of *what*). As the 'since' (*epei de*) indicates, this should all be common knowledge.

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away. Take for example, Anacharsis' [argument] that there are no flute-girls among the Scythes since there are no vines."

[24] These explanations of the reason why, picking out *to aition* through the middle term (cf. 78b12-34; the term *hê aitia* occurs in 78b24 and 78b28; 85b23-27 and 85b35-36). In 93b33, *hê aitia* indicates a non-syllogistic causal account.

[25] One might object that in *APo.*I.24, 85b24-27 Aristotle uses the expressions 'of the *aitia* and of the *dia ti*' and 'of the *aition* and of the *dia ti*' interchangably. However, the first expression applies to the nature of the demonstrative syllogism (what is demonstrated is the explanation and the reason why), while the second applies to the nature of the universal premise, which is more explanatory in the sense that it shows the *aition* more clearly (cf. *APo.*I.31, 88a5-6).

[26] Cf. Moravcsik (1974), 3: "*aitia* are whatever answers a 'why'-question, and whatever answers a why-question is an explanation."

The new information is that all of these explanations are brought out through the middle term. This is the process of demonstration: the explanations of the reason why (*to dioti*) are demonstrated through middle terms which explain why the predicate holds of the subject in the conclusion. The middle term thus reveals a causal connection underlying the *per se* relation between these two terms.[27] The point is that it is only by setting out the whole syllogism and thereby expressing explicitly the cause of why the predicate holds of the subject term that we come to reach true understanding of a phenomenon.

Aristotle then works out three examples of explanations (material, efficient, and final) that are brought out through the middle term. Aristotle gives no separate example of formal explanation, supposedly because that "that has already been proven" (*APo.*II.11, 94a35-36) in earlier chapters.[28] For the sake of completeness, I will supply a formal cause explanation from an earlier chapter in my discussion below.

### *5.2.2 Examples of different types of explanations*

My reconstruction of the four examples and their formalizations into syllogisms is as follows:

**Example 1: Material Explanation** (*APo.*II.11, 94a27-35; cf. Euclid, *Elements* III.31)

Explanandum: i. [Why (*dia ti*) is there a right angle?] [Why A?]

ii. Why (*dia ti*) is the angle in a semicircle a right angle? [Why A of C?]

A = right

B = half of two rights (*aition* = *material cause*)

C = angle in a semicircle

AaC because of B: right holds of the angle in a semicircle because of being half of two rights.

[27] In *APo.*I.4, 73a10-17 Aristotle explicates the *per se* relation in terms of causation, i.e. as something holding because of itself (*di'hauto*). Freeland (1991), 58-60 takes this as evidence for reading Aristotle as a causal realist.

[28] I take Aristotle to refer to the demonstrations of the reason why set out in chapter II.8, which is part of his larger investigation into the relation of definition and causal explanations in chapters II.8-10.

**Example 2: Formal Explanation** (*APo.*II.8, 93b8-13)

Explanandum: i. What is thunder? [What is A?]

ii. Why (*dia ti*) is there noise in the clouds? [Why A of C?]

A = thunder (a sort of noise)

B = extinction of fire (*aition* = *efficient cause*)

C = cloud

AaC because of B: thunder is noise in the clouds because of fire being extinguished.

**Example 3: Efficient Explanation** (*APo.*II.11, 94a36-b8):

Explanandum: i. [Why (*dia ti*) is there a Persian war?] [Why A?]

ii. Why (*dia ti*) did the Persian war come upon the Athenians? [Why A of C?]

A = war

B = being the first to attack (*aition* = *efficient cause*)

C = Athenians

AaC because of B: being warred upon holds of the Athenians because of being the first to attack.

**Example 4: Teleological Explanation** (*APo.*II.11, 94b8-26):

Explanandum: i. Why (*dia ti*) does he walk? [Why C?]

A = being healthy

B = food not floating (*aition* = *material cause*)

C = walking after dinner

AaC because of B: being healthy holds of walking after dinner because of the food not floating.

Before turning to an analysis of these examples, let me state from the outset that contrary to the traditional interpretation I see no decisive indications in the text as to why Aristotle should only be concerned with syllogisms in the Barbara mood. I submit that the introduction of the four types of explanations in *APo.*II.11 rather shows that Aristotle is concerned with laying out a general syllogistic structure in which *every* causal relation can be fit. Reading the chapter in this way, the contingency and singularity of the examples noted by various critics of Aristotle need no longer constitute a lingering problem. They can be accounted for within the

larger framework of causal relations Aristotle is interested in, and so can the other examples Aristotle mentions in the remainder of the chapter (*APo.*II.11, 94b27-34).[29]

#### *5.2.2.a The example of material explanation*

The first example on material explanation is developed in the context of a discussion of the necessary nature of demonstrative syllogisms (*APo.*II.11, 94a24-27).[30] The example can be analysed as follows (see also figure 1 below). The *dia ti* question Aristotle poses is 'because of what the angle in a semicircle is a right angle.' An adequate explanation should thus state the geometrical proof showing 'that out of which' it follows that the angle in a semicircle is right. This example of material explanation in fact reflected in a theorem from Euclid (*Elements* III.31), and the proof might do so as well.

Here Aristotle induces the search for the middle term by rephrasing the question explicitly in terms of material necessity: "given what being the case is it a right angle?" What we are looking for is a condition that necessitates the rightness of the angle in a semicircle – a condition, incidentally, that will be immediately evident once the right mathematical figure has been discovered (cf. *Met.*IX.9, 1051a22-28). Aristotle then formalizes the explanation, while introducing 'half of two rights' as the middle term (B) that explains why 'right' (A) holds of 'angle in a semicircle' (C).

The rationale Aristotle offers in this section is somewhat obscure, but is not too problematic once we presuppose the familiarity of Aristotle's readership with the relevant mathematical figure and the proof of the proposition as we know it from Euclidean geometry (Aristotle hints at both of them in the above mentioned passage in *Met.*IX.9). Important in this proof is that the geometrical relations between 'right angle' and 'angle in a semicircle' are discovered by *division*.[31] It is this

[29] These latter examples are rather more fanciful than serious, such as the Pythagorean belief that it thunders in order to frighten the inhabitants of Tartarus, or report scientific views that Aristotle rejects elsewhere, such as the explanation of thunder as being fire that is being extinguished in the clouds (this explanation is explicitly rejected in *Mete.*II.9, 369b12-24) or the theory that light is a fine grained substance capable of passing through porous bodies (this theory does not seem to belong to Aristotle). For an assessment of these kinds of examples, see Wians (1996), 137.

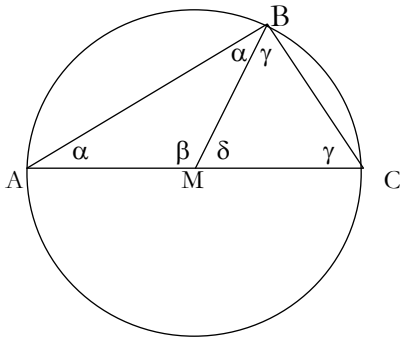
[30] Here Aristotle states that, given a middle term shared by two propositions, it is necessary for the conclusion of the syllogism to hold. The middle term, or the two premises taken as one, literally bring about the conclusion, and are therefore in a sense the material causes of the conclusion (cf. *Ph.*II.3, 195a18-19).

[31] Cf. *Met.*IX.9, 1051a22-23: mathematical figures, too, are discovered by actualization; for they find them by dividing [the figures] (*diairountes*).

division that Aristotle refers to when claiming that "[the term B] is equal to A, and C to B, because it [C] is of two rights – half.[32] It is this 'being half' that necessitates the angle in a semicircle being a right angle. In addition, Aristotle claims that B holds of A because 'being half of two rights' is a definition of 'a right angle.' In sum, the angle in a semicircle is thus a right angle because it is half of two rights; 'being half of two rights' is the material cause of 'right' holding of 'the angle in a semicircle.' The angle in a semicircle is by material necessity a right angle *given that it is two rights – divided in half*.

In this case, both the causation expressed by the explanation and the explanatory middle term that brings out this explanation are of the material type.

*Figure 1: Material Explanation*




Demonstration: ∠ABC = 90°
∠MAB = ∠MBA (α)
∠MCB = ∠MBC (γ)
(i.) β + δ = 180°;
(ii.) 2α + β = 180°;
2γ + δ = 180°
(iii.) 2(α + γ) + β + δ = 360°
(iv.) 2(α + γ) = 180°
(v.) α + γ ('the angle in a semicircle') = 180° ('two rights') divided by 2 ('half') = 90° ('right')

*5.2.2.b The example of formal explanation*

The second example, on formal explanation (taken from *APo*.II.8, 93b8-13), can be analysed as follows. The *dia ti* question Aristotle poses is why there is thunder. This is a reformulation of the question 'what is thunder', which is a question for the definition of thunder (Aristotle answers the 'what is'-question by stating that it is the extinction of fire in cloud, which is not a demonstration of the essence of thunder yet). For Aristotle, the question why there is thunder is equivalent to the question what thunder is, except that the first is a question for a demonstration and the latter

[32] Note the word order in the Greek: while B is defined as ½-2R (94a29: *hêmiseia duoin orthain*; 94a32-33: *ontos hêmiseos duo orthôn*), C is explained as 2R-½ (94a32: *duo gar orthôn hêmiseia*).

for a definition.[33] An adequate explanation of why there is thunder thus needs to be a formal explanation expressing the essence of thunder through a middle term that brings out this essence.

However, as Aristotle indicates in another text where he discusses the same example (*Met.*Z.17, 1041a24-32),[34] the only way to get a demonstration is by converting the explanandum into a predicative relation.[35] This can be done in the first place by taking the nominal definition of thunder (as being 'a sort of noise in the cloud'; *APo.*II.8, 93a22-23). In the second place by turning the request for a definition into a *dia ti* question for a demonstration, in which the object of inquiry is 'a something of something else' (i.e. why is there thunder in the clouds). Because the explanation in this case is already known (i.e. thunder comes about through the extinction of fire in the cloud), Aristotle sets out immediately to formalize the example: the subject term (C) is 'cloud'; the middle term (B) is 'extinction of fire'; and the predicate term (A) is 'thunder'. From this it follows that B holds of C, because the extinction of fire takes place *in* the cloud (the cloud is the locus in which the phenomenon typically resides), and that A – 'thunder' (i.e. a sort of noise) – holds of B, because B is a definition of A.

In this case, the explanatory middle term picks out an efficient cause of why there is thunder or noise in the clouds: the origin of motion of the noise lies in the extinguishing of fire. It is through this efficient cause that the essence of thunder and thereby the formal explanation of why there is thunder are revealed: thunder is noise in the clouds caused by fire being extinguished.[36]

#### *5.2.2.c The example of efficient explanation*

The third example of efficient explanation (*APo.*II.11, 94a36-b8) is fairly straightforward. Here Aristotle picks a historical example in asking why it is that the Persian war came upon the Athenians, rephrased as what the explanation is for the

[33] See *APo.*II.10, 94a1-8: "[One type of definition] will clearly be like a demonstration of what something is, differing in arrangement from a demonstration. For there is a difference between saying why it thunders and saying what thunder is. In answering why you will say 'because the fire is extinguished in the clouds'. But if you ask 'what is thunder?', you will say, 'a noise of fire being extinguished in the clouds'. Hence the same account is given in different ways: in one way it is a continuous demonstration, in the other a definition."

[34] For thunder-examples in *APo.* and *Met.*, see Charles (1999), 233-235; 238-239.

[35] Lennox (2004), 90n2.

Athenians being warred upon. As in the other examples, it is not clear from the outset which type of explanation will be demonstrated.[37] However, the short explanation Aristotle offers first ("because the Athenians attacked Sardis with the Eretrians") points to the type of demonstrative explanation Aristotle is looking for: he is looking for some state of affairs that initiated the movement, which is an efficient cause (and not for that for the sake of which, such as the desire of the Persians to gain an empire). Aristotle then formalizes the example in the following way: "War, A; being the first to attack, B; Athenians C." It is significant that Aristotle here adds the notion of 'first' to the attack: it is being the *first* to do wrong that is explanatory for being wronged, and this is the origin of motion.

In this case, the middle term picks out the efficient cause of why war came upon the Athenians: for "people make war on those who first began," which is why being warred upon holds of those who first began. The Athenians were the ones who first began (they fall under this formal description), and this explains the origin of the Persian war.[38]

#### *5.2.2.d The example of final explanation*

Aristotle introduces the section on final explanation (*APo.*II.11, 94b8-26) with a somewhat puzzling clause: "*hosôn d'aition to heneka tinos*." From what follows it is clear that the explanations that are at stake here are teleological ones: Aristotle gives two parallel examples ("For what reason does he walk? In order to be healthy. For what reason is there a house? In order to protect possessions."), and identifies the final cause or the purpose in each example ("In the one case it is in order to be healthy, in the other in order to protect."). He also explains that in these cases there is no difference between a 'because of what' question and a 'for the sake of what' question. However, it is not immediately clear whether or not Aristotle means that the final cause has to be picked out by the middle term.

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[36] Charles (1999), 239; Lennox (2001), 141.

[37] A similar example in *Ph.*II.198a18-19 ("[for the why ultimately leads back either] to the first source of motion, e.g. why did they go to war? Because they were plundered, or to that for the sake of which, e.g. in order to rule") points out that the question why there is war can be answered in different ways.

[38] Note that in all three examples the primary explanandum is the occurrence of a certain phenomenon (i.e. 'rightness', 'thunder', and 'war') that can be expressed in a predicative relation with a subject in which the phenomenon typically and for the most part inheres (i.e. 'angle in a semicircle', 'cloud', and

The introductory clause (*APo.*II.11, 94b8) has often been read as implying just that (i.e. that in these cases the cause is that for the sake of which), but it does not have to be read in this way. The Greek has *to heneka tinos*, which means something different from *to hou heneka.*[39] *To hou heneka* is the more common expression and is used more or less as a stock phrase designating the end (literally, 'that for the sake of which', in which *hou* is a relative pronoun).[40] *To heneka tinos/tou* designates rather the teleological relation of something being for the sake of something else (literally, that which is for the sake of something, where *tinos* is a indefinite pronoun). In this expression, the '*to'* is not used as a definite article to substantivate the prepositional phrase, but to identify whatever is for the sake of something, or the relation as such.[41]

Under this interpretation, the point Aristotle makes here is not that the explanatory middle term in this case is the final cause, but that the causal relation involved is teleological, and that the middle term must pick out something that explains how something is for the sake of something. The teleological explanation is brought out through a middle term that need not itself be a final cause, but that rather shows how an end can hold of something. This causal relation is then illustrated by the two examples: walking is for the sake of health, and a house is for the sake of protection. The middle term that we are looking for needs to pick out a state of affairs that shows why this teleological relation between walking and being healthy obtains.

In a simplified version of the demonstrative syllogism, the predicate term (A) is being healthy, the middle term (B) is the food not floating, and the subject term (C) is walking after dinner. In this case, the middle term picks out the material cause of why being healthy holds of walking after dinner, because it identifies the physiological condition that is healthy – a condition that itself is initiated by walking

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'Athenians'). In the demonstration that follows what is revealed is that there is always some aspect of this subject that explains the holding of its attributes.

[39] See, e.g., Apostle (1981), 59: "Lastly, there is a final cause [or, that for the sake of which]"; Barnes (1993), 60: "suppose it is the purpose which is explanatory".

[40] See, e.g. *Ph.*II.2, 194a27-30 "Further, that for the sake of which (*to hou heneka*), or the end, as well as whatever is for the sake of these (*hosa toutôn heneka*), belong to the same study. But nature is an end and a that for the sake of which (*hou heneka*)" and *Cael.*II.12, 292b6-7: "for action always consists in two factors, when there is that for the sake of which (*hou heneka*) and that which is for the sake of something (*to toutou heneka*)."

[41] Cf. *Ph.*II.5, 196b17-22); *DA.*434a32; *GA.*715a4; *GA.*778b13; *MA.*700b26-27; and *Met.*1065a31.

that brings about health as an efficient cause.[42] For the identification of 'the food not floating' as a material cause, compare Aristotle's qualification of the boiling of the blood surrounding the heart as a material cause of anger in *DA*.I.1, 403a25-b1.

In all four examples, the different explanations that are at stake are revealed through the middle term, which picks out a cause for the holding of the predicate term of the subject term. However, in my analysis of the example of teleological explanation, I have left two important questions unanswered. First, if Aristotle did not intend the final cause to be picked out by the middle term, what does he mean by 'changing the *logoi*'? Secondly, one might wonder what it is about this example – or about teleological explanations in general – that makes it so hard to rewrite the demonstrations in such a way that the final cause is actually picked out by the middle term. The following sections address these questions.

### *5.2.3 Teleological explanations and what it means to metalambanein tous logous*

#### *5.2.3.a Why walking is for the sake of health*

The argument of the section on final causes is fairly long compared to the illustration of the other types of explanation, and it proceeds in a quite complicated way. Here I will first separate the different steps in the argument and give a detailed interpretation of each; next, I will propose two possible interpretations of *metalambanein tous logous*. Let me start by introducing the way Aristotle originally formulates the terms of the explanation (see table 1 below):

*Table 1: The original formulations of the terms*

| | | | | |
|---|---|---|---|---|
| $A_1$: | Being healthy | *to hugiainein* | Condition | Final cause |
| $B_1$: | The food not floating | *to mê epipolazein ta sitia* | Condition | *Aition* |
| C: | Walking after dinner | *peripatos apo deipnou* | Activity | Explanandum |

For the sake of clarity, I also add the alternative formulations of the terms that Aristotle uses during the argument (see table 2 below).[43]

[42] As Bolton (1997), 113-115 suggested.

*Table 2: The alternative formulations of the terms*

| | | | |
|---|---|---|---|
| $A_2$: | Healthy | *hugieinos* | Productive of condition |
| $B_2$: | To make the food not floating | *to poiein mê epipolazein ta sitia* | Activity productive of condition |

The argument that follows the distribution of the terms proceeds in roughly the following four steps. First Aristotle asks us to suppose that to make the food not floating ($B_2$), holds of C, walking after dinner, and that this is healthy ($A_2$). Note that Aristotle changes the formulations of the terms A and B, presumably to show that walking (which is an activity) holds of another activity that produces the condition of the non-floating of food. It is this latter activity that Aristotle calls healthy, for healthy is just that which produces (or is useful to) the condition of being healthy. This is in fact the way Aristotle characterizes 'healthy' in the *Eudemian Ethics* (*EE*.I.8, 1218b16-22):

> ὅτι δ' αἴτιον τὸ τέλος τοῖς ὑφ' αὑτό, δηλοῖ ἡ διδασκαλία. ὁρισάμενοι γὰρ τὸ τέλος τἆλλα δεικνύουσιν, ὅτι ἕκαστον αὐτῶν ἀγαθόν· αἴτιον γὰρ τὸ οὗ ἕνεκα. οἷον ἐπειδὴ τὸ ὑγιαίνειν τοδί, ἀνάγκη τόδε εἶναι τὸ συμφέρον πρὸς αὐτήν· τὸ δ' ὑγιεινὸν τῆς ὑγιείας αἴτιον ὡς κινῆσαν, καὶ τότε τοῦ εἶναι ἀλλ' οὐ τοῦ ἀγαθὸν εἶναι τὴν ὑγίειαν.
>
> "And that the end stands in a causal relation to the means subordinate to it is shown by teaching. For, having defined the end they show, regarding other things, that each of them is a good, because that for the sake of which is causative. For example, since 'being healthy' is such and such a thing, then necessarily this other thing will be what is useful for it. And *what is healthy will be the efficient cause of health*, though only the cause of its being, but not of health being a good."

By characterizing walking as an activity that is productive of the food not floating, and the latter as being productive of health, Aristotle implies that C is an efficient cause of $A_1$, being healthy: walking is productive of a healthy condition (cf. *Rh*.I.6, 1362a31-34). Walking and health are thus causes of each other: while walking is the efficient cause of health, health is the final cause of walking (cf. *Ph*.II.3, 195a8-11). Now, if walking is a health-producing activity, it remains for the teleological demonstration to exhibit why it is that walking effects a change that is directed

[43] I will retain the numbering in my discussion of the example on teleological explanation; where it is not clear which formulation Aristotle has in mind the term is not numbered.

towards health. Accordingly, Aristotle continues the argument (and this is step two) by explaining that it is thought that $B_1$, the material condition where the food is not floating on the surface, holds of C, walking, and healthy ($A_2$) holds of B ($B_1$). This opinion points towards the explanatory role of $B_1$.

Indeed, Aristotle now (in the third step of the argument) poses the question what the *aition* is that causally connects C, walking, and A, the 'that for the sake of which'.[44] The answer is $B_1$, the not floating. Aristotle adds that "this is like a definition of that (*APo.*II.11, 94b19-20)." Probably the first 'this' refers to $B_1$, the not floating, while 'that' refers to $A_1$, being healthy, "for", Aristotle explains, "in that way the A will be explained." The not floating of the food is like a definition of being healthy in the sense that it shows how being healthy in this context (i.e. in the context of a person who just had dinner) is to be understood. Part of what it means to be healthy in this case is to be in a condition where the food is not floating on the surface of the stomach.[45]

Finally, Aristotle turns to an account of the minor premise: "For what reason does B hold of C?" Aristotle answers that the reason is "because that is what being healthy is: to be in such a condition." The formulation of this response suggests that we have touched upon a premise that is not further analyzable but is immediately evident (i.e. the premise is immediate). At this point, Aristotle ends his discussion of this particular example of teleological explanation.

#### *5.2.3.b Two possible interpretations of metalambanein tous logous*

The section is completed by the enigmatic statement (Barnes called it the 'Delphic injunction')[46] that one needs to *metalambanein tous logous*, and that "in that way each of them will become clearer (*APo.*II.11, 94b21-22)." The traditional interpretation reads this sentence in an apologetic way: Aristotle realizes that his example on the final cause is ill-chosen and messy, and that by mistake the middle term does not pick out the final cause. In order to make sense of this example, we should therefore (stipulate that the terms are coextensive and) rearrange the order of the terms or of

[44] The apposition 'the for the sake of which' in *APo.*II.11, 94b18 belongs to A, not to the *aition.*
[45] As opposed to definitions of health as, for instance, having one's body in a uniform state (*Met.*VII.7, 1032b6-8) or having fasted for a wile (*Ph.*194b36).
[46] Barnes (1993), 229.

the premises in such a way that the middle term will pick out health as the final cause. However, I see two problems with this reading that strongly suggest that we should look for a different interpretation.

First, Aristotle spends quite some time explaining the example of teleological explanation, and it seems not very charitable to assume that this is not the example he actually would have liked to present to his readers. In fact, the explanation that walking is for the sake of health is a stock example in the Aristotelian corpus, and the rationale Aristotle provides for health holding of walking in this chapter is perhaps not entirely transparent, but very much in line with other accounts of the example. If my interpretation holds, then we might say that Aristotle succeeds quite well in demonstrating how the middle term, i.e. the food not floating, exhibits the teleological relation between walking and health. There is thus no need to rearrange the example.

Secondly, Aristotle uses the verb *metalambanein* as a technical term in the *Prior Analytics* and in the *Topics*, where it means without exception 'to substitute for'.[47] This suggests that we should expect *metalambanein tous logous* to mean something like 'substituting the *logoi* (for something else)'. In fact, the use of *metalambanein* as some kind of technical procedure of substitution in these texts presents two options for how to interpret the expression in the context of the *Posterior Analytics* and neither one of them implies a rearrangement of the example.

One possible interpretation[48] is that the substitution concerns the formulations (*logoi*) of the terms. This reading is based on Aristotle's use of *metalambanein* in chapter 34 of the first book of the *Prior Analytics* (*APr.*I.34, 48a1-27):

> πολλάκις δὲ διαψεύδεσθαι συμπεσεῖται παρὰ τὸ μὴ καλῶς ἐκτίθεσθαι τοὺς κατὰ τὴν πρότασιν ὅρους. (...) τούτου δ' αἴτιον τὸ μὴ καλῶς ἐκκεῖσθαι τοὺς ὅρους κατὰ τὴν λέξιν, ἐπεὶ μεταληφθέντων τῶν κατὰ τὰς ἕξεις οὐκ ἔσται συλλογισμός, οἷον ἀντὶ μὲν τῆς ὑγιείας εἰ τεθείη τὸ ὑγιαῖνον, ἀντὶ δὲ τῆς νόσου τὸ νοσοῦν. οὐ γὰρ ἀληθὲς εἰπεῖν ὡς οὐκ ἐνδέχεται τῷ νοσοῦντι τὸ ὑγιαίνειν ὑπάρξαι. τούτου δὲ μὴ ληφθέντος οὐ γίνεται

[47] Smith (1989), 137; 261. See *APr.*I.39, 49b3-6 ("One also needs to substitute things which have the same value for one another – words in place of words, phrases in place of phrases – whether a word or a phrase, and always to take a word in place of a phrase; for the setting out of terms will be easier."); but also *APr.*I.17, 37b15; *APr.*I.20, 39a27; *APr.*I.22, 40a34-35; *APr.*I.23, 41a39; *APr.*I.29, 45b12-20; *APr.*I.34, 48a1-27; *APr.*I.38, 49b1-2; *APr.*II.4, 56b7-8, and *APr.*II.8, 59b1-11; *Top.*II.2, 110a4-9; *Top.*V.2, 130a29-b10; *Top.*VI.4, 142b3, *Top.*VI.9, 147b12-14, and *Top.*VI.11, 148b24-149a7 (passim).

[48] Already suggested by Fortenbaugh (1966), 192.

> συλλογισμός, εἰ μὴ τοῦ ἐνδέχεσθαι· τοῦτο δ' οὐκ ἀδύνατον· ἐνδέχεται γὰρ μηδενὶ ἀνθρώπῳ ὑπάρχειν ὑγίειαν. (...) Φανερὸν οὖν ὅτι ἐν ἅπασι τούτοις ἡ ἀπάτη γίνεται παρὰ τὴν τῶν ὅρων ἔκθεσιν· μεταληφθέντων γὰρ τῶν κατὰ τὰς ἕξεις οὐδὲν γίνεται ψεῦδος. δῆλον οὖν ὅτι κατὰ τὰς τοιαύτας προτάσεις ἀεὶ τὸ κατὰ τὴν ἕξιν ἀντὶ τῆς ἕξεως μεταληπτέον καὶ θετέον ὅρον.
>
> "Mistakes frequently will happen because the terms in the premise have not been well set out. (...) The reason for this is that the terms are not set out well with regard to formulation, since if the terms for being in the conditions are substituted [for the terms for the conditions themselves], there will not be a deduction; for example, if instead of 'health' 'healthy' is posited, and instead of 'disease' 'diseased'. For it is not true to say that being healthy cannot hold of someone diseased. But if this is not assumed, there is no deduction, except in respect of possibility: and that is not impossible. For it is possible that health holds of no man. (...) It is evident then that in all these cases the fallacy results from the setting out of the terms; for if the terms for being in the conditions are substituted, there is no fallacy. Thus, it is clear that in such premises the term for being in the condition always needs to be substituted and posited instead of that of the condition itself."

In this passage, Aristotle deals with fallacies that occur when the terms of the syllogisms have not been set out well with regard to formulation (48a9: *kata tên lexin*).[49] The problem is solved by substituting terms 'for being in the conditions', that is, adjectives such as 'healthy' (*hugiainon*) and 'diseased', instead of the terms for the conditions themselves, that is, nouns such as 'health' (*hugieia*) and 'disease'.

We might postulate that a similar kind of substitution of the formulation of the terms has taken place in *APo.*II.11: the terms indicating the conditions are substituted by terms indicating what is in the condition, or rather, by terms indicating what is productive of the condition. We have seen that Aristotle substituted *hugieinos* ($A_2$) for *hugiaiein* ($A_1$), and *to poiein mê epipolazein ta sitia* ($B_2$) for *to mê epipolazein ta sitia* ($B_1$). Through these substitutions A and B could be predicated of C (a term indicating an activity), and also the causal relations (in this case, both material causal and efficient causal ones) between the three terms would become more evident.

[49] There is an interesting parallel for this method of *metalêpsis* in the ancient grammar tradition; see Sluiter (1990), 111ff.

A second possible interpretation[50] is that the substitution concerns the replacement of words by their definitions. This is the stock use of the expression in the context of the *Topics*, and accordingly, we should supply '*anti tôn onomatôn*' in the passage in the *Posterior Analytics*. One context in which the expression 'to substitute the definitions for the words' is used in the *Topics*, is in that of the fallacy of repeating the word that is being defined or predicated in the definition or predication. The failure pertains to not having used the prior or better known term in the definition or predication. The procedure of substituting definitions for words is one of the recommended ways to detect the fallacy (*Top.*VI.9, 147b12-14; *Top.*VI.4, 142a34-b6):

> Ἄλλος, εἰ αὐτῷ κέχρηται τῷ ὁριζομένῳ. λανθάνει δ' ὅταν μὴ αὐτῷ τῷ τοῦ ὁριζομένου ὀνόματι χρήσηται, οἷον εἰ τὸν ἥλιον ἄστρον ἡμεροφανὲς ὡρίσατο· ὁ γὰρ ἡμέρᾳ χρώμενος ἡλίῳ χρῆται. δεῖ δ', ὅπως φωραθῇ τὰ τοιαῦτα, μεταλαμβάνειν ἀντὶ τοῦ ὀνόματος τὸν λόγον, οἷον ὅτι ἡμέρα ἡλίου φορὰ ὑπὲρ γῆς ἐστιν· δῆλον γὰρ ὅτι ὁ τὴν φορὰν ἡλίου ὑπὲρ γῆς εἰρηκὼς τὸν ἥλιον εἴρηκεν, ὥστε χρῆται τῷ ἡλίῳ ὁ τῇ ἡμέρᾳ χρησάμενος.
>
> "Another [failure] is, if one has used the term defined itself. This passes unnoticed when the actual name of the object being defined is not used, e.g. supposing anyone had defined the sun as a star that appears by day. For in bringing in day he brings in the sun. To detect errors of this sort, substitute the definition for the word, e.g. the definition of day as the passage of the sun above the earth."

The expression is also used in the context of examining the correctness of definitions rendered of a complex term. For the definition to be correct, the words of the complex term have to be substituted by the definitions of the words (*Top.*VI.11, 149a1-3). The substitution of definitions of words used in definitions also helps to clear up whether or not the predications hold non-accidentally (*Top.*II.2, 110a4-9):

> λαμβάνειν δὲ καὶ ἀντὶ τῶν ἐν τοῖς λόγοις ὀνομάτων λόγους, καὶ μὴ προαφίστασθαι ἕως ἂν εἴς τι γνώριμον ἔλθῃ· πολλάκις γὰρ ὅλου μὲν τοῦ λόγου ἀποδοθέντος οὔπω δῆλον τὸ ζητούμενον, ἀντὶ δέ τινος τῶν ἐν τῷ λόγῳ ὀνομάτων λόγου ῥηθέντος κατάδηλον γίνεται.
>
> "One should substitute definitions also for the words contained in the definitions, and not stop until one comes to something familiar; for often when the definition is

[50] This interpretation was suggested to me by Pieter Sjoerd Hasper in personal correspondence.

> given as a whole, the thing looked for is not cleared up, whereas if for one of the words used in the definition a definition be stated, it becomes obvious."

Under this interpretation, we need to replace the words set out in the syllogism – such as 'walking', or 'being healthy' – by their definitions (perhaps just as Aristotle did himself), until we find the more familiar terms,[51] and in that way the predications will become clearer. A striking parallel is provided by Galen, who – plainly following Aristotle – uses *metalambanein* in this exact same way while discussing scientific demonstrations.[52]

The elliptical expression of *metalambanein tous logous* might not provide us with sufficient information to decide which of the two possible interpretations we should favor, but this problem need not concern us too much. Both uses seem to be at play in the *Posterior Analytics* context: Aristotle probably meant some technical procedure of substitution that he applied himself in discussing the example, through which the causal relations between the terms and the predications became more evident.

### *5.2.3.c Ends cannot be picked out by middle terms*

If my interpretation is right, then Aristotle has offered us an example of teleological explanation where the middle term picks out a material cause, while the final cause is picked out by the predicate term. This leaves us with the question why Aristotle did not simply provide us with an example of teleological explanation where the middle term picks out a final cause.

I believe that Aristotle indirectly addresses this question in the passage where he brings up the order of causation in different types of demonstrations (*APo.*II.11, 94b23-26):

> αἱ δὲ γενέσεις ἀνάπαλιν ἐνταῦθα καὶ ἐπὶ τῶν κατὰ κίνησιν αἰτίων· ἐκεῖ μὲν γὰρ τὸ μέσον δεῖ γενέσθαι πρῶτον, ἐνταῦθα δὲ τὸ Γ, τὸ ἔσχατον, τελευταῖον δὲ τὸ οὗ ἕνεκα.

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[51] This type of substitution might be connected to the one Charles observes in the *Posterior Analytics* with regard to the example of thunder: in this example the predicative term 'thunder' is replaced by its nominal definition 'noise in the clouds', which both gives us more familiar terms and indicates how thunder is to be understood in the relevant syllogism. See Charles (1999), 240.

[52] See Galen, *De Methodo Medendi* X.39, 5-10: Καί σοι τὸν ἑξῆς λόγον ἤδη ἅπαντα ποιήσομαι, χρώμενος ταῖς μεθόδοις ἃς ἐν τοῖς περὶ τῆς ἀποδείξεως ὑπομνήμασι κατεστησάμην. ὅτι τε γὰρ ἀρχαὶ πάσης ἀποδείξεώς εἰσι τὰ πρὸς αἴσθησίν τε καὶ νόησιν ἐναργῶς φαινόμενα καὶ ὡς ἐπὶ πάντων τῶν ζητουμένων εἰς λόγον χρὴ μεταλαμβάνεσθαι τοὔνομα ("that with regard to every inquiry one needs to substitute the definition for the word"), δι' ἐκείνων ἀποδέδεικται· I am grateful to Jim Hankinson for bringing this parallel to my attention.

> "Here the events occur in the opposite order from the cases where the causes are according to motion. For in the latter the middle term must occur first, while here C, the ultimate term, [must occur first] and last the for the sake of which."

In this passage Aristotle contrasts the order of causation in demonstrations of efficient causal explanations with those of teleological explanations. As we saw earlier, the middle term in the example of efficient explanation (i.e. being the first to attack) picked out an event that *later* initiated the war against the Athenians. The explanatory efficient cause thus precedes the explanandum in time. However, in the example of teleological explanation, we saw that the action picked out by the subject term (i.e. walking) occurred first. The final cause, health, came about last. It seems that in teleological explanations the final causes are literally, in a temporal sense, the *telos* or the end (and culmination) of the events to be explained.

In later discussions of the temporal relations between the three terms (*APo*.II.12 and *APo*.II.16), Aristotle puts forward the requirement that the state of affairs picked out by the middle term must be simultaneous with the states of affairs it explains.[53] However, in case of events that come about consecutively (*APo*.II.12, 95b13: *ephexês*), the middle term must be chronologically prior to the states of affairs it explains. As Aristotle points out (*APo*.II.12, 95b33-38), there is no difference in demonstration between the two cases.[54]

The upshot of these passages is that, given that demonstrations are to reflect the order of causation in the real world,[55] final causes of events cannot be picked out by the middle term, but must always be part of the conclusion that is demonstrated. Since an efficient cause of an event typically occurs before the event itself, the efficient cause can be picked out through the middle term as being causally prior of what needs to be explained. The final cause of an event – although being logically prior – typically occurs in actuality after the event itself already has taken

[53] See mainly *APo*.II.12, 95a22: "that which is causative in this way and that of which it is a cause come to be simultaneously (*hama ginetai*)," and *APo*.II.12, 95a36-37 where it is argued that the middle term must be *homogonos* with the state of affairs it explains.

[54] The coming to be of a house, for instance, is demonstrated through a middle term that picks out a state of affairs that is chronologically prior to the explanandum: that is, the earlier coming to be of a foundation. See *APo*.II.12, 95b38: *estai themelion proteron*.

[55] Cf. Charles (2000), 198-204 on the dependence of the practice of definition on the order of causation in the *Posterior Analytics*.

place and the necessary prerequisites have been fulfilled.[56] The demonstration then shows how the events to be explained actually bring about the end that constitutes the final cause.[57] This is exactly what Aristotle has shown us, namely that the action of walking actually leads to health, because walking is what makes the food not floating, and being in a condition of having the food not floating is what being healthy is. On this account, ends are part of the conclusion that needs to be demonstrated, and cannot be picked out by the middle term through which the conclusion is demonstrated.

The question I will focus on below is how this picture of the structure of teleological explanations as described in the *Posterior Analytics* relates to the structure of actual teleological explanations offered by Aristotle in his *Parts of Animals*. I will first turn briefly to Aristotle's discussion of demonstration in the natural sciences, and then analyse three predominant types of explanations involving final causes that Aristotle uses in his biology. Without going into too much detail, it will be shown that the actual teleological explanations illustrate our findings about the theory of explanation rather well.[58]

## 5.3 Teleological Explanations in Theory and Practice: Evidence from *De Partibus Animalium*

### *5.3.1 Demonstration in the natural sciences and conditional necessity*

Aristotle discusses the question of demonstration in the natural sciences in the first book of *PA*: the modes of demonstration in the theoretical sciences and in the

[56] This might explain why in the case of the teleological explanation in *APo.*II.11 the explanandum is picked out by the subject term ('why does walking after dinner occur?'), rather than by the predicate term as in the other three types of explanation.
[57] Cf. Natali (2001), 95-100.
[58] This question touches upon the important debate on the relation between the ideal of scientific investigation and demonstration set out in the *Posterior Analytics* (the 'theory') and the methodological reflections and actual explanations Aristotle offers in his treatises on natural science (the 'practice'). Although I cannot defend my position here, I am more sympathetic to the approach defended by, amongst others, Lennox (1987a, 2001a, 2001b, 2001c) and Gotthelf (1987), who hold that Aristotle builds upon and elaborates his scientific standards for the different sciences, than to the approach defended by, amongst others, Lloyd (1996), who argues that Aristotle is a methodological pluralist, and that theory and practice cannot be reconciled with each other.

natural sciences are different, because the modes of necessity are different (*PA*.I.1, 640a3-6):

> Ἡ γὰρ ἀρχὴ τοῖς μὲν τὸ ὄν, τοῖς δὲ τὸ ἐσόμενον· ἐπεὶ γὰρ τοιόνδε ἐστὶν ἡ ὑγίεια ἢ ὁ ἄνθρωπος, ἀνάγκη τόδ' εἶναι ἢ γενέσθαι, ἀλλ' οὐκ ἐπεὶ τόδ' ἐστὶν ἢ γέγονεν, ἐκεῖνο ἐξ ἀνάγκης ἐστὶν ἢ ἔσται.
>
> "For the starting point is in some [i.e. the theoretical sciences] that what is, but in others [i.e. the natural sciences] that what will be. For, 'since health or man is such, it is necessary that this is or comes to be,' but not 'since this is or has come about, that from necessity is or will be."

As usual, Aristotle identifies the mode of necessity operative among natural perishable things as conditional necessity, which Aristotle here explains as the necessity of certain things having to come to be on account of the end being as it is. Again, because demonstrations of the reason why have to reflect the true order of causality, the necessity that governs deductions of natural phenomena has to be conditional, too:[59] if the end is to be or is (such and such), then its necessary prerequisites have to come to be or be present first (or, in other words, its necessary prerequisites cannot not be). The deduction is not of the consequences of a certain starting point, but of the antecedents of the end.[60] The demonstration that results is not as strong as the demonstrations of the theoretical sciences, because the physiological or material-efficient prerequisites (though all in some sense being conditionally necessary for the end) do not ensure[61] the coming to be of the end. Of course, for the most part, and if nothing impedes, they *will* bring about the end.

These remarks about the nature and structure of demonstrations in the natural sciences present the following picture of what these demonstrations in practice would look like (cf. table 3 below). First of all, it needs to be noted that the predominant form of demonstration is teleological demonstration. What needs to be demonstrated in the context of the *PA* is mainly why certain functions belong to the parts whose presence these final causes explain. The final cause of something is the realisation of the form of that thing, and this is something that chronologically

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[59] Cf. *Ph*.II.9, 200a19-22: "But in things which come to be for an end, the reverse is true. If the end is to exist or does exist, that also which precedes it will exist or does exist; otherwise just as there, if the conclusion is not true, the principle will not be true, so here the end or that for the sake of which will not exist."

[60] Lloyd (1996), 32.

comes to be last. At the same time, this final cause is taken as a (heuristic and observational) starting point, presumably as a part of the conclusion of the demonstration. Next, one has to work one's way back to the conditionally necessary antecedents, which the realisation of this end demands. These antecedents will be exhibited by material or efficient causes (or both) that are directed towards this final cause,[62] and as such will be picked out by the middle term.

*Table 3: Suggested structure of teleological explanations in Parts of Animals*

| | | |
|---|---|---|
| Predicate term | Function, goal | P explains presence of S |
| Subject term | Part (of animal), process | Explanandum: why S? |
| Middle term | Conditionally necessary antecedents | Explanans of why P holds of S |

This picture is largely consistent with the example of why one walks after dinner in *APo.*II.11. The question why one walks after dinner parallels the biological question why for instance a certain part is present in a certain animal. The question is answered by identifying the final cause: in the case of walking, health; in the case of biological parts, the function of that part. In both cases the middle term will have to pick out the conditionally necessary antecedents that for the most part will bring about the end that constitutes the final cause.

This general picture can be confirmed through a comparison of the 'theory' with the three most common types of teleological explanation (analyzed in section 3.2) that Aristotle actually provides in *PA.*

### *5.3.2 The place of final causes in actual teleological explanations*

#### *5.3.2.a The explanation of the presence of parts: final cause is subsumed under the formal cause*

The most common question in Aristotle's *PA* is as we have seen why a certain animal has a certain part, and Aristotle typically answers this question by pointing out the function that part plays within the particular animal kind that has that part.

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[61] This is because, as Aristotle explains, the necessity involved does not convert: it is not possible to say that 'since this is, therefore that is or will be.' See *PA.*I.1, 640a6-9 and *GC.*II.11.

[62] As Lloyd rightly points out, the antecedents that are deduced are antecedents of the final cause in a chronological or ontological sense, not in a logical one; see Lloyd (1996), 32.

The presence of parts is thus explained teleologically through reference to their function, but in many cases the presence of these functions themselves is explained by reference to the definition of the substantial being of the animal.

Let me explain this by giving an example. The question why birds have wings is answered by reference to the function of flying as a part of the definition of the substantial being of birds: birds are essentially fliers, and fliers necessarily have wings.[63] In a formalization of this example, the middle term would be 'fliers' (which picks out a functionally defined essence), not 'flying' (which picks out the function or final cause). It is this definition of the substantial being of birds that is taken to be explanatorily basic, and which is thus picked out to explain why certain parts with certain functions hold of certain animal kinds.[64] From the definition of birds as blooded fliers not only the presence of wings can be demonstrated, but also many of the bird's other features, like for instance the having of two feet (rather than four, or six; see *PA*.IV.12, 693b2-13).

Additionally, Aristotle sometimes explains the presence of parts in subspecies by reference to the functions that are part of the definition of the substantial being of the wider kind. The fact that birds are essentially flyers explains according to Aristotle why ducks have wings for the sake of flying. Here, the functions (the final causes) tend to be subsumed under the essence (the formal cause) of the animal or its wider kind. Wings belong to ducks because ducks are essentially birds.

In these cases, functions and goals are picked out by the predicate term and only indirectly through the middle term as being part of the definition of the substantial being of something – that is, as being included in the formal cause.[65] Final causes of parts are demonstrated to hold of parts through the functionally defined substantial being of an animal, and it is this formal cause that is explanatorily basic.

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[63] See, for example, *PA*.IV.12, 693b10-14: "for the substantial being of the bird is that of the blooded animals, but at the same time that of the winged animals (…); and the ability to fly is in the substantial being of the bird." Cf. *PA*.IV.13, 697b1-13 and *PA*.III.6, 669b8-12.

[64] Gotthelf (1987), 190-191.

[65] Cf. *Ph*.II.9, 200a14: "necessity is in the matter, while that for the sake of which is in the definition (*logos*)."; *PA*.I.1, 639b13-14: "Now it is apparent that first is the one we call for the sake of which; for this is a definition"; and *PA*.I.1, 640a33-35: "hence we must in particular say that since this is what it is to be a human being, on account of this it has these things; for it cannot be without these parts."

*5.3.2.b The explanation of differentiations of parts: differentiae are causally basic*

Another common question in *PA* is why a part has the structural and material properties it has in the particular animal that has it. Or, in other words, why the part is differentiated in the way it is in this particular animal, relative to other parts with the same name and approximately the same function in other animals.

Take the example of eyes: both birds and insects have eyes for the sake of vision, but birds have eyes made of fluid eye jelly, while insects have hard eyes. This material differentiation of eyes cannot be explained by reference to the function of vision as such, which only requires eyes to be made of some transparent stuff (the general function only explains the presence of parts, not their differentiations). Aristotle explains these differentiations by claiming that they are for the better: that is, they are for the sake of the functional optimization of that part within the particular animal kind (*PA*.II.2, 648a14-19):

> (...) ὑποληπτέον ἔχειν τὴν διαφοράν, τὰ μὲν πρὸς τὸ βέλτιον ἢ χεῖρον, τὰ δὲ πρὸς τὰ ἔργα καὶ τὴν οὐσίαν ἑκάστῳ τῶν ζῴων, οἷον ἐχόντων ὀφθαλμοὺς ἀμφοτέρων τὰ μέν ἐστι σκληρόφθαλμα τὰ δ' ὑγρόφθαλμα, καὶ τὰ μὲν οὐκ ἔχει βλέφαρα τὰ δ' ἔχει πρὸς τὸ τὴν ὄψιν ἀκριβεστέραν εἶναι.
>
> "They [i.e. parts] should be assumed to possess a differentiation, in some cases relative to what is better or worse, in other cases relative to each animal's functions and substantial being. For instance, two animals may both have eyes. But in one these eyes are hard, while in the other they are of fluid consistency; and while the one does not have eyelids, the other has it – both are for the sake of a greater accuracy of vision."

Aristotle thus explains the (relative) fluidity of the eyes of birds as being for the sake of *better* vision in birds: birds have fluid eyes to be better able to see. However, Aristotle explains this functional optimisation by reference to the specific nature, habitat, and needs of the animal in question. That is, the explanatorily basic features in these explanations are the four differentiae of the animal kind, which are the other parts (and functions) the animal has, the animal's *bios* (life-style and habitat), its activities, and its disposition. These four *differentiae* immediately necessitate the variation among parts through conditional necessity. The *differentiae* demand a functional fine-tuning of the part, and this will in its turn conditionally necessitate

material-structural changes or a relocation of the part. This is clear in the following example (*PA*.II.13, 657b22-29):

> Τὰ δὲ τετράποδα καὶ ᾠοτόκα οὐ σκαρδαμύττει ὁμοίως, ὅτι οὐδ' ὑγρὰν αὐτοῖς ἀναγκαῖον ἔχειν καὶ ἀκριβῆ τὴν ὄψιν ἐπιγείοις οὖσιν. Τοῖς δ' ὄρνισιν ἀναγκαῖον· πόρρωθεν γὰρ ἡ χρῆσις τῆς ὄψεως. Διὸ καὶ τὰ γαμψώνυχα μὲν ὀξυωπά (ἄνωθεν γὰρ αὐτοῖς ἡ θεωρία τῆς τροφῆς, διὸ καὶ ἀναπέτονται ταῦτα μάλιστα τῶν ὀρνέων εἰς ὕψος), τὰ δ' ἐπίγεια καὶ μὴ πτητικά, οἷον ἀλεκτρυόνες καὶ τὰ τοιαῦτα, οὐκ ὀξυωπά· οὐδὲν γὰρ αὐτὰ κατεπείγει πρὸς τὸν βίον.
>
> "The four-footed, egg-laying animals do not blink in the same way as the birds, because since they are terrestrial, it is unnecessary for them to have moist and accurate vision. But for the birds it is necessary, since they use vision to see from a great distance. Accordingly, crook-taloned birds have sharp vision (for they search their food from above, which is also why these most of all soar to the heights), while those which are terrestrial and incapable of flight, such as domestic fowl and the like, do not have sharp vision. For nothing related to their way of life requires them to have it."

A reconstruction of the premises involved in this example shows that the fact that crooked-taloned birds search for their food from above explains why they need accurate vision, and it is this need for accurate vision that conditionally necessitates the moistness of the eyes of these birds. However, the ability of crook-taloned birds to see accurately *follows* from the material differentiation of eyes: the specific material disposition of each kind of eye explains the accurateness of vision of the animal that has those kinds of eyes.[66] Again, the final cause is part of the conclusion of the demonstration, while the middle term refers to formal or material-efficient causes.

#### *5.3.2.c The explanation of luxurious parts: secondary teleology*

A third type of explanation that is fairly common in Aristotle's *PA* is the so-called 'double-barrelled' explanation. In these cases, Aristotle explains the presence of a part or its differentiation both by reference to a final cause and by reference to material necessity. This type of explanation usually pertains to parts or functions that are not of vital or essential importance for the animal (and therefore not necessary in a strict sense), but 'merely' contribute to its well-being. Examples of such parts are

[66] For habitat being picked out as an explanatorily basic feature, see Gotthelf (1997a), 85-89 and Charles (1999), 249-250.

horns, spurs, hoofs, nails, teeth, hair, and eyebrows; these parts all serve the luxury-function of defence or protection. The doubleness of the explanation indicates that these parts are the results of what I have called 'secondary teleology'. That is, the *coming to be* of the materials out of which the luxurious parts are constituted is due to material necessity.[67] The *presence* of these parts, on the other hand, and their organization and distribution in an animal's body are due to the goal-directed actions of the formal nature of the animal. Aristotle describes the action of the formal nature of the animal in these cases as *making use* of materials that are present of necessity for a good purpose, rather than as *producing* those materials for the sake of some function.[68]

Take the example of horns. Aristotle's discussion of horns (*PA*.III.2) falls into two accounts. In the first paragraphs of his discussion of horns, Aristotle explained that horns are present in the animals that have them for the sake of self-defence and attack (*PA*.III.2, 663b21-22). Next, Aristotle introduces the second part of his account of horns (*PA*.III.2, 663b22-24):

> πῶς δὲ τῆς ἀναγκαίας φύσεως ἐχούσης τοῖς ὑπάρχουσιν ἐξ ἀνάγκης ἡ κατὰ τὸν λόγον φύσις ἕνεκά του κατακέχρηται, λέγωμεν.
>
> "We must say what the character of the necessary nature is, and, how nature according to the account has made use of things present of necessity for the sake of something."[69]

The necessary nature of the animal indicates, I submit, the amount and kind of materials that come to be as a result of material necessity, as a by-product or surplus of conditionally necessitated processes (without being themselves conditionally necessary). As Aristotle explains, large animals seem to produce more earthen material than is conditionally necessary (and necessitated) for the production of their bones, and it is this residual surplus which is part of the necessary nature of these

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[67] Explicit examples are *PA*.IV.3, 677b22-29 (677b22: *hê genesis ex anagkês sumbainei*) and *PA*.IV.4, 678a3-10 (678a3: *tên genesin ex anagkês ousan*).

[68] Cf. Aristotle's description of two types of *technai* in *Ph*.II.2, 194b1-5.

[69] Here Ogle's translation (1912: "Let us now consider the character of the material nature whose necessary results have been employed by rational nature for a final cause.") is grammatically closer to the Greek than Lennox's translation is (2001b: "Since there is a necessary nature, we must say how the nature according to the account makes use of things present of necessity for the sake of something"). *Pôs* should be taken with *echousês* in the genitive absolute, *and* with *katakechrêtai*: as soon as we know what kind of thing the necessary nature is, we can explain how nature makes use of the things that are present on account of this necessary nature.

animals and which is then "used by nature for the sake of protection and advantage (*PA*.III.2, 663b25-35)."

What is interesting in these cases is that the function that explains the presence (or the differentiation) of the part *follows* from the potentials the available material has.[70] The earthen residue is used by the formal nature of an animal to produce parts like horns, *because* this kind of material has a defensive potential. Formalizations of examples like these are not easy, but for our purposes it suffices to notice that again a final cause will be demonstrated to belong to some feature through another more basic feature, in this case the presence of materials with certain material potentials.

Let me end this exposition of common types of teleological explanation in *PA* by pointing out that although the actual explanations are more complicated than the example of walking after dinner in *APo*.II.11, the basic structure and the role of final causes seem to be the same. In biology, Aristotle attributes functions to (differentiations of) parts in order to explain the presence of the latter. However, the holding of these functions follows from other, more basic features, such as the animal's essence (that comprises functions), its life-style, or the availability of certain material potentials. It thus seems that, also in practice, final causes are what is attributed to a subject, and not what can be picked out by an explanatory middle term.

### 5.4 Conclusion

In the preceding sections, I have argued that *APo*.II.11 shows how each of the four types of explanation is brought out through an explanatory middle term, which needs not express the same type of causality as the explanation does.

This interpretation, supported by the lexical difference between *aitia* and *aition*, takes away the need to rearrange Aristotle's syllogistic example of walking after

[70] This is what Aristotle explains in *PA*.II.9, 655b4-12: "All these <uniform parts> the animals have for the sake of protection; for the whole <organs> constituted from these <uniform parts>, and synonymous with them, e.g., the whole hoof and whole horn, have been constructed for the safety of each of these animals (…). Of necessity all of these parts have an earthen and hard nature; for this potential is of the defensive kind."

dinner for the sake of health. Nothing in the text of *APo.* suggests that final causes *must* be picked out by the middle term in a teleological demonstration. A comparison with the use of *metalambanein* in the *Prior Analytics* and the *Topics* shows that the expression '*metalambanein tous logous*' should be taken as referring to some kind of procedure of substitution that Aristotle has applied himself while setting out his example, rather than as an admonition to us to change the order of the terms or premises. The fact that in teleological explanations the end for the sake of which the event is undertaken comes to be chronologically last, together with Aristotle's requirement that explanations have to reflect real causal sequences, explains why it is impossible to construct a syllogism in which the middle term picks out this end as a final cause.

A short analysis of Aristotle's methodological remarks about demonstration in the natural sciences and of his actual practice of teleological explanation in *PA* confirms the general picture found in *APo* with regard to the structure of teleological explanations. Functions explain the presence (or differentiations) of parts, but the holding of these functions of those parts is demonstrated through the discovery of some other basic explanatory feature. Final causes are the starting points from which the conditionally necessary antecedents are to be traced back, but it is the presence of these prerequisites that cause – for the most part, and if nothing interferes – the coming to be of ends.

Final causes form the starting points of explanations, and then need to be demonstrated to hold of the features whose presence they explain; as such, they are always part of the conclusion that is being demonstrated, and can never be picked out by the middle term as being explanatorily basic.

**Appendix: Translation of Aristotle's *Posterior Analytics* II.11, 94a20-94b26**

Since we think we have <scientific> knowledge when we know the explanation, and there are four explanations – one, what it is to be a thing and another, given what things being the case it is necessary for that to hold; another, what first initiated the motion; and fourth, the for the sake of what – all of them are brought out through the middle term. For, 'given what thing being the case it is necessary for this to hold' does not occur when one proposition is assumed, but when at least two are. This is the case when they have one middle term. Thus when this one is assumed, it is necessary for the conclusion to hold. It is clear too in the following way. Because of what is the angle in a semicircle a right angle? Given what thing being the case is it a right angle? Suppose then that right is A, half of two rights B, the angle in a semicircle C. Thus of A's – right – holding of C – the angle in a semicircle B is the cause. For this [B] is equal to A and C to B, because it [C] is of two rights – half. Thus given B, half of two rights, being the case, A holds of C (for that was it that [necessitates] the angle in a semicircle being a right angle). And that [B] is the same as what it is to be it, since the definition signifies this [i.e. what it is to be it].

Now it has also been shown that the middle term is explanatory of the essence.

For what reason did the Persian war come upon the Athenians? What is an explanation of the Athenians' being warred upon? Because they attacked Sardis with the Eretrians. For that initiated the movement. War, A; being the first to attack, B; Athenians C. B holds of C, the Athenians being the first to attack, and A holds of B, because people make war on those who have wronged them first. Therefore A holds of B, being warred upon to those who first began, and this, B, holds of the Athenians – for they first began. And in this case, too, the cause, that what initiated the movement, is the middle term.

Regarding the cases in which the causal relation is that something is for the sake of something – for example: for what reason does he walk? In order to be healthy. For what reason is there a house? In order to protect the possessions. In the one case it is in order to be healthy, in the other in order to protect. There is no difference between for what reason it is necessary to walk after dinner and for the sake of what it is necessary. Call 'walking after dinner' C, 'the food not floating on

the surface' B, and 'being healthy' A. Suppose then that to make the food not floating on the surface at the mouth of the stomach holds of walking after dinner, and suppose the first is healthy. For it is thought that B, the food not floating on the surface, holds of to walk, of C, and that thereof (of B) A, healthy, holds. What then is the causal factor for C of A's – the for the sake of which – holding of it? B, the not floating. This is like a definition of it <of A>; for A will here be explained in this way. And for what reason does B hold of C? Because that is what being healthy is: being in such state. Surely one must substitute the definitions, and in that way each of them will become clearer. Here the events occur in the opposite order from the cases where the causes are according to motion. For in the latter the middle term must occur first, while here C, the ultimate term, [must occur first] and last the for the sake of which.

## CHAPTER 6:
## CONCLUSION

Aristotle's natural treatises display a large variety of uses of teleology as an explanatory principle: organisms reproduce for the sake of preserving their own kind such that they can participate in the eternal and the divine. Birds have wings because they are essentially fliers (being a flier is part of the substantial being of birds), and wings are a necessary prerequisite of being a flier. Neither snakes nor stars have feet, because in these beings the presence of feet would have been in vain, and nature does nothing in vain. Most of the hoofed life-bearing animals have horns, because there is an excess of earthen material present in their bodies, and because of the defensive potentials this material has, nature uses it for the better to make horns in all the males. In the females, however, the excess of material is excreted, because females are not strong enough to be able to use the horns, and nature never gives anything to an animal that would not be able to use it. Human beings build houses for the sake of providing shelter for their belongings, and walk after dinner for the sake of being healthy, both because they have the capacity to do so, and because they desire shelter and health as something good.

Aristotle considers it foremost the task of natural philosophers to state teleological explanations such as the ones cited above, because he is convinced that these explanations are the most effective at serving the function of providing scientific knowledge.

For Aristotle, who is a realist concerning causal explanation, the discovery of explanations supplies scientific knowledge. We know something when we know its causal explanation, and there are four types of causal explanations: formal, material, efficient, and teleological ones. In natural philosophy, we have seen that Aristotle stresses the importance of teleological explanations. Apparently, the most important way (but certainly not the only way) of explaining the presence, absence, or differentiation of natural phenomena is by picking out the final causes of these phenomena under their causally relevant and appropriate description, and then to show how these final causes hold of the phenomena to be explained.

The importance Aristotle attributes to *teleological* explanations does not derive from a denial of the causal force of the material and efficient causes in natural phenomena: Aristotle argues that the operation and interaction of *all* four causes are necessary for natural phenomena to come about. According to Aristotle, the fact that natural processes are regular and typically have regular beneficial outcomes indicates that there exist such things as natures and that they are intrinsically directed towards the realization of those outcomes. In addition to material and efficient causes operating from the 'bottom up', there must be overarching formal and final causes at work that from the 'top down' guarantee the regularity of those outcomes by ordering and timing the complex sequence of natural events. Aristotle repudiates his materialist predecessors for treating the results of such events as being incidental to chance interactions between material elements. They were not able to account for those results in terms of intrinsic causation. Aristotle holds that this requires the assumption of final and formal causes *in addition to* material and efficient causes.

The importance of teleological explanations does not lie in the fact that they pick out final causes as being explanatorily basic or causally prior, for final causes never are. The ends picked out in explanations of natural phenomena as final causes are usually of two types: the natural being's realized potential for form (i.e. the complete and mature living being), or the function that arises from the potentials of the material from which a structure is constituted. In the first case, it is the formal cause as the potential for form that is causally prior in the coming to be of the living being. In the second case, it is the combined material and efficient causes necessitating the coming to be of the structure that is causally prior in the coming to be of its function. Final causes are causative in virtue of being formally one with the formal and efficient cause such that the realization of the form will be the end-state towards which the efficient cause is intrinsically directed and confined. In his biological works, the coincidence between the three causes leads Aristotle to speak of the 'formal nature' of an animal, which is identical with its soul. This formal nature is then contrasted with the living being's material nature, which is identical with its natural, instrumental body in which the soul is realized. In every case, however, the natural end-result that constitutes the final cause is realized last chronologically. This means that final causes are never causally prior.

The importance of final causes, then, (and hence of teleological explanations that pick out those final causes) lies in their *explanatory* priority. The reason for this is that the functions and goals that constitute final causes are in most cases easy to identify, either immediately by observation or indirectly through comparative research or through the use of teleological principles. Once these functions and goals have been established, one can then proceed to determine the conditionally necessary antecedents, which will be part of the complete causal explanation. Final causes are thus relatively easy to detect, and once detected provide the best starting points for the discovery of other causally relevant features and developments related to the explanandum. Since all properties and developments are equally significant or insignificant from a material-efficient point of view, the boundary between essential and incidental properties can only be determined by studying natural beings as teleologically organized wholes. For Aristotle not every end of a continuous process is a final cause, but only that in which this process – if nothing prevents it – would normally culminate. The end that constitutes a final cause is a 'good', that is, something which contributes to the existence or well-being of the whole of which it is part. Through the investigation of natural phenomena from a teleological viewpoint, one is able to distinguish the causally relevant features of that phenomenon, and thereby to discover the features that are to be included in the complete explanation of it.

The general structures underlying Aristotle's actual teleological explanations provided in the natural treatises are largely consistent with the theory of teleological explanations as described in *APo.*II.11. Both practice and theory, however, prove to be more complex and flexible than has traditionally been acknowledged.

Aristotle's actual teleological explanations consist of explanations that refer directly to final causes, and of explanations that make use of teleological principles. In those cases where the final causes are immediately discernible, Aristotle starts by identifying that final cause and then proceeds to show how this function or goal belongs to the natural phenomenon in question. In the case of living beings, the functions attributed to the parts of living beings or the living being as a whole are the realizations of the capacities of the soul, which are all teleologically grounded as

being necessary for or otherwise contributory to the preservation of life and the reproduction of the living being in question. The 'classification' of the various soul-functions living beings must and can have in Aristotle's psychology thereby forms the starting points of the explanations in his biology.

The strategy Aristotle employs to connect the function with the bearer of that function in each of these cases depends first and foremost on the type of question that needs to be answered (i.e. whether it concerns the presence, absence, or differentiation of some part or feature). It also depends on the status of the part or feature that needs to be explained. Parts or features that are necessary for the living being that has them are shown to belong to the living being through reference to their essence, picked out by the definition of their substantial being, which includes (among other features) the necessary functions to be realized.[1] Parts or features that are 'for the better', are shown to belong to living beings through reference to materials that have come to be by material necessity in their bodies, and which are then used for the better by their formal nature. Similarly, necessary differentiations of parts are usually shown to belong to the living beings that have them through reference to one of their specific differentiae (i.e. the being's way of life, its activities, character, and the parts it possesses), which are then shown to require a functional optimalization of the part or feature in question. Non-necessary differentiations of parts, on the other hand, are shown to be present on account of material that has come to be by material necessity, and which is then used for the better. The absence of parts or features is either explained by reference to their lack of function for this particular kind of animal, or non-teleologically by reference to the absence of the constitutive material (or natural place) in this animal. In explaining the actions of animals or human beings, Aristotle first picks out the goal of that action. He then shows how this action comes about by reference to the intermediate efficient causes, which usually take the form of the desire for an object and of the perception of that object as something good.

Teleological principles, such as "nature does nothing in vain, but always does what is best for the substantial being of each kind of animal," are generalizations over the goal-directed actions of formal natures, explicating what

[1] Future research will have to make clear how exactly this *logos tês ousias* is related to other Aristotelian notions such as essence, function, and definition as used in natural philosophy.

they 'always' or 'never' do or make when they are said to produce living beings and their parts. In general these principles (or suppositions), function as heuristic tools and are not part of the premises of the explanation itself. The principles provide a framework (established inductively through observation) of what is and what is not possible in this world as opposed to other possible worlds, and thereby set the natural boundaries within which the explanation of a particular phenomenon must take place.

Teleological principles are used in the following way. First, the presence of parts is explained through the use of the principle that nature does everything either because it is necessary or because it is for the better. The principle helps to determine the status of parts and their differentiations, and thereby to determine the kind of function one should look for. The absence of parts is explained through the use of the principle that nature does nothing in vain. Aristotle constructs a counterfactual argument of the following form: if the formal nature of this particular being had equipped it with this part, the part would have been in vain (for instance, because it would not have been able to use it properly). The part is absent then, because nature does nothing in vain. Finally, the principle that nature does what is best is used for explanations of the presence of parts and of their differentiations in cases where observation shows that there are several means for nature to fulfill a certain functional need. Aristotle shows how the features an animal has are the best for it, relative to the other natural possibilities.

In all the actual teleological explanations provided in the natural treatises it is either a formal cause (e.g. an essential property picked out by the definition of the substantial being of a living being, or one of its differentiae), an efficient cause, or a material cause that turns out to be explanatorily basic, while the functions are shown to follow from these factors. Aristotle's practice provides the following picture of teleological explanation. The final cause is taken as a (heuristic and observational) starting point of explanation. From there Aristotle reconstructs the conditionally necessary antecedents which the realization of this end demands. These antecedents will then be exhibited by either material causes, or efficient causes, or formal causes: The material causation is either that induced by the potential for form that needs to be realized if the animal is to live and to be the animal it is, or that induced by the

materials acting according to their own material natures; the efficient causes are directed towards a particular end; and the formal causes include functions. These are causes that are picked out as being explanatorily basic on account of their causal priority in the phenomena in which they operate.

This picture is consistent with the *theory* of the structure of teleological explanations Aristotle provides in *APo.*II.11, where he integrates his theory of four causes with the syllogistic pattern of scientific demonstrations. It is my contention that in this chapter Aristotle shows how there *may be* a difference between the type of causality expressed in the explanation of a state of affairs and the type of causality expressed in the middle term that picks out the explanans of a state of affairs. In teleological explanations, there *must be* a difference between the two. In addition, Aristotle argues that it is through the explanans that a certain type of causal relation is shown to obtain. In contrast with the traditional interpretation of *APo.*II.11, I have argued that in teleological explanations final causes are never to be picked out by the middle term as being explanatory of the conclusion, but rather are itself part of the conclusion that is being demonstrated. Walking after dinner is for the sake of health, because walking brings about the physiological condition of having the food not floating on the surface of the stomach, which is exactly what being healthy is in the context of a person who just had dinner. The middle term that picks out the condition of having the food not floating brings out the teleological relation that obtains between walking and health. Under this scheme, teleological explanations are explanations in which a final cause is demonstrated to hold of some state of affairs through the operation of other types of causes picked out by the middle term. This is consistent with the idea that for Aristotle the structure of scientific demonstrations in the natural sciences is to reflect the order of causation in the real world. If the necessity that obtains in the world of change is conditional, then the necessity that governs deductions of natural phenomena has to be conditional, as well: if the end is to come to be, then its necessary prerequisites have to come to be first. In the natural treatises, Aristotle never produces actual syllogisms, but the underlying pattern is largely the same. Final cause are demonstrated to hold of some feature through another, causally prior factor that is conditionally necessary for the end to be realized, and, where the explanation obtains, also has necessitated that end.

This schematic picture of the structure of teleological explanations points also to the wider ramifications of this dissertation: both the incorporation of conditional necessity into the demonstrative framework, and the room for variability between the type of explanation that is being demonstrated and the type of causation picked out by the middle term allow for a more flexible and comprehensive model of scientific demonstration than is usually attributed to Aristotle under the influence of the ancient commentary tradition.

Another aspect of the structure of teleological explanations concerns the integration of references to both teleology and necessity in the explanation of living nature. I have argued that in his explanations Aristotle picks out (roughly speaking) two types of teleology in combination with two types of necessity: primary teleology in combination with conditional necessity, and, secondary teleology and material necessity.

Aristotle invokes what I have called 'primary teleology' in explaining those parts and features of living being that are realizations of capacities already given with the kind of soul that being has. The parts and features are the instruments for the performance of functions included in the definition of the substantial being of that living being. In those cases, the formal nature or the soul of that living being is the cause of both the coming to be of those parts and features, and of their presence. The necessity of the coming to be of the part or feature in question is conditional upon the need of some essential or vital soul-function to be realized; the part and features that are present are then exhibited as the necessary prerequisites of something being what it is and being able to lead the live it does.

However, Aristotle also recognizes that some parts or features that can be observed to be present among living beings are not given with the definition of the substantial being of that animal, but do give rise to the performance of functions that contribute to the well-being of the animal. In these cases, Aristotle ascribes the cause of the coming to be of the matter constitutive of those parts and features to material necessity, while ascribing the cause of their presence to the goal-directed actions of the formal nature or soul of the animal. The material processes that take place in an animal body for the sake of generating the necessary parts lead *incidentally*

to the generation of residues or to indirectly conditionally necessitated materials. These materials are then used by nature – 'who, as a good housekeeper, is not in the habit of throwing away things that could be useful' – for the sake of some good. These processes are teleological in Aristotle's view, but not without qualification: the formal nature of the animal attributes a function to a part or to a flow of material, after this part or material has already come to be as the result of material necessity, and does so in accordance with the available material potentials. There is no capacity for the performance of a function that conditionally necessitates the realization of luxurious parts.

The integration of material necessity in secondary teleological explanations gives evidence for my view that Aristotle's theory of teleology was not developed for the sake of replacing materialist explanations, which explained everything in terms of material necessity and its coincidental outcomes. In Aristotle's view, material natures usually operate under the constraints of teleology, but not always: sometimes material natures operate according to their own natures without being directed towards the realization of some end, and give rise to structures that can be and often are used for the sake of something. When Aristotle restricts unqualified necessity to the eternal realm of the heavenly bodies he does not thereby deny the existence of material necessity in the sublunary realm. He rather points out that in causal sequences that take place in the heavenly realm the prior always necessitates the coming to be of the posterior, because the coming to be of the posterior is necessary 'without qualification'. In the sublunary realm the posterior in a causal sequence is never necessary 'without qualification', whether it is necessitated by conditional necessity or by material necessity. The role of material necessity in the sublunary realm is therefore not confined to the negative part of constraining the realizations of ends in natural beings. It also has a more positive role to play, in that it provides extra possibilities ('extra' in the sense that the possibilities are not already given with the soul some living being possesses) for the realization of features and functions that may contribute to some beings' well-being.

The distinction between 'primary' and 'secondary' teleology also solves some of the problems pertaining to the scope of Aristotle's teleology. For instance, it allows us to attribute an anthropocentric purpose to winter-rain (i.e. the growth of

crops), without having to conclude that Aristotle's whole theory of natural teleology is anthropocentric. Just as in nature, formal natures make use of what is present by material necessity for the better, human beings may impose secondary functions upon natural phenomena such as winter-rain (which occurs regularly due to material necessity) through the application of art, while following the material potentials and propensities rain has. It is the application of art that ensures the regular *beneficial* outcomes of winter-rain, not a pre-existing potential for form that is being realized. Aristotelian teleology pertains strictly to individual kinds of formal natures, and is not in any essential way anthropocentric or cosmic.

The explanatory power of the actual teleological explanations Aristotle provides of natural phenomena derives from two facts. In part, it derives from the success of his theory of natural teleology in integrating and making sense of phenomena that would otherwise be dissociated facts of our universe. It also derives from the extent to which the explanations achieve in actually making sense of natural phenomena, that is, to the extent to which they amount to scientific demonstrations of the sort required in natural philosophy, or, where this is not possible, to reductions of puzzlement.

Aristotle's theory of natural teleology, in combination with his theory of four causes, allows him to explain natural processes, deliberative action, and artistic production as variations of one and the same basic phenomenon. Aristotle sets up the analogy between agency and nature, and especially between art and nature (where intentionality and deliberation are left out of the picture), in order to bring out the goal-directedness of the latter through our familiarity with the goal-directedness of the former. The analogies thus serve primarily a didactic function: Aristotle reveals the causal frameworks that apply to art and agency and extends those to natural generation as far as the similarities hold. Ultimately, however, the goal-directedness of art and agency are ontologically dependent on that of nature, where goals are asserted to be present most. Living beings (humans, animals, and perhaps in some sense even the heavenly bodies) act goal-directedly, and craftsmen produce artifacts through goal-directed activity, because they *imitate* nature and are themselves endowed with natures.

The force of the analogy between art and nature remains visible also in Aristotle's explanations in the biological works, where the formal, efficient, and final causes are said to coincide in the souls of living beings. Aristotle characterizes these 'formal natures' as internal craftsmen who 'make', 'use', or 'redirect' materials for the sake of realizing the living being's characteristic functions. The theory that nature is goal-directed thus unifies natural beings such as elements, plants, animals, human beings, and even the heavenly bodies under one ontological category. They become teleologically organized composites of form and matter. The coming to be and presence of their bodies, features, and the occurrence of their motions and actions all involve goals, ends, and functions that ultimately contribute to their being and life. The teleological explanations Aristotle provides pick out those goals, aims, and functions, and relate them to the beings, parts, and events of which they constitute the final cause.

Teleological explanations are most successful in biology. Aristotle provides comprehensive and detailed accounts of why parts belong to the animals that have them, why they are differentiated in the way they are, and why some animals do not have parts that might be expected. The references to functions Aristotle makes in these explanations are grounded in his theory of soul. In particular, they build upon the classification of the various capacities of the soul to perform living functions and upon the idea that the soul is the final cause of the natural body that is instrumental. Different kinds of living beings are indicated by their characteristic soul-functions, and the parts and bodies they have must be instrumental to those functions. Any part of a living being's body is the way it is for the sake of the capacities that characterize its life, because it is causally dependent on and conditionally necessary for these capacities. Capacities and the living bodies in which they are realized are essentially connected.

The success of the use of teleological principles in biology as a heuristic tool for finding final causes where they are not immediately discernable might have inspired Aristotle to use those principles also in cosmology. The lack of empirical data in the latter domain makes the endeavor to explain the heavenly phenomena very difficult. Aristotle tries to integrate the study of the heavens into the science of nature, which means that material explanations of the mathematical properties of the

heavenly phenomena are insufficient for a complete scientific understanding of them. Aristotle thus uses teleological principles as a heuristic to find final causes, and by doing so tries to turn his cosmology into a proper physical science.[2] The teleological principles are not a priori axioms, but suppositions derived from the numerous observations Aristotle made in the biological domain. However, because of the lack of empirical data, the teleological explanations that are provided in cosmology amount to – as Aristotle keeps pointing out himself – plausible or reasonable explanations that take away some puzzlement concerning the heavens. They do not constitute explanations that reach the same level of accuracy and necessity as the explanations provided in biology. The use of teleology as a principle of explanation is thus limited in those domains where our observations of the phenomena are incomplete. On the other hand, Aristotle's attempt to give teleological explanations of the features and motions of the heavens shows the comprehensiveness of his theory of natural teleology: ultimately he is trying to establish a coherent picture of the whole cosmos and all its natural beings in which (at least for the most part) things are present or absent or differentiated in the way they are for a purpose.

In sum, if my interpretation of the theory and practice of teleological explanations in Aristotle holds, then the explanatory work performed by final causes is significantly different from what has traditionally been thought. Final causes exert no 'mysterious pull' from the future, but rather function quite literally as ends and limits of developments. They are to be used as starting points for investigations. This does not mean, however, that final causes only have a heuristic value: because final causes are part of the conclusion that is being demonstrated, the demonstration demonstrates the very existence of natural teleology.

[2] These principles are typically used in combination with analogies and counterfactual reasoning; Aristotle's explanatory strategies and scientific methodology in *De Caelo*, especially in relation to the ideal as set out in the *Posterior Analytics*, have not yet received the attention that they deserve.

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## SAMENVATTING

## VERKLARING EN TELEOLOGIE IN ARISTOTELES' NATUURFILOSOFIE

Waarom planten organismen zich voort? Waarom hebben vogels vleugels? Waarom hebben slangen noch sterren voeten? Waarom hebben de meeste gehoefde, levendbarende dieren hoorns (maar niet alle)? Waarom bouwen mensen huizen en maken ze na de maaltijd een wandeling?

Vragen zoals deze raken voor Aristoteles het hart van de natuurfilosofie, die het ontstaan en bestaan van wezens bestudeert die hun eigen interne principe van verandering en rust bezitten. Aristoteles was gedurende zijn hele leven diep geëngageerd met het onderzoeken en verklaren van natuurlijke fenomenen, zoals valt op te maken uit het grote aantal werken over de natuur van zijn hand dat we vandaag de dag bezitten. Van deze werken is de *Physica* het meest fundamenteel. In dit werk zet Aristoteles het algemene theoretische raamwerk uiteen voor zijn natuurfilosofie door begrippen zoals 'natuur', 'beweging', 'causaliteit', 'plaats' en 'tijd' te definiëren. In de andere werken onderzoekt Aristoteles meer specifieke problemen met betrekking tot de studie van natuurlijke wezens, zoals ontstaan en vergaan (in *De Generatione et Corruptione*), de aard en de beweging van de elementen (in *De Generatione et Corruptione* en in het tweede gedeelte van *De Caelo*), de bewegingen en de eigenschappen van de hemellichamen (in het eerste deel van *De Caelo*), atmosferische oorzaken en veranderingen (in *Meteorologica*), het begrip 'ziel' en de relatie tussen ziel en natuurlijk lichaam (in *De Anima*), en tenslotte de oorzaken van het ontstaan en bestaan van levende wezens, van hun delen, en van hun bewegingen (in de biologische werken).

De vragen die Aristoteles probeert te beantwoorden in de werken over de natuur (zoals bijvoorbeeld bovengenoemde vragen), hebben met elkaar gemeen dat zij hoofdzakelijk vragen naar de reden waarom, of, zoals Aristoteles het formuleert, naar 'dat omwille waarvan'. Door het stellen van deze specifieke vraag naar het waarom probeert Aristoteles de *functie* te achterhalen die wordt gediend door de aanwezigheid, afwezigheid, of materiële differentiatie van een bepaald natuurlijk fenomeen, of het *doel* omwille waarvan een natuurlijke beweging of verandering plaatsvindt. Volgens Aristoteles' begrip van wetenschappelijke kennis vormen

antwoorden op zulke vragen teleologische verklaringen, omdat zij verwijzen naar de doeloorzaak (als functie of als 'goed eindresultaat') omwille waarvan iets ontstaan is of bestaat (of afwezig is, enzovoort). Deze teleologische verklaringen vormen een kenmerkende eigenschap van Aristoteles' onderzoek naar de natuur, en weerspiegelen het belang dat hij toekent aan teleologie in het ontstaan en bestaan van regelmatige natuurlijke fenomenen. Volgens Aristoteles ontstaat of verandert alles dat 'van nature' ontstaan is of bestaat – tenzij er iets tussen komt – omwille van een doel en is het aanwezig omwille van dat doel. Teleologie opereert dus gelijkelijk onder alle natuurlijke wezens, van het niveau van de levenloze elementen tot dat van de levende wezens, en zelfs tot aan het domein van de onvergankelijke hemellichamen.

Hoewel het belang van teleologie voor Aristoteles' natuurfilosofie onbetwist is, zijn haar aard en reikwijdte een voortdurend onderwerp van debat. Deze debatten hebben met name in de laatste dertig jaar tot een steeds beter begrip van Aristoteles' opvatting van teleologie geleid. De voortuitgang betreft met name Aristoteles' opvatting van teleologie als een descriptief principe van de natuur, te weten de interne doelgerichtheid van natuurlijke processen (te contrasteren met factoren als toeval of noodzakelijkheid). Wat echter ontbreekt in de bestaande literatuur over Aristoteles' teleologie, is een begrip van de rol die Aristoteles toeschrijft aan teleologie in de *verklaring* van natuurlijke fenomenen.

De vraag die deze dissertatie heeft willen beantwoorden is hoe Aristoteles – gesteld dat hij erin is geslaagd teleologie te grondvesten als een oorzaak van natuurlijke fenomenen –deze teleologie vervolgens *gebruikt* als een principe van wetenschappelijke verklaring (bijvoorbeeld hoe hij verwijst naar, conclusies afleidt van, premissen bouwt op basis van, en andere mogelijke verklaringen afwijst op grond van een teleologische overweging), en dan met name in zijn werken over de *levende natuur* waar verwijzingen naar teleologie het meest prominent zijn.

Deze dissertatie dient een tweedelig doel. Ten eerste hoopt deze studie de functie, de structuur en de verklarende kracht van teleologische verklaringen te bepalen in vier van Aristoteles' werken over de natuur: de *Physica*, *De Anima*, *De Partibus Animalium* en *De Caelo*. Daarmee hoop ik inzicht te verschaffen in Aristoteles' gebruik van

teleologie als een principe van verklaring in de wetenschappelijke praktijk van het doen van natuurfilosofisch onderzoek.

Ten tweede hoopt deze studie bij te dragen aan een ruimer onderzoeksprogramma dat poogt de relatie tussen Aristoteles' wetenschapsfilosofie en de praktijk in de wetenschappen zelf in kaart te brengen. Met dat doel confronteer ik de bevindingen over Aristoteles' gebruik van teleologie met een nieuwe interpretatie van de theorie betreffende de structuur van teleologische verklaringen en wetenschappelijke bewijzen die Aristoteles uiteenzet in *Analytica Posteriora* II.11.

De dissertatie bestaat uit vijf afzonderlijke maar gerelateerde studies naar de functie, structuur en verklarende kracht van teleologische verklaringen in Aristoteles' filosofie van de levende natuur.

De kern, bestaande uit hoofdstukken 1-4, is gewijd aan een analyse van de teleologische verklaringen die Aristoteles geeft in zijn werken over de natuur: in zijn verdediging van het bestaan van de doelgerichtheid van de natuur in de *Physica* (hoofdstuk 1); in zijn analyse van een 'bio-functionele' opvatting van de ziel, haar functies en haar relatie met een natuurlijk lichaam in *De Anima* (hoofdstuk 2); in zijn onderzoek naar de eigenschappen en delen van levende wezens in *De Partibus Animalium* (hoofdstuk 3); en tenslotte in zijn onderzoek naar de eigenschappen en bewegingen van de hemellichamen in *De Caelo* (hoofdstuk 4).

In het laatste hoofdstuk (hoofdstuk 5), bespreek ik hoe Aristoteles zijn vier-oorzakenleer introduceert in het syllogistische raamwerk van wetenschappelijke bewijzen in *Analytica Posteriora* II.11, en wat daarbij de structuur van teleologische verklaringen of bewijzen zou moeten zijn. Volgens mijn analyse wordt in een teleologisch bewijs aangetoond dat er een teleologische relatie bestaat tussen het explanandum ('wandelen na de maaltijd') en de explanans ('gezondheid') door het in de middenterm identificeren van een tweede, causaal primaire oorzaak ('het niet bovendrijven van voedsel'), die zelf nooit een doeloorzaak kan zijn. Vervolgens onderzoek ik in hoeverre deze basisstructuur ook ten grondslag ligt aan de meest voorkomende typen verklaringen uit Aristoteles' praktijk van het verklaren van natuurlijke fenomenen.

In de conclusie, ten slotte, breng ik al deze gegevens samen en bespreek ik de verdiensten en beperkingen van Aristoteles' gebruik van teleologie als een principe van verklaring. De conclusies die ik in dit proefschrift verdedig zijn in het kort de volgende:

(1) De functie van het geven van teleologische verklaringen en het zoeken naar doeloorzaken is het leveren van wetenschappelijke kennis. Binnen de natuurfilosofie zijn volgens Aristoteles van alle soorten verklaringen de verklaringen die verwijzen naar functies of doeleinden het meest succesvol hierin vanwege de *verklarende prioriteit* van doeloorzaken.

De reden hiervoor is dat doorgaans functies van structuren en eindresultaten van processen gemakkelijk te identificeren zijn (ofwel direct via de waarneming of indirect via het gebruik van teleologische principes als heuristische middelen). Zodra deze zijn geïdentificeerd is het mogelijk de condities vast te stellen die noodzakelijkerwijs gerealiseerd moeten worden, willen deze functies of eindresultaten zich voordoen. Het verschil tussen essentiële en incidentele factoren die een rol kunnen spelen in een verklaring wordt pas duidelijk wanneer men natuurlijke wezens als teleologisch georganiseerde gehelen gaat beschouwen: via de doeloorzaak komt men de andere oorzaken op het spoor en kan men een zo compleet mogelijke verklaring van een natuurlijk fenomeen te geven. Deze verklarende prioriteit moet nadrukkelijk onderscheiden worden van causale prioriteit: doeloorzaken zijn namelijk nooit primair in causale zin en kunnen daarom nooit als de primaire verklarende factor worden opgenomen in verklaringen. In deze context is het ook belangrijk op te merken dat Aristoteles geenszins de causale werking van materiële of efficiënte oorzaken in de natuur ontkent. De kritiek die hij uit op zijn voorgangers betreft het feit dat zij niet naast de werking van materiële factoren, ook de werking van de formele en finale oorzaken erkenden. Door het samenspel van doeloorzaken, vormoorzaken en efficiënte oorzaken (in zijn biologische werken verwijst Aristoteles naar dit samenspel als naar de 'acties van de formele natuur' tegenover de materiële natuur van een wezen), garandeert teleologie 'van boven af' de regelmatigheid van het voorkomen van goede eindresultaten door de complexe sequentie van natuurlijke gebeurtenissen te ordenen en te timen.

(2) De structuur die ten grondslag ligt aan de teleologische verklaringen die Aristoteles in de praktijk levert is grotendeels *consistent met* de theorie van teleologische verklaringen zoals die beschreven wordt in *APo.*II.11. Zowel de praktijk als de theorie blijken echter gecompliceerder en flexibeler te zijn dan traditioneel werd aangenomen.

De teleologische verklaringen die Aristoteles geeft in zijn werken over de natuur bestaan ofwel uit verklaringen die direct naar doeloorzaken verwijzen, ofwel uit verklaringen die gebruik maken van teleologische principes (zoals dat de natuur niets voor niets doet) om doeloorzaken te kunnen identificeren. De strategieën die Aristoteles gebruikt om functies of eindresultaten te verbinden met de fenomenen die zij verklaren zijn divers, maar steeds afhankelijk van (a) de soort vraag die beantwoord moet worden (d.w.z. of het om de aanwezigheid, afwezigheid, of differentiatie van een fenomeen gaat); (b) de status van het te verklaren fenomeen (d.w.z. of het noodzakelijk is of 'slechts' beter is voor het wezen om te hebben). Teleologische principes zijn op waarneming gebaseerde generalisaties (in Aristoteles' wetenschappelijk jargon 'hypothesen' genaamd) van de doelgerichte handelingen van de formele natuur van elke afzonderlijke natuurlijke soort. Deze generalisaties maken expliciet wat deze formele natuur 'altijd' of 'nooit' doet – tenzij zij daarin gehinderd wordt – wanneer men zegt dat zij levende wezens en hun delen produceert. Deze principes worden elk op hun eigen manier en in hun eigen verklarende context gebruikt als heuristische middelen daar waar teleologie niet onmiddellijk te onderscheiden is: de generalisaties bieden een raamwerk van wat doorgaans wel en niet mogelijk is in deze wereld, en stellen daarmee de grenzen waarbinnen natuurlijke fenomenen moeten worden verklaard.

Alle verklaringen in de natuurlijke werken hebben met elkaar gemeen dat causale prioriteit wordt toegekend aan een formele, efficiënte, of materiële oorzaak, terwijl de gerealiseerde functies of eindresultaten hieraan secundair zijn: ze zijn het gevolg van een gerealiseerde vorm, de uitkomst van processen en veranderingen, of worden gefaciliteerd door de potenties die aanwezig in de gebruikte materialen. Dit beeld van de praktijk is consistent met de theorie van de structuur van teleologische verklaringen die Aristoteles in *APo.*II.11 presenteert. In dit hoofdstuk laat Aristoteles

zien dat het in teleologische verklaringen de functie is van de middenterm een explanans weer te geven die laat zien dat er een teleologische relatie bestaat tussen dat wat verklaard wordt en de doeloorzaak die wordt gegeven om dat fenomeen te verklaren. Het vinden van zo'n middenterm is wat een wetenschappelijk bewijs oplevert. Deze verklarende middenterm kan echter zelf geen doeloorzaak zijn: dat is namelijk in strijd met de eis dat wetenschappelijke bewijzen de volgorde van causatie in de werkelijkheid weergeven. Als de noodzaak die in de ondermaanse natuur opereert conditioneel is, dan moet de noodzaak in de syllogistische bewijzen van natuurlijke fenomenen ook conditioneel zijn: als dit eindresultaat er moet zijn, dan moeten de volgende noodzakelijke vereisten eerst gerealiseerd worden. In zijn werken over de natuur produceert Aristoteles nooit echte syllogismen, maar de onderliggende structuur van zijn eigen wetenschappelijke verklaringen benadert dit 'ideaal' sterk.

Dit schematische beeld van de structuur van teleologische verklaringen wijst ook op de wijdere ramificaties van deze dissertatie: zowel de incorporatie van conditionele noodzakelijkheid in het demonstratieve raamwerk als de ruimte voor variëteit tussen het type verklaring dat wordt bewezen en het type causaliteit dat wordt gerepresenteerd door de middenterm zorgen voor een meer flexibel en omvattend model van wetenschappelijke bewijsvoering dan gewoonlijk aan Aristoteles wordt toegeschreven onder invloed van de antieke commentaartraditie.

(3) Een ander aspect betreffende de structuur van teleologische verklaringen betreft de *integratie* van verwijzingen naar zowel doelgerichtheid als naar noodzakelijkheid in Aristoteles' verklaringen van de levende natuur. Ik heb beargumenteerd dat Aristoteles in zijn verklaringen ruwweg twee soorten teleologie combineert met twee soorten van noodzakelijkheid: 'primaire teleologie' in combinatie met conditionele noodzakelijkheid en 'secundaire teleologie' in combinatie met materiële noodzakelijkheid.

Aristoteles verwijst naar wat ik 'primaire teleologie' heb genoemd in de verklaringen van die delen van levende wezens die realisaties zijn van potenties die reeds besloten liggen in de soort van ziel (of vorm) dat het wezen heeft. In deze gevallen is de formele natuur of de ziel de oorzaak van zowel het ontstaan als het

bestaan van deze 'conditioneel noodzakelijke' delen: zij *maakt* deze delen omdat het levend wezen in staat moet zijn om zijn essentiële en vitale functies te beoefenen. Aan de andere kant onderscheidt Aristoteles ook gevallen van delen van levende wezens die niet bijdragen tot de beoefening van essentiële en vitale functies, maar die wel bijdragen tot hun welzijn. In deze gevallen verwijst Aristoteles naar materiële noodzakelijkheid als de oorzaak van het ontstaan van deze 'luxe delen', terwijl hij de doelgerichte handelingen van de formele natuur of de ziel aanwijst als de oorzaak van hun bestaan. De materiële processen die plaatsvinden in het lichaam van een levend wezen omwille van het voortbrengen en in stand houden van de noodzakelijke delen leidt incidenteel ook tot het ontstaan van extra materialen. Deze materialen worden vervolgens *gebruikt* door de formele natuur – "die, als een goede huishoudster, niet gewoon is dingen weg te gooien die bruikbaar zouden kunnen zijn" – omwille van iets goeds. De functie die de formele natuur toedeelt aan de beschikbare materialen hangt af van de potenties die die materialen hebben en van welk gebruik het beste is voor elke soort levend wezen; de teleologie in deze gevallen is dus secundair aan het ontstaan van al dan niet bruikbare materialen.

Wanneer Aristoteles het bestaan van 'ongekwalificeerde noodzakelijkheid' in het ondermaanse ontkent, ontkent hij daarmee niet het bestaan van materiële noodzakelijkheid in dat domein. De term 'ongekwalificeerde noodzakelijkheid' duidt aan dat in een causale sequentie 'het voorafgaande' altijd en zonder uitzondering 'het eropvolgende' veroorzaakt. Deze vorm van noodzakelijkheid komt alleen voor in het bovenmaanse, in de wiskunde, en in cyclische natuurlijke processen. De noodzaak die voorkomt in het ondermaanse is materiële noodzaak, die meestal onderworpen is aan teleologische processen, maar soms ook los van een te realiseren doel opereert. In het laatste geval biedt zij extra mogelijkheden ('extra' in de zin dat deze mogelijkheden niet reeds als potenties besloten liggen in de vorm of ziel) voor de realisatie van luxe delen tijdens de ontwikkeling van levende wezens.

Het onderscheid tussen 'primaire' en 'secundaire' teleologie helpt tenslotte ook om enkele problemen met betrekking tot de reikwijdte van Aristoteles' teleologie op te lossen. Door deze twee vormen van teleologie te onderscheiden is het bijvoorbeeld mogelijk een antropocentrisch doel toe te schrijven aan winterse regenval, zonder dat het noodzakelijk is de conclusie te trekken dat Aristoteles'

teleologie in zijn geheel antropocentrisch is. Net zoals de formele natuur in de formatie van levende wezens gebruik kan maken van wat door materiële noodzakelijkheid geproduceerd is om zo het welzijn van het wezen te verbeteren, zo kunnen ook mensen 'secundaire functies' opleggen aan natuurlijke fenomenen zoals regen in de winter (die regelmatig voorkomt vanwege materiële noodzakelijkheid). Zij doen dat door middel van de landbouwkunde, waarbij zij gebruik maken van de materiële potenties van regelmatige regenval. Het is enkel dankzij de toepassing van kunde dat regen in de winter regelmatig goede eindresultaten oplevert; er is geen onderliggende vorm die gerealiseerd wordt. Aristoteles' teleologie beperkt zich tot de werking van de formele natuur van elke afzonderlijke natuurlijke soort, en is in geen enkel opzicht antropocentrisch of kosmisch.

(4) De teleologische verklaringen die Aristoteles geeft in zijn werken over de natuur ontlenen hun verklarende kracht aan de volgende twee factoren. Enerzijds ontlenen zij hun kracht aan het succes dat zij boeken in het verenigen en uitleggen van (met name natuurlijke) fenomenen die zonder de theorie van teleologie onbegrijpelijk en onverenigbaar zouden zijn met andere fenomenen. Voorbeelden hiervan zijn (a) Aristoteles' verklaring van natuurlijke processen, praktisch handelen, en artistieke productie als variaties van een en hetzelfde causale patroon (waarbij dat van de natuur primair is), en (b) zijn gebruik van het beeld van de formele natuur als handwerksman in zijn biologie.

Anderzijds ontlenen zij hun kracht ook aan de mate waarin zij erin slagen bevredigende wetenschappelijke bewijzen te leveren zoals dat vereist is binnen de natuurwetenschappen. Wanneer dat niet mogelijk is dienen zij tenminste iets van de onbegrijpelijkheid van het fenomeen weg te nemen.

Het meest succesvol zijn de teleologische verklaringen die Aristoteles geeft in de biologie. *De Partibus Animalium* vertoont een grote diversiteit van teleologische verklaringen van waarom bepaalde delen toebehoren aan de dieren die ze hebben, waarom ze op een bepaalde manier gedifferentieerd zijn, en waarom sommige dieren onverwacht delen missen; en zoals gezegd, de structuur van deze verklaringen weerspiegelt die van wetenschappelijke bewijzen zoals gepresenteerd in *APo.*II.11. De verwijzingen naar functies in deze verklaringen zijn gegrond in Aristoteles' leer

van de ziel: met uitzondering van de luxedelen is het gehele levende lichaam, met al zijn delen, structuren, en differentiaties zoals het is omwille van de beoefening van die capaciteiten die zijn leven karakteriseren. In de kosmologie, waar veel minder empirische gegevens voorhanden zijn dan in de biologie en doeloorzaken moeilijker te identificeren zijn, gebruikt Aristoteles teleologische principes om op die manier de eigenschappen en de bewegingen van de hemellichamen zoveel mogelijk te kunnen verklaren. Het vinden van doeloorzaken is belangrijk, omdat Aristoteles probeert zijn studie van de hemellichamen te integreren in zijn algemene studie van de natuur, waar kennis van alleen de materiële oorzaken onvoldoende is. Echter, vanwege het gebrek aan empirische gegevens bieden de teleologische verklaringen die Aristoteles uiteindelijk geeft weliswaar een plausibele of redelijke uitleg, maar geen wetenschappelijk bewijs in strikte zin. De verklarende kracht van teleologie voor zover deze gebruikt wordt als een principe van verklaring is dus beperkt in die domeinen van de natuur waar onze waarnemingen incompleet zijn. Aan de andere kant geeft Aristoteles' poging om ook de kosmologische fenomenen te verklaren via het gebruik van teleologische principes blijk van de veelomvattendheid van zijn theorie van natuurlijke teleologie: uiteindelijk probeert Aristoteles een coherent beeld te geven van de gehele kosmos met alle natuurlijke wezens, waarin (tenminste voor het merendeel) dingen aanwezig, afwezig, of op een bepaalde manier gedifferentieerd zijn om een reden.

Tot slot: als mijn interpretatie van de theorie en de praktijk van teleologische verklaringen in Aristoteles juist is, dan is de verklarende functie van doeloorzaken significant anders dan traditioneel wordt gedacht. Doeloorzaken oefenen geen 'mysterieuze kracht' uit vanuit de toekomst, maar functioneren daarentegen juist bijna letterlijk als eindpunten en grenzen van processen. Ze vormen de beginpunten van wetenschappelijk onderzoek. Dit betekent niet dat doeloorzaken slechts een heuristische functie hebben: omdat doeloorzaken deel zijn van de conclusie die in een wetenschappelijk bewijs wordt gedemonstreerd, demonstreert het bewijs het bestaan van natuurlijke teleologie.

## CURRICULUM VITAE

Mariska Elisabeth Maria Philomena Johannes Leunissen was born on July 17th 1979, in Heerlen. From 1991 to 1997, she went to the Sintermeerten College in Heerlen. After she received her Gymnasium-diploma (*summa cum laude*), with emphasis on languages, history, and mathematics, she went to the University of Leiden. There she studied Classical Languages (emphasis on Ancient Greek, master's degree *cum laude* in 2003) and Philosophy (emphasis on Philosophy of Science, master's degree with high distinction in 2002). In 2003, she started her Ph.D. research at the Faculty of Philosophy at Leiden University on teleological explanations in Aristotle's philosophy of nature. During her years as a graduate student, she presented papers at international conferences in the Netherlands, United Kingdom, Canada, and the United States of America. In addition, she taught ancient philosophy courses to students in the Faculty of Philosophy (for which she received the Faculty's Outstanding Teaching Award in 2005) and the Department of Classics. In the Spring-semesters of 2005, 2006, and 2007, she had the pleasure of working with the excellent faculty and students of the Joint Program in Ancient Philosophy at the University of Texas at Austin. Starting in July 2007, she will take up a position as an Assistant Professor in the Philosophy Department at Washington University in St. Louis.