

Explanation and Teleology in Aristotle's Science of Nature. By MARISKA LEUNISSEN. Cambridge and New York: Cambridge University Press, 2010. Pp. [xiii] + 250.

The elevated status of the biological works is among the more important developments in the last fifty years of Aristotelian scholarship. Though the level of attention scholars devote to these texts will likely never match the share they occupy in the *Corpus Aristotelicum*, David Balme, Montgomery Furth, Allan Gotthelf, James Lennox, and many others have established the importance that a proper and thorough understanding of Aristotle's biology has for any inquiry into his physical and metaphysical views. It is surprising, then, that most examinations of natural teleology, a topic so central to Aristotle's biological investigations, focus principally on its existence, its causal nature, and its scope, and do so in a manner that either minimizes the teleological explanations Aristotle so often employs in his biology or neglects them altogether.

Mariska Leunissen's book, *Explanation and Teleology in Aristotle's Science of Nature*, stands as a much-needed deviation from this typical course. L. tackles the perennial questions surrounding the presence of teleology and final causation in the natural world, but her views are rooted in an impressive analysis of the teleological explanations Aristotle actually employs in his biological works. The analyses she provides are clear, careful, and detailed, and the account of final causation and teleological explanation that arises from them demands serious attention and rewards careful reflection.

In the course of her book, L. discusses numerous topics: the relationship between art and nature (chap. 1), Aristotle's infamous rain example in his defense of teleology in *Physics* 2.8 (chap. 1), the nature of the soul and the relationship between the soul's capacities (chap. 2), and the use (and limitations) of teleological explanation in cosmology (chap. 5). These discussions, however, are put forward in service of the book's three principal theses:

1. There are two types of teleological causation—*primary* and *secondary* (chaps. 1–3).
2. There are teleological principles, for example, nature does nothing in vain, that serve as heuristic tools for the discovery of the “real” causes that play a role in the ultimate explanations of natural phenomena (chap. 4).
3. In order to integrate final causes into the theory of demonstration Aristotle provides in *Posterior Analytics* 2.11, we must recognize that final causes are not causally primary in explanations of natural phenomena but rather are explanatorily primary (chaps. 6–7).

Given the centrality of these three claims to her overall project, I will limit this review to them and will reserve my critical remarks for the first thesis, the distinction between primary and secondary teleology, as it drives the book's entire argument.

Though commentators have traditionally taken Aristotle to be working with a single account of teleology, L. argues that he employs two distinct patterns of teleological explanation when he investigates the coming to be and presence of a living organism's parts. Recognizing this diversity not only enables one to attain a better understanding of teleology's explanatory power, but also makes it possible to grant material necessity a larger role in goal-directed natural phenomena.

Primary teleology concerns the realization of a preexisting internal potential for form (the fully realized form is the final cause of the process). The stages of these realizations are governed by conditional necessity. For each kind of organism (say, birds) there is a definition of its substantial being (being a flyer), and this formal definition determines those functional features (flying) that are either vital or essential to any natural being that is to realize that form. In order for an organism to come to be with this form, it must, by conditional necessity, have parts that can execute these functions (say, wings). These parts come to be with certain features and come to be made of/ from certain materials for the sake of realizing a particular form-determined function.

Secondary teleology is also guided by an organism's formal nature. But phenomena governed by secondary teleology do not involve the realization of a form. Rather, an organism's nature appropriates materials that happen to be available and produces parts that serve the organism's well-being. (Usually these materials are non-conditionally necessitated residues that are the materially necessary byproduct of biological phenomena governed by primary teleology.) Parts that come to be through secondary teleology come to be either (a) for the sake of contributing to the performance of the vital or essential parts that primary teleology produces, or (b) in order to perform an inessential function that nevertheless benefits the organism's well-being.

So we have two kinds of teleology and two corresponding kinds of parts. Vital or essential parts, the products of primary teleology, come to be for the sake of living—they are required if the organism is to be or to live (p. 19). Their coming to be is primarily "driven by form" (p. 20). They are generated first, come to be from the best nutriment, and come to be from nutriment with conditionally necessitated material characteristics (pp. 84–89). Subsidiary or luxury parts, the products of secondary teleology, do not come to be for the sake of living but for living well (p. 19). Their coming to be is primarily "driven by matter" (p. 20). They are generated after the vital/essential parts, come to be from inferior nutriment or residues, and come to be from nutriment/residues that have material characteristics that are not conditionally necessitated but are present by material necessity (pp. 89–95).

L. argues for these distinctions by presenting a series of texts in which they are manifest, the majority of which come from *The Parts of Animals*. This allows for disagreement over the cases she provides and concerns over the cases that she omits. For example, L. claims that the presence of eyelids in moist-eyed animals is the result of primary teleology (p. 129). Animals that need to see sharply must have moist eyes, and eyelids come to be for the sake of protection (animals with hard eyes need no such protection, *Part. an.* 2.13). But this seems like a paradigmatic case of secondary teleology. The moistness of eyes is conditionally necessitated by the formal requirement of keen sight, but the coming to be of eyelids merely contributes to the performance of this essential function. Eyelids certainly make an organism's life better, and they mirror kidneys and other subsidiary organs in many other respects as well, despite being subject to explanations that invoke conditional necessity.

My main concern, however, does not involve any particular example, but rather L.'s claim that the distinction between primary and secondary teleology is driven by form and by matter respectively. A complete teleological explanation, according to L., will "reveal whether it is a formal or a material factor that is primarily driving the realizations of functions" (p. 123). The qualifier 'primarily' is important. All of the phenomena in question are in part driven by form. They all "involve the goal-directed

action of the formal nature—which is why *both processes qualify as being teleological*” (p. 20). And all of the phenomena in question are in part driven by matter. The movements that take place when tissues and organs come to be are in some sense the same movements that occur when bodies mix and change in inanimate environments (*Mete.* 4.3.381a10–11).

So the distinction between primary and secondary teleology must consist in (a) the manner in which form is operative and (b) the status of the matter upon which form operates. This is exactly what L. provides. Phenomena governed by secondary teleology occur when (a) an organism’s formal nature “co-opts,” “adapts,” “makes use of,” “appropriates,” or “assigns a function” to (b) nutriment or residues that are present due to material necessity. But it seems as if neither the formal nor the material aspect of this account can do the work of distinguishing primary and secondary teleology.

The account’s formal aspect, namely, the analogy to craft, is insufficient.¹ The coming to be of all tissues, including conditionally necessitated tissues, in generation, nutritive maintenance, and growth involves changes in which the organism’s nutritive capacities make use of materials. The principles of an organism’s nutritive movements are external or foreign to the nutriment that is moved, and “the capacity of the nutritive soul makes growth out of the nutriment, using heat and cold as its instruments” (*Gen. an.* 2.4.740b34–37).

The account’s material aspect, namely, the absence of teleology in the presence of the matter from which tissues and organs come to be, also seems to be unable to ground the primary/secondary distinction. Every nutritive process begins at some stage with materials whose presence and material constitution are in no way conditionally necessitated by an organism’s form. L. claims that subsidiary and luxury parts “would never have come to be if it were not for the prior operation of material necessity” (p. 146). But this is true of every tissue and organ. In extreme cases, say plants, the processing of nutriment is almost complete by the time at which the soul capacities are exercised upon it since “plants take their already worked-up nutrients from the earth [. . . and] use the earth and its heat as a stomach” (*Part. an.* 2.3.650a20–23).

These comments are not intended to undermine the importance of the distinction L. makes. There is clearly a difference between parts that are essential for an organism to come to be and parts that are useful but, at best, necessary with qualification.² But Aristotle’s explanations of the coming to be and presence of these parts is complex, and the fact that soul is the principle of all nutritive/reproductive phenomena may prevent these explanations from being susceptible to clean classifications.

Before describing the second and third of L.’s principal theses, I should briefly note one feature of her analysis that may be of wider interest. According to L., assessments of whether a part is essential/vital to an organism or merely for the better “are not meant to be *descriptive* of a part’s status in actual, realized living beings [. . . but] rather pertain to the *hypothetical* ‘design’ of animals, where nature is, metaphorically speaking, still figuring out how to best realize the potential(s) for form for each individual kind of animal” (p. 126). This design concerns not individual species, but the widest class of animals that need to perform a particular function or (conditionally)

1. L. takes the craft analogy seriously since “*all art* is in some sense a form of secondary teleology” (p. 39).

2. This distinction has been made before, notably in Richard Sorabji, *Necessity, Cause, and Blame* (Ithaca, N.Y., 1980).

need to possess a particular organ. The explanations concern neither the Bengal tiger nor the human being, but the blooded animal and the animal that breathes air. Now many philosophers take Aristotle's account of living organisms and their forms to ground an important variety of natural normativity.³ The form of an organism is the benchmark against which one can assess judgments of natural goodness and defect. If L. is right, it will have consequences for such theories. For if I am born without a foot, I will be defective in one respect—I will not have an essential part, a part that is necessary for me to realize fully my form given the locomotive function that is present in its substantial definition. If I am born without a kidney, a spleen, testicles, teeth, and hair, I will be defective in a different way. Given how human beings actually are, some of these parts are necessary for living. But the fact that one could, in principle, design something that realizes completely the essential functions of human beings without having any subsidiary and luxury parts, means that the absence of such parts in any particular human being is a defect of a quite different sort. These parts contribute to a man's well-being but are not essential to the realization of the form of man.

L.'s second major thesis concerns a class of well-known Aristotelian maxims such as 'nature does nothing in vain' and 'nature does everything because it is necessary or because it is for the better.' L. argues that these teleological principles are heuristic tools. The label 'heuristic' accurately describes L.'s view, but is perhaps misleading given that many employ the expression to describe views that deny all empirical content to such principles. According to L., these teleological principles are generalizations over the causal characterizations of the actions of formal natures. They "carry ontological force" (p. 119) and are hypotheses that are "empirical in nature" (p. 121).

L. argues that these principles cannot serve as premises in the ultimate explanations of natural phenomena. They cannot do so because they fail to fit the formal structure of demonstrative syllogisms (they are propositional in form), they would provide only weak and unspecific explanations (they are generalizations and would therefore provide too much explanatory force to the middle terms), and they fail to capture the distinction between primary and secondary teleology (pp. 121–22).

These teleological principles do, nevertheless, serve a purpose. They are employed when immediate, simple observation is unable to reveal the causally relevant features of a given phenomenon. They facilitate the identification of the causally relevant features, and it is these features alone that serve as premises in the phenomenon's ultimate explanation.

The book's penultimate chapter contains L.'s third major topic, namely, how to understand the relationship between Aristotle's four causes and the account of syllogistic demonstration in *Posterior Analytics* 2.11. The account she puts forward depends on a distinction between "the type of causality expressed in the *explanation* of a phenomenon (i.e., the type of causality expressed by the whole demonstrative syllogism), and the type of causality expressed in the middle term that picks out the explanans of cause of this phenomenon" (p. 179). This allows L. to argue that the type of cause picked out by a demonstration's middle term need not correspond to the type of causality the demonstration explains. In fact, L. argues that demonstrations of teleological phenomena cannot have a middle term that picks out a final cause (pp. 195–97).

3. E.g., Philippa Foot, *Natural Goodness* (Oxford and New York, 2001).

The arguments for this view are innovative and provide a strong alternative to the standard reading of the passages that concern the relationship between final causation and scientific demonstration. Anyone interested in the relationship between the model of scientific explanation in the *Posterior Analytics* and the explanations of biological phenomena Aristotle actually gives will find this discussion valuable.

In sum, L.'s book is an important contribution to the literature on natural teleology. Like any attempt to provide novel solutions to long-standing and difficult problems, its conclusions will not (and occasionally ought not) be embraced universally. It nevertheless deserves to be engaged not only by those interested in Aristotle's natural philosophy, but also by anyone interested in teleological explanations.

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Apollonius of Rhodes and the Spaces of Hellenism. By WILLIAM G. THALMANN.
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In this astute and original study, William G. Thalmann addresses a common frustration in reading the *Argonautika*. Writing in the wake of Alexander's conquests, Apollonius rings the heroic world with geographies and ethnographies that should speak to our own globalizing and postcolonial condition. Yet his *aitia* sketch the Greek future erratically and often unflatteringly, and all roads do not lead to Alexandria, much as some seem to; this is not a Ptolemaic *Aeneid*. Nonspecialists bog down in the mix of myth and science as the poet reconfigures the lands and seas of Homer, Hesiod, Pindar, Herodotus, geographers, local historians, and other authorities. Apollonius promises much about the larger world and, vexingly, delivers even more.

In constructing the spaces of this elegant volume, T. foregrounds what we most want to know from these geographies. He situates the body of his text between maps of the *Argo's* voyage and of the post-Alexander *oikoumenê* (pp. xvi–xix) and, in the conclusion, a street plan of Ptolemaic Alexandria with the location of known structures (p. 207). Given the Alexandrian poets' curious silence about Egypt, these maps make a provocative promise as they work from the world (heroic and Hellenistic) to the Mouseion. There is, of course, a catch. For T. investigates what maps *conceal*, that is, the ideologies and cultural tensions that are veiled as maps are constructed from experiences, narratives, and political formations. He leads through Apollonius' thicket of geographies by reframing the question as "space, not geography" (p. 9) and by demonstrating spatial analysis as a skill that the reader can master. By way of the social processes underlying geographical constructs he arrives at an Alexandria that is more than a mirage.

Drawing on recent work in anthropology and cultural geography, T. contrasts the cartographic space of positivist geography with the lived space—the medium of narrative—that the Argonauts see, feel, smell, mark, name, cognitively master, and ultimately link place-to-place into an *oikoumenê*. Following the Marxist metaphilosopher Henri Lefebvre,¹ T. terms this process the "production of space" (or "spatialization").

1. Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Oxford and Cambridge, Mass., 1991).