1. Platonic and Aristotelian Roots of Teleological Arguments

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ABSTRACT

Aristotle's central argument for teleology—though not necessarily his conclusion—is repeated in the teleological arguments of Isaac Newton, Immanuel Kant, William Paley, and Charles Darwin. To appreciate Aristotle's argument and its influence I assert, first, that Aristotle's naturalistic teleology must be distinguished from Plato's anthropomorphic one; second, the form of Aristotle's arguments for teleology should be read as instances of inferences to the best explanation. On my reading, then, both Newton's and Paley's teleological arguments are Aristotelian while their conclusions are Platonic. Kant and Darwin's arguments are likewise Aristotelian while their conclusions are unique.

The authors contributing to this anthology focus on a variety of issues concerning 'functional explanations' in both biology and psychology. 'Functional explanation' is our chosen term because 'teleological explanation' is thought to imply backwards causation or bizarre ontological categories (for example, vital forces) attributable to the teleological theories of Plato and Aristotle. Functional explanation is not so imbued and hence, as opposed to teleology, is an appropriate topic for naturalistic analysis. However, scholars of ancient Greek science and metaphysics know that Aristotle's and Plato's teleologies are richer and more interesting than many of the writers on modern functional explanation realize. Between Aristotle's and Plato's writings are found several different categories of teleology, only some of which invoke bizarre metaphysical entities, and several powerful arguments for the legitimacy of teleological explanation in biology.

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There is considerable disagreement about the relation between teleological explanation and functional explanation. Consider Woodfield's influential remark that teleological explanations are part of the domain of purposive behavior while functional explanations are part of the larger domain of system analysis (Woodfield 1976). The distinction has no clear support, however, in the writings of Aristotle from which the modern concept of 'functional explanation' takes root. According to Aristotle's schema, functional explanations are a *subset* of teleological ones.

Most importantly, insofar as Aristotle's teleology pertains to explanations of natural items, it is misleading to cast off Aristotle's teleology as reading purposive behavior into natural events. This perception of Aristotle's teleology is the result of conflating Aristotle's naturalistic teleology with Plato's. As I will discuss in this essay, Plato's natural teleology is and Aristotle's is not creationist, anthropomorphic, and externally evaluative. Plato's natural teleology invokes the concept of the 'good'. Aristotle's does not. Aristotle's natural teleology is and Plato's is not naturalistic, immanent, and functional.

Aristotle's central mode of argument for both artifactual and natural teleology is an inference to the best explanation: teleology best explains facts about the organic world. We shall see arguments of this type in three separate discussions within Aristotle's *Physics*, book II. The distinction between Plato's teleology and Aristotle's natural teleology is worth revisiting for three reasons (which provide the three theses for this essay). 1. Both Aristotle's and Plato's teleology arguments are more sophisticated than historically and currently presented. 2. Many teleology arguments in post-eighteenth-century science are variants on Aristotle's inferences to the best explanations while the conclusions are *Platonic*. I will demonstrate this dualism in the works of Isaac Newton, Immanuel Kant, and William Paley. 3. Once we strip away Platonic teleology from Aristotle's inferences to the best explanation, the question 'To what extent was Darwin a teleologist?' can be answered plainly: Darwin endorsed a subset of Aristotle's teleology.

1. Aristotelian versus Platonic Teleology

1.1. Aristotle's Teleology

Teleological explanation in Aristotle pertains broadly to goal-directed actions or behavior. Aristotle invokes teleology when an event or action pertains to goals: 'that for the sake of which' (e.g. *Phys.* II. 194^{b}32). Following David Charles (1995; with some modification) we can distinguish two distinct conceptions of teleology in Aristotle's writings and at least two sets of subcategories:

I. Agency-centered teleology
   (i) *Behavioral.* Activities undertaken for the sake of something, which may be either a state or further action.
   (ii) *Artifactual.* Activities undertaken for the sake of producing an object of a certain sort (artifact).

II. Teleology pertaining to natural organisms
   (iii) *Formal.* Biological developmental processes that occur for the sake of self-preservation or preservation of the species (form).
   (ii) *Functional.* Parts of organisms that are present for the sake of the organism possessing them.

I and II are *distinct* notions of teleology: Aristotle should have used two words to distinguish them. Agent-specific teleology (I) is purposive, rational, and intentional, and represents an external evaluation. The goal is the object of an agent's *desire* or choice. In behavioral teleology (i) actions are done out of the desire to produce a goal—for example, walking is for the sake of health. In artifactual teleology (ii) the object (artifact) is produced for the sake of achieving some goal—for example, building a house to shelter oneself. Agents are *aware* of the means to fulfill the goal (Charles 1995: 107). To explain why a builder builds a house or to explain why doctors do what they do, we can cite their goal: a builder builds for the sake of shelter and a doctor doctors for the sake of health.

Teleology pertaining to natural organisms is distinct: *non*-purposive (though seemingly so), *non*-rational, *non*-intentional, and *immanent*—that is, an inner principle of change. The goal is *not* an object of any agent's desire. In formal teleology (iii) the *telos* is an inherent property of the process to complete the organism's developmental end state as seen in the form of the species (Zunjich, pers. com.). For example, plants require nourishment for self-fulfillment of the (species) form. So, roots extend downwards rather than upwards for the sake of nourishment (199^{a}29). In functional teleology (iv) the *telos* is inherent in the relationship between the part of the organism in question and the whole organism. For example, sharp teeth are in the front of the mouth for the sake of tearing (199^{b}24). Sharp teeth contribute to the flourishing of organisms possessing them. Put more strongly, carnivores flourish *because* they possess sharp teeth. This is consistent with the form of functional explanation that many authors in this volume accept: sharp teeth persist in nature among carnivores because they contribute to the flourishing of carnivores. In neither (iii) nor (iv) is the *telos* a conscious goal of the organism. Nor is the goodness of the process a part of the explanation for what occurs. Roots are not aware that it is good to grow downwards. Rather, a consequence of roots growing downwards is that plants flourish; those that do not grow downwards do not flourish. I summarize the differences in figure 1.1.

	Answer to: 'why is X there'?	*Awareness of means to a goal*	*Valuation*
Agents I(i), I(ii)	In terms of what's good	Agent is aware and flexible to change means	Deliberate, external
Organic development II(iii)	Contributes to the development of the organism according to its form (species)	Unaware and inflexible to change means	Goal is in the form of the species
Natural objects II(iv)	Contributes to self-flourishing	Unaware and inflexible to change means	Goal is property of relation between part and organism

Fig. 1.1. Summary of differences between Plato's and Aristotle's conception of *telos*
Source: adapted from Lennox (1992).

The roots of agency-based teleology (I) are found in the writings of Plato, while teleology pertaining to natural organisms (II) is Aristotle's own. Next, I compare Plato's and Aristotle's teleology. Then, I examine the three central Aristotelian arguments for teleology that I claim are at the core of many teleological arguments throughout history, despite the Platonic conclusions of many of them.

1.2. Plato's Teleology

In the *Phaedo* Plato recounts Socrates' criticisms of the Pre-Socratics for missing the real cause of the orderly arrangements of natural phenomena. Anaxagoras explains the orderly arrangements of the cosmos by means of mechanistic principles of motion of matter such as air, water, and ether. Simple material motions are what Anaxagoras takes to be the Reason for the motion in the cosmos. Socrates is unsatisfied. He expected Anaxagoras to explain how the natural order was the *best* of possible world orders. The difference is captured in asking the analogous question, 'Why does Socrates sit in prison?'. While facts about physiology, the composition of bones and sinews and their arrangements, offer a complete explanation of his current position in prison, the explanation is unsatisfactory, for it does not provide the *real* reason for Socrates' predicament. Socrates remains in prison because remaining rather than escaping is what Socrates deems the *best* course of action. Reference to the simple motion does not capture best intentions.

In the *Timaeus* Plato takes up Socrates' challenge to provide an account of why the cosmos was created for the best. Again, reference to simple motions provides a complete explanation of the orderly arrangement of the heavens. However, it is necessary to take account of the good if we want fully to understand the order of the heavens (Morrow 1950: 425). The true cause is agency working for the best.

> This ordered world is of mixed birth; it is the offspring of a union of Necessity and Intellect. Intellect prevailed over Necessity by persuading it to direct most of the things that come to be toward what is best, and the result of this subjugation of Necessity to wise persuasion was the initial formation of this universe. (*Timaeus*, 48a, trans. Zeyl)

Agency is constrained both by goodness and in the materials available. For example, while spheres may be the finest shape possible, other shapes are used in nature because the sphere has already been used for the body of the cosmos (Strange 1985: 28).

It is important to note the distinctions between Plato's teleology and Aristotle's. Each is influenced by a different cosmology. For Plato the universe is an artifact, as are the living organisms within (thus subsuming Aristotle's III and IV into I(ii)). The demiurge is the general cause of all motion, including motion on earth. Aristotle fundamentally distinguishes between the cause of motion in the heavens and the cause of motion on earth. The heavens are incorruptible. The primary motion of the sun, stars, and planets is circular—the natural tendency of the distinctly heavenly element, ether. In contrast, earth (or rather the sublunar realm) is corruptible, with motions described in terms of the natural tendencies of the distinctly earthly elements, fire, air, water, and earth. None of these elements tends to circular motion. However, the distinction between heavenly and earthly motion has a caveat: the circular movement of the sun, stars, and planets causes the earth's seasons, which exert a general influence upon growth on earth (Balme 1987: 277).

For Plato's teleology, the striving towards good depends on a standard of excellence in the forms. The artifacts of the universe (including the living organisms therein) are created after the model of the forms. Hence the standard of excellence that drives the striving towards the good is external to the object itself. Aristotle's teleology is immanent, not external to the object. Organic development is an activation of a particular potentiality as seen in the form of the species to which the individual belongs. That activation is not external to the individual but is an inner principle of change (*Phys.* II, ch. 1). Consequently, on Aristotle's account, while humans are sensitive to the means by which they attain their particular goals, there is no explicit requirement that the goal is *best* for the individual's requirements. Plato's and Socrates' teleology is stronger in that actions are always for the best (Annas 1982: 314). I summarize the distinction between Aristotle's and Plato's teleology in figure 1.2.

	Cosmology	*Source of change*	*Valuation*
Plato	Creator (demiurge) governs all motion	External model	Action is for the *best* (from a cosmological point of view)
Aristotle (both agent and organismal)	Distinct motions for heavens and earth	An inner principle of change (Immanent)	Action or part is *useful* to individual

Fig. 1.2. Summary of the differences between Plato's and Aristotle's teleology

2. Aristotle's Arguments against the Materialist

2.1. *Aristotle's Argument from Flourishing*

All of Aristotle's arguments for teleology we will consider are pitted against the materialist conception that, roughly, materials and their necessary causes are sufficient to explain all physical events. Material necessity refers to a physical event that is the result of the nature of the matter involved as opposed to being interfered with by some external force (Cooper 1987: 260). Aristotle agrees with the materialist that citing the materials and their causal interactions suffice for the explanation for *some* physical events. For example, the reason why the sky rains is due to the material necessity of sky and water: 'what is drawn up must cool, and what has been cooled must become water and descend' ($198^{b}19$–20). The 'must' refers to the natural unimpeded regularities of the sky.[1] Further, in the case that the rain spoils a man's crop ('on the threshing floor'), the spoilage comes as a result of rain's natural tendency to come out of the sky. Rain does not fall for the sake of spoiling a man's crop; the result is due to both the material necessity of rainfall and the unfortunate placement of the crop. In other words, Aristotle accepts the abductive inference from the *observational fact* (O) of the particular occurrence of rain spoiling a man's crop to the *hypothesis* (H (materialist)) that the observation is a coincidence.

O: Rain falls.

H (materialist): nature and motion of simple bodies.

According to Aristotle H (materialist) sufficiently explains O. Further, in the case of:

[1] *Pace* Furley (1985). Furley believes that Aristotle rejects the materialist view at all levels. I prefer the interpretation presented here, which is probably more mainstream. However, my main concern is Aristotle's argument for teleology so not a lot rides on this controversy for me.

O′: Rain falls and spoils a man's crop.

H (materialist)′: coincidence.

Aristotle agrees that the H (materialist)′ sufficiently explains O′. That is, coincidence sufficiently accounts for the relationship between rainfall and spoilage of a man's crop.

However, Aristotle contends that coincidence is not sufficient to explain all events. Consider the dental arrangement of humans and some animals: sharp teeth grow in front and broad molars in the back. Aristotle asks what accounts for the fact that carnivores possessing this particular dental arrangement (nearly) invariably prosper 'whereas those which grew otherwise perished and continue to perish'?.

Since the materialist denies that natural events occur for the sake of some end, he or she would have to accept that the usefulness of the dental arrangements occurs as a coincidental result of the material necessity of dental matter. The situation is essentially no different from the man's crop spoiling because of rainfall.

By Aristotle's lights, there is a difference: evidence that particular dental arrangements are *useful* to the organism comes from the fact it is a *regular occurrence in living nature.* It happens nearly invariably; organisms with different dental arrangements nearly always die. So, the proper explanation is that sharp teeth grow in front and broad molars in the back *for the sake* of an organism's flourishing. The 'goal' is inherent in the nature of growth.

Unlike the case of rain, where Aristotle accepted as coincidence the relation between rain and crop spoilage, Aristotle cannot accept as coincidence the fact that organisms possessing sharp teeth in front and broad molars in the back invariably flourish while organisms possessing alternative arrangements invariably die. The latter phenomenon is better explained by teleology: possessing sharp teeth in front and broad molars in the back occurs for the sake of the organism flourishing. That is, teleology can be abductively inferred from the fact that the dental arrangements regularly contribute to the flourishing of individuals possessing them. To schematize (redefining the variables O and H accordingly):

O: Sharp teeth growing in front and broad molars in the back regularly lead to the flourishing of carnivores possessing that arrangement.

O′: Alternative dental arrangements lead to the death of carnivores possessing the alternative.

H (materialist): What does not occur by simple movement occurs by chance. The difference between O and O′ is by chance.

H (teleologist): The difference between O and O′ is that, for carnivores, a particular dental arrangement (sharp teeth in front, broad molars in the back) *occurs for the sake* of flourishing.

Aristotle argues that H (materialist) insufficiently accounts for the difference between O and O′ while H (teleologist) sufficiently accounts for the difference between O and O′.

I will refer to this Aristotelian argument as 'the argument from flourishing'.

2.2. *Aristotle's Argument from Regularity*

In *Physics* II.9 Aristotle strengthens his argument against the materialist by providing an alternative explanatory scheme. In addition to the nature and movement of simple bodies (material necessity) and chance, Aristotle offers a third mode of explanation: hypothetical necessity.[2]

What is hypothetical necessity? Take eyelids, for example. Eyelids are flaps of skin that protect eyes from easy external penetration. According to Aristotle, the eyelid material—the flaps of skin—is *necessary* for the sake of eye protection. The necessity referenced here is called 'hypothetical necessity': it is a constraint on materials given the specific purpose for which the part will be used. Not any material will do for the sake of eye protection, only eyelid material, given the specific form of eye protection that humans and other animals require. This is meant to be taken strongly: the actual materials that compose an organ are required for the completion of the process where completion is the goal of development. Put differently, if there had not been a need for eye protection, there would not have been materials present to form eyelids (Cooper 1987: 255).

The concept of hypothetical necessity makes clear the relationship between functional (iv) teleology and formal (iii) teleology. Consider the example: eyelid material is present for the sake of eye protection (that is the function of eyelid material). So, eyelid material has a functional role (iii) to play in the growth of eye protection. Further, eye protection is necessary for seeing, and seeing occurs for the sake of the organism's growth (iv). The necessity is granted to matter, eyelids, and is conditional in that it contributes to the goal of natural growth. Eyelid material contributes to natural growth by affording eye protection, which itself is crucial for the function of seeing (Cooper 1987).

Hypothetical necessity is inherent in actions pertaining to deliberate agents as well (Charles 1988: 119). In such a case, hypothetical necessity explains why some action has been taken or why some object has been created. These occur because of the agent's goal. In this case, the agent is aware of the goodness of the action or object as a means to the goal.

I follow John Cooper (1987) in viewing Aristotle's argument for hypothetical necessity in terms of an inference to the best explanation for regularities of

[2] One might argue that hypothetical necessity refers to a teleology that does not invoke the final *aitia* (Zunjich, pers. com.).

processes. To make the case stronger let us switch examples to the development of a newborn from sperm, egg, and the usual background developmental conditions. Accordingly, the materialist cannot account for how these materials conspire to produce fetuses (nearly) every time. In other words, by appeal to simple motion and material cause, materialists cannot fundamentally distinguish between:

1. physical forces that are unconstrained to produce a range of different possible outcomes; and
2. physical forces that (nearly) always result in the same product—a newborn.

The materialist's only recourse is an appeal to *coincidence*. Aristotle's reply is that coincidence is insufficient to account for the regularity of the conjugation seen in organic development because chance operates only in unusual circumstances ($198^{b}35$–$199^{a}3$). The principle of hypothetical necessity better explains the regularity of development: the materials are there for the sake of producing the conjugation that leads to the development of newborns.

O: sperm and egg invariably conjugate to produce newborns.

H (materialist): accident.

H (teleologist): hypothetical necessity.

H (teleologist) better explains the regularity by which we observe organic development because accidents are rare in nature.

On Aristotle's account, materials are, so to speak (in Cooper's words) 'the seat of the necessity' (Cooper 1987: 255). However, these material arrangements are conditional on the production of newborns being something that occurs in nature. In this way, goal is prior to matter (Charles 1995: 121n.). That is, sperm and egg do cause the goal of producing newborns; however, the goal of newborns is not there because of the sperm and egg. Quite the opposite: if newborns are to exist (and they do by nature), then sperm and egg and the process that leads them have to exist. That is what it means that sperm and eggs have to exist *for the sake of newborns*.

We will refer to this argument for hypothetical necessity as 'the argument from regularity'.

2.3. *Aristotle's Argument from Pattern*

Finally, it is worth considering a third inference to the best explanation Aristotle employs to support the irreducibility of teleology in explanation. This time Aristotle recognizes that the same teleological scheme applies to explain a particular sort of organization that regularly occurs both within

human action and in the non-human natural world. The organization he has in mind is exemplified in the following cases: housebuilding, leaves growing to shade fruit, roots descending for nourishment (rather than rising), nestbuilding in birds, and webmaking in spiders. In all of these cases we recognize a certain *pattern of arrangement and sequential order*. For example, in development of an artifact (such as housebuilding) or in nature (as in roots descending downwards), all the steps of development occur in sequence, which leads up to the final state. Further, parts of an object that contribute to some whole effect are situated to contribute to the whole effect (Charles 1995: 115). These patterns do not happen by accident. Rather they occur in every instance where the relevant organization is found—for example, in the intentional production of artifacts (housebuilding) or the non-deliberate formation of natural objects (webmaking, nestmaking, roots descending, leaves shading fruit). It is in this respect that Aristotle famously remarks that 'as in art, so in nature' (*Phys.* 199^{a}9–10) and 'as in nature, so in art' (199^{a}15–16). The same pattern that explains certain organizations found in nature also explains the same organizations found in artifacts (Charles 1995: 115). This 'certain organization' is just goal-directed activity. Aristotle infers teleology from patterns of order and arrangement. We will call this the 'argument from pattern'.

To strengthen this argument, Aristotle presents the first instance where teleology preserves a distinction between function and accident, except for Aristotle the term is a 'mistake'.[3] Mistakes occur when one of the stages required to achieve the goal has failed to complete its role in the production of the goal. Mistakes occur, for example, when a doctor pours the wrong dosage or when a man miswrites or when monstrosities such as 'man-headed ox-progeny' or 'olive-headed vine-progeny' develop. The same teleological pattern whereby each stage of development occurs in order for the sake of the goal allows us to explain the difference between what occurs by art or nature, on the one hand, or by mistake, on the other. What occurs by art or nature follows the pattern successfully, while mistakes or the creation of monsters feature a failed developmental stage.

On the face of it, Aristotle *presupposes* teleology in order to explain it. If so, Aristotle is guilty of circular reasoning. However, on closer inspection, Aristotle does not commit the fallacy. Teleology is not part of the explanandum; orderliness and functional relationships are. Contrast orderliness among the normal beings with disorder found in monstrosities. The difference is explained teleologically. The inference is something like the following:

O (nature): Orderly developmental patterns occur by nature.
O (nature)′: Disorderly developmental patterns lead to mistakes or monstrosities.

[3] The function/accident distinction is crucial for modern-day teleology.

Analogously,

O (artifact): Orderly creative procedures lead to functional artifacts.
O (artifact)′: Disorderly creative procedures lead to mistakes.
H (materialist): All phenomena are explained according to the same materialistic principles. There is no essential difference in their explanation.
H (teleologist): Orderly patterns occur *for the sake of* the form while monstrosities do not.

The teleological explanation better explains what distinguishes O from O′. According to Aristotle, the materialists cannot explain what goes wrong when mistakes occur or what goes right when developed or created things work.

So far I have spent much of this essay explicating Aristotle's teleology arguments and distinguishing between Aristotle's 'localized' teleology from Plato's 'global', divine agent-centered teleology. After Aristotle, a pattern in teleological arguments emerges: a variation of one of Aristotle's three types of teleological argument is put forward in support of the existence of a Platonic divine agent. Aquinas exemplifies the melding of two teleologies whereby regularity of pattern is offered as evidence of design. As Ron Amundson so aptly puts it, 'In Aquinas's time it was easy to move from *always acts the same* to *acts for an end*, and thence to *achieves the best result*' (Amundson 1996: 16). The distinguishing Aristotelian feature is the move from 'always acts the same' to 'acts for an end'. The extra inference is Platonic and explains why the end 'achieves the best result'. Later on we see this same pattern in teleological arguments from Newton, Whewell, Paley, Kant, and Darwin.

Commentators have failed to appreciate this pattern in their interpretation of post-Aristotelian teleological arguments for many reasons. First, they often interpret what I have been calling 'teleological arguments' as 'arguments *from* design'. The latter argument infers the existence of a creator to explain purpose in nature. While I do not doubt that such arguments have been offered in history, we should recognize that the inference from purpose to agent is poor. Teleological explanations are supposed to be contrasted with material explanations. A materialist thinks that there are no purposes in nature to explain. So, an inference *from purpose* begs the question that purpose exists and requires an explanation. None of Aristotle's three arguments, the argument from flourishing, the argument from regularity, and the argument from pattern, begs the question against the materialist. In each, Aristotle infers teleology from the relevant factor, flourishing, regularity in development, or patterns of order and arrangement. For one example (to refresh our memories), Aristotle argues that dental arrangements are *useful*, and hence grow for the sake of their usefulness, because those carnivores that possess the particular dental arrangement tend to prosper, while those that do not, die. I hope to demonstrate that the more careful teleologists follow Aristotle's lead.

A second reason why commentators fail to appreciate the sophistication of teleological arguments is that some appear to hold that the key feature of a teleological argument is the analogy between human artifacts and natural 'designs' (e.g. Hurlbutt 1965: 14). As we have seen, such analogies are neither a distinguishing feature—there are other sorts of teleological arguments—nor, in the case that such arguments are presented, primarily an argument from analogy. Aristotle's argument that features the analogy is an inference to the best explanation and not an argument from analogy. In arguments from analogy, a feature ascribed to a target subject is ascribed to an analog. The strength of the analogy depends on the degree to which the analog *resembles* the target. For example, we might think that, since dog biology resembles human biology, and since humans have a circulatory system, dogs do too. We do not evaluate an inference to the best explanation in the same way. There is no comparison between targets and analogs. Instead, an inference to the best explanation begins with an observation and considers which hypothesis offered might explain the observation. Again, Aristotle's three arguments for teleology feature the inference to the best explanation schema.

Finally, many commentators dismiss Aristotelian teleology as it is purported to ascribe fishy vital forces or bizarre backwards causation to nature. However, I think this is the biggest misreading of Aristotle. First, as I mentioned above, there are good reasons to think that Aristotle's final aitia are not *causes* but *reasons* or *explanations*. Of course, on this reading, there is an open question whether Aristotle thought that his final aitia corresponded to irreducible ontological properties of the world above that of material causes, or whether he viewed them as useful forms of explanations.[4] Nevertheless, even if one holds that final *aitia* are ontologically irreducible to material causes, it does not follow that these irreducible properties are forward-'looking', intentional 'vital forces'. A 'vital force' is a force that drives a causal process. Picking one out would be to pick out the source of motion or developmental change. However, in Aristotle's account of explanation, to attribute this role to final *aitia* would be to collapse the distinction between final *aitia* and *efficient causes* (Gotthelf and Lennox 1987: 201). It is the latter, *causal aitia* that pick out the source of change.

[4] I follow many commentators in thinking that final aitia do pick out an ontological category distinguished from material causation. Aristotle most likely would have thought that human intentionality was not reducible to material causes. And, likewise, organic development (growth) is irreducible to causal laws of motion.

3. Cosmological Teleology

3.1. Newton

Centuries later Aristotle's teleological arguments reappear in inferences to explain the order that govern the motions in the cosmos. Ironically, Isaac Newton, who is best known for his mechanistic physics, employs an Aristotelian teleology inference. Truth is, Newton was not a thoroughgoing proponent of a mechanical universe. In a letter to Richard Bentley, Newton lists a number of questions that he thinks the mechanical sciences *cannot* answer, including:

> What is there in places almost empty of matter, and whence is it that the sun and planets gravitate towards one another, without dense matter between them? To what end are comets; and whence is it that planets move all in one the same way in orbs concentrick, while comets move all manner of ways in orbs very excentrick; and what hinders the fixed stars from falling upon one another? How came the bodies of animals to be contrived with so much art, and for what ends were their several parts?' (*Opera Omnia*, IV. 237)

Newton presents evidence for teleology in both the motions of the solar system—'cosmological teleology'—and in the adaptability of living organisms to their environments—'biological teleology'.

In a revealing passage, Newton remarks on the ontology of gravity: 'Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers' (Amundson 1996: 15). This clearly leaves room for teleology in Newton's cosmology. But so far these passages are negative; they state the limitations of mechanical sciences (Hurlbutt 1965: 7). A hint of a positive teleological argument comes later in Newton's letter to Bentley:

> To make this system, therefore, with all its motions, required a cause which understood, and compared together, the quantities of matter in the several bodies of the sun and planets, and the gravitating powers resulting from thence; the several distances of the primary planets from the sun, and of the secondary ones from *Saturn*, *Jupiter*, and the Earth; and the velocities, with which these planets could revolve about those quantities of matter in the central bodies; and to compare and adjust all these things together in so great and variety of bodies, argues that cause to be not blind and fortuitous, but very well skilled in mechanicks and geometry'. (*Opera Omnia*, IV. 431–2; quoted in Hurlbutt 1965: 7)

Newton's argument is similar to Aristotle's inference from pattern. Accordingly, the stable motions of the heavens depend on a singular arrangement of planet sizes, distances, number, and position. Implied here is that, if the system were arranged haphazardly—that is, by blind chance—its balance

would have been compromised. Hence blind and fortuitous causes do not explain the origins of the universe's stable motions. Rather, the delicate balance we see in the solar system suggests a creative origin: an act of intelligent design.

O: The solar system exhibits a balanced arrangement of variously sized planets.

O′ (counterfactual): Had the arrangement been haphazard, the balance would not exist.

The best inference is teleological: the arrangements exist for the sake of the balance. However, as we see, Newton goes a step further and postulates the existence of a skilled designer. So, while Newton's argument resembles Aristotle's, the conclusion is Plato's. The telos is the intention of a skilled designer.

Newton knew that the harmony and stability of the solar system have exceptions in the orbital speeds of Jupiter and Saturn. Jupiter's speed was accelerating while Saturn's was decelerating. Newton argued in the *Optics* that the solar system would fall apart, the stability compromised, unless the orbital speeds of Jupiter and Saturn were adjusted. Perhaps, Newton hypothesized (despite the fact that Newton famously despised hypotheses), comets played the adjustment role (Amundson 1996: 18). If so, the eccentric motion of the comets would be explained: they restore stability in the solar system. So, there is an interesting difference between Plato's demiurge and Newton's divine creator. While Plato's demiurge created in a single act, Newton's God intervened with its creation.

3.2. *The Death Knell of Cosmological Teleology*

LaPlace eventually solved the problem of the exceptional orbits of Saturn and Jupiter, demonstrating that the orbits would eventually reverse, creating an oscillation that is stable in the long run (Amundson 1996: 20). Consequentially, there was less of a motivation to think that the eccentric orbits of the comets had the purpose to adjust the solar system, since the exceptional orbits of Saturn and Jupiter were self-correcting. Worse for Newton's teleology, LaPlace put forward the hypothesis that the solar system coalesced from nubular clouds. If correct, this would explain the origins of the solar system without reference to an intelligent designer.

Yet, cosmological teleology dies hard. As Whewell argued, LaPlace's Nebular Hypothesis for the origins of the solar system merely forced the issue of origins back a step. Accordingly, we are left with an open question of what accounts for the laws that govern the coalescing of nubulae. This opens the door again for teleology: 'What but design and intelligence prepared and tempered this previously existing element, so that it should by its natural changes produce such an orderly system?' (Whewell 1836; quoted in Amundson 1996: 21).

Spinoza despised such arguments, calling them arguments *ad ignorantiam*. Underhill (1904: 224) captures the spirit of Spinoza's disdain nicely:

> a tile falls from a roof on a man's head and kills him: the tile, they argue, must have fallen on purpose to kill him. Otherwise, if it had not been God's will, how could all the cicumstances have concurred just then and there? You may answer: It happened because the wind blew and the man was passing that way. They will urge—Why did the wind blow and why did the man pass that way just at that time? If you suggest fresh reasons, they will ask similar questions, because there is no end of such questioning, until you take refuge in that *ignorantiae asylum*, the will of God'.

As a consequence of LaPlace's work, the popularity of cosmological teleology waned while the popularity of biological teleology waxed. The cosmos lacked a means/end patterning from which teleology could be inferred. Recall Aristotle's argument from pattern whereby evidence for teleological principles is found in particular orderly arrangements of developmental phenomena such as in organic development of adapted organisms or the creation of human artifacts. The last gasp of cosmological teleology seized on that pattern in the correlations between organic cycles and astronomical time period (Amundson 1996: 21). Just as Aristotle considered thousands of years before, Whewell argued that the correspondence between the solar year and the vegetative growth cycle suggested, not chance, but 'intentional adjustment' (Whewell 1836: 26).

4. Biological Teleology

The remaining figures we will consider, Kant, Paley, and Darwin, apply teleology to biological explanations as opposed to cosmological explanations. Again, the Aristotelian influences on these figures are striking. Of the three, only Paley will endorse a Platonic *telos*.

4.1. *Kant*

Kant distinguishes two sorts of causation, mechanical and teleological. Mechanical causes exhibit a progressive series of causes preceding their effects. Teleological causes exhibit both a progressive and a *regressive* series of causal chains whereby effects *both* precede and proceed from their causes. An effect can be the *cause* of its preceding cause. Regressive cause-and-effect chains are most clearly represented in purposive human behavior. For example, the existence of a house is the cause of rental income, yet the 'representation' of the income is the cause of building the house in the first place (Butts 1990: 5).

Kant concludes (a sketch of the argument is below) that the processes of nature can *be understood only* teleologically. Interestingly, the *telos* Kant

ascribes to nature is meant to be distinct from the *telos* ascribed to human purposive behavior. Kant is being careful to avoid the Platonic conclusion that natural processes serve useful ends as evaluated from 'on high'. Rather, natural *telos* is immanent, *in rerum natura*, very much in the mold of Aristotle's natural teleology. So, when final causes are ascribed to human behavior, they refer to 'utility'—as in iron is useful to shipbuilding; when final causes are ascribed to natural processes, they refer to 'internal', biological ends.

What is Kant's argument for the existence of these biological internal ends? Kant's answer is consistent with his general epistemology: to understand nature we must view it 'as if' nature is rational and acts for practical ends. That is to say not that nature *is* rational but that nature acts as a rational analog to a living being (Butts 1990: 7).

I take Kant's argument so far to be similar to half of Aristotle's argument from pattern: the same pattern that explains organizations found in human activity is the same pattern that explains organization in nature. I say this is 'half' of Aristotle's argument from pattern because Aristotle's argument works both ways, 'as in art, so in nature' and 'as in nature, so in art'. The pattern Kant sees 'as in art, so in nature' is the progressive and regressive causal series. Where in nature is that pattern evident? The answer: in *self-preserving activity*. Kant considers three ways in which a tree may be 'regarded as an end to itself or internal end' (quoted in Underhill 1904: 226).

1. *Phylogenetic.* Reproduction begets organisms that resemble a generic kind (i.e. species). The kind is both the effect of continued generic existence and the cause of reproduction.
2. *Individual growth.* Growth is more than increase in size according to mechanical laws, for individuals deviate from their generic form to secure their own self-preservation under particular circumstances. This leads to originality in individual design unequalled in art.
3. *Functional part/whole relations.* Parts of animals form in a way that the maintenance of any one part depends reciprocally on the maintenance of the rest.

Note, Kant's conclusion is stronger than the argument from pattern presented above. According to Kant, we must *necessarily* think of nature as designed. That is what Kant means when he remarks that it would be absurd to expect that 'another Newton will arise in the future who will make even the production of a blade of grass understandable by us according to natural laws which no design has ordered' (quoted in Beatty 1990: 54). (I find the reference to Newton ironic, given our discussion above.) The remaining steps of Kant's argument, I think, are unAristotelian hence beyond the scope of this chapter.

My point has been to point out the Aristotelian kernel of Kant's biology. First, his distinction between external and internal ends reflects nicely

Aristotle's own distinction between what I called 'Agent-centered' and 'Natural' teleology. Second, Kant's argument for ascribing *telos* in nature resembles Aristotle's argument from pattern. Finally, reflect on Kant's remarks on growth (above). Kant recognized that mechanical principles are necessary to understand some parts of animal formation but mechanical principles *alone* cannot explain the individuality of growth. We explain the latter by reference to the self-preserving (teleological) activities of an individual organism. Aristotle would have been proud.

4.2. *Paley and Darwin*

Darwin is often thought to have brought the demise of teleological thinking in biology (Ghiselin 1969; Mayr 1988). But, since the concept of telos is so packed with different meanings, it is unclear what sort of teleology Darwin's theory of evolution by natural selection rejected. Darwin himself unabashedly utilized the concept of a final cause in his *Species Notebooks* and even in the *Origin of Species* itself (Lennox 1993: 410–11). Elsewhere, in an illuminating exchange between Asa Gray and Darwin, Gray commented on 'Darwin's great service to Natural Science in bringing back to it Teleology: so that instead of Morphology versus Teleology, we shall have Morphology wedded to Teleology' (quoted in Lennox 1993: 409). In response, Darwin wrote, 'What you say about Teleology pleases me especially and I do not think anyone else has ever noticed the point' (quoted in Lennox 1993: 409). The issue here is to what extent did Darwin reject teleology and to what extent did he support it? The key is to distinguish clearly between what I have been calling 'Platonic' and 'Aristotelian' teleology. A Platonic *telos* is an agent that operates or creates purposively for the sake of the best.[5] An Aristotelian telos is a property of an individual's functioning—its contribution to its own sustainability. One way to interpret the significance of Darwin's theory to teleology is to view Darwin's theory as a rejection of Platonic agency as the cause of natural phenomena. Rather than appealing to a divine creator with a good plan, Darwin appealed to facts about nature. This interpretation arises when we view Darwin's theory as an answer to, in particular, William Paley's argument from design. As we shall see, both Paley's argument and Darwin's response are plausibly seen as applications of Aristotle's teleology.

4.3. *Paley*

William Paley (1828) asks us to consider what we would infer about the presence of a watch lying on a heath. How did the watch come to exist? Had we

[5] Kurt von Baer thought Platonic teleology was misleading and even 'silly'. He blamed the association of Platonic teleology (he called it 'theological teleology') for much of the 'teleophobia'.

found a stone rather than a watch, it would suffice to infer that the stone had lain on the heath forever. However, that answer is not applicable to the watch, for watches, as opposed to stones, exhibit a particular organization, a singular order in the way their component parts are put together such that the hands move in accordance to time:

> For this reason, and for no other, viz. That, when we come to inspect the watch, we perceive (what we could not discover in the stone) that its several parts are framed and put together for a purpose, e.g. that they are so formed and adjusted as to produce motion, and that motion so regulated as to point out the hour of the day . . . (Paley 1828: 5)

If the watch were composed in any other manner, had its parts been shaped or sized differently, the hands would not move in the same way (or not at all). Many commentators ignore this Aristotelian component of Paley's argument—the contrast between the functioning and malfunctioning watch depends on the arrangements of the parts of the object:

> that if the different parts had been differently shaped from what they are, of a different size from what they are, or placed after any other manner, or in any other order, than that in which they are placed, either no motion at all would have been carried on in the machine, or none which would have answered the use that is now served by it. (Paley 1828: 5)

Paley infers purpose in the watch's intricate composition. This purpose is the rational intention of a creator.[6] Schematically, Paley's inference is as follows:

O: A particular assemblage produces motion.

O′: Deviations of the assemblage results in no motion.

H (designer): The assemblage is purposeful (put together by a designer).

It is important to note that Paley's inference does not depend on prior observations of watches being made by watchmakers.[7] Rather, Paley infers the existence of an intentional designer from the watch's complexity, arrangement, intricacies, and well-suitedness to the completion of certain tasks. The key point, what we will call 'the inferential step', is that certain patterns in artifacts suggest design and the existence of a designer. The pattern is exhibited when

[6] I realize that the passage above, where Paley writes, 'we *perceive* . . . that its several parts are framed and put together for a *purpose* . . .', suggests a different reading from the one I offered—namely, that Paley observes a purpose rather than inferring one. However, I think Paley's supporting examples are meant to be taken as evidence for what Paley 'perceives'. If I am wrong, that is, if the proper way to read the passage is that Paley infers a creator *from* the purpose he perceives rather than from the pattern of assemblage, then Paley's argument begs the question against the materialist who 'perceives' no purpose in nature.

[7] Paley (1828: 42) writes: 'Nor would it, I apprehend, weaken the conclusion, that we had never seen a watch made—that we had never known an artist capable of making one . . . Ignorance of this kind exalts our opinion of the unseen and unknown artist's skill, if he be unseen and unknown, but raises no doubt in our minds of the existence and agency of such an artist, at some former time and in some place or other.'

the artifact's effect requires a particular arrangement or order in its parts. Had the artifact exhibited any other order, it would probably not have produced its wondrous effects. As Paley (1828: 10) writes, 'Arrangement, disposition of parts, subserviency of means to an end, relation of instruments to a use, imply the presence of intelligence and mind'.

Next, Paley applies the same inference to an object with extraordinary complexity, a watch that, in addition to ability to track time, is capable of self-replication. Now, the parts are more complex, and the order of parts more crucial. The most obvious inference is, according to Paley, a designer with extraordinary abilities. Let us call this additional step in the argument, the 'increasing order of complexity': the more complex the organization, the more complex the design, the more cunning the creator.

Finally, Paley applies both the 'inferential step' and the 'increasing order of complexity' to account for living things. As with the existence of the watch and the self-replicating watch, creatures and organs of the natural world demonstrate a super-extraordinary complexity, order, and arrangement. The only rational inference is a designer of sufficient intelligence and purpose. That designer must be God, according to Paley. Much of the rest of Paley's book is an ode to the complexity and intricacies found in nature.

Many commentators take Paley to infer a creator *from purpose found in objects*. Paley writes, above, that we perceive that parts of the watch are put together for a purpose. I do not read the inference the same way. If it were so, then the argument would be question begging—presupposing purpose to infer teleology. Rather, I take the inference to be similar to Aristotle's analogy between artifacts and nature (Sober 2000). Paley's 'inferential step' is similar to Aristotle's analogy between artifacts and nature. Recall, Aristotle inferred teleology from patterns of order and arrangement. The end states depend on previous parts in an appropriate position to contribute to the whole. If these arrangements are not present, either development shuts down, or the organization fails to produce a particular effect ('mistakes'). Paley's teleological inference runs the same way, from particular order and arrangements for both nature and artificial contrivances.

Yet, Paley's *telos* is an agent, a designer with intentions to create the *best* possible world while Aristotle's is immanent and relative—relative to organisms in their surroundings. Paley's goodness is global. Purpose is in the good intentions of a creator that has created the best possible cosmos. Paley's *telos* is clearly in the mold of Plato's demiurge. Since Paley's teleology is much stronger than Aristotle's both in the concept of striving for the best and in globalizing the perspective, Paley's inference requires the additional inference, 'the increasing order of complexity'. While Aristotle's inference recognizes a pattern in both art and nature, Paley's inference recognizes a pattern in art that is more exquisite in nature.

4.4. *Darwin*

Perhaps Darwin's answer to Paley's design argument was to demonstrate how the good designs in nature could be explained differently from the good designs of artifacts; replacing a Platonic creator with the blind forces of natural selection. Richard Dawkins (1986: 5) has popularized this reading of Darwin's contribution to biology:

> A true watchmaker has foresight: he designs his cogs and springs, and plans their interconnections, with a future purpose in his mind's eye. Natural selection, the blind, unconscious, automatic process which Darwin discovered, and which we now know is the explanation for the existence and apparently puposeful form of all life, has no purpose in mind. It has no mind and no mind's eye. It does not plan for the future . . . If it can be said to play the role of watchmaker in nature, it is the *blind* watchmaker.

On Dawkins's reading the *explanandum* is the same for both Paley and Darwin: the existence of highly complex and intricate creatures well suited for the task of reproduction. Darwin himself invites this reading of the explanatory role the theory of natural selection plays, since much of the *Origin* compares natural selection with artificial selection.

On this approach, Darwin's task is steep. He has to explain how natural forces could conspire to assemble products displaying intricate and complex orders and arrangements that are so well suited to the environmental conditions. Recall that most important for Paley's creator is that its intentions and powers for creation are for the *best* in a global sense. Darwin then needs to demonstrate how a non-intentional physical force (or set of forces) could produce creations that match the global standard. Some historians think that Darwin's theory succeeds: 'Here we have nature selecting, in that we have a deliberate metaphor that has nature doing what man familiarly does, but doing it much better' (Hodge 1991: 214). But there are two problems with this approach. First, by regarding the living world as full of good designs, Darwin's theory is not clearly a better explanation for their existence than the creation theory. While a Darwin supporter might succeed in showing how certain natural processes could produce good designs, there always remains a nagging doubt as to whether the blind forces of natural selection could produce so many different perfections. Second, and more importantly, this interpretation ignores one of two components of Darwin's evolutionary theory, the 'tree-of-life' hypothesis. Darwin viewed all species as sharing a history, all evolving from a single common ancestor. Darwin's theory of natural selection, the second component, explains how species evolve from ancestral species; how modifications lead new species to branch out of old ones.

The proponent of Paley's natural theology most clearly opposes Darwin's tree of life and hence sees no motivation for the theory of natural selection.

Accordingly, creationists view each species as the unique creation of an all good God and thereafter immutable and eternal. How could Darwin demonstrate the superiority of his tree-of-life hypothesis? Should Darwin infer evolution from the same perfections and intricacies that Paley viewed as evidence for God's handiwork? No. As S. J. Gould (1980: 20) puts it, 'ideal design is a lousy argument for evolution for it mimics the postulated action of an omnipotent creator. Odd arrangements and funny solutions are proof of evolution—paths that a sensible God would never tread but that a natural process, constrained by history, follows perforce'. Darwin's argument against a creator and for a non-intentional force of nature is found in the awkwardness of developmental patterns, and the seemingly poor designs of nature. Baleen whales develop teeth in neotony only for them to be reabsorbed into the baleen structure that they use to feed on krill. Why would an omnibenevolent God bother to allow whales to develop teeth that won't be used later in life? Pandas get at the tender shoots of bamboo through the inefficient process of running the stalks along an inflexible spur of bone that juts out like a thumb. Why did God give pandas this clumsy design feature?

Paley (1828: 6–7) argued that design is evident in mishaps as well, for the purpose is clear even if the system does not achieve it. However, Paley is referring to instances of failed development—for example, deformed individuals. Darwin's mishaps are flaws of type—'design' flaws from a creator's point of view. Darwin writes: 'Rudimentary organs may be compared with the letters in a word, still retained in the spelling, but become useless in the pronunciation, but which serve as a clue in seeking for its derivation' (quoted in Gould 1980: 27). To illustrate (something close to) Darwin's language example, the fact that Spanish, French, and Italian assign similar names to numbers is evidence that the words did not arise *de novo* for each language (Sober 1993: 42). See Table 1.1 for an example.

Given the data, compare a 'creationist' hypothesis with an 'evolutionary' one:

> **H** (creationist): each language is the result of an *independent* act of creation by a wise creator.

Table 1.1. Similarities between languages for words indicating numbers

Number	French	Italian	Spanish
1	*un*	*uno*	*uno*
2	*deux*	*due*	*dos*
3	*trois*	*tre*	*tres*
4	*quatre*	*quattro*	*cuatro*

H (evolutionist): the different languages are derived from modification of a common language.

In this case, the evolutionary hypothesis is clearly the better inference from the data.

Analogously, the reabsorbtion of a whale's teeth in its mother's womb is evidence that whale development is not a separate act of creation but survives as a remnant and modification (by natural selection) of an ancestral developmental pattern. In other words,

H (evolutionist): Organic traits are derived and modified from the traits of their ancestors.

better explains the evidence from 'poor' design than does:

H (creationist): Each species is the result of an independent act of creation.

Let us take stock of the importance of Darwin's answer to Paley's argument to the issue of teleology. Darwin, in gathering evidence for his 'tree-of-life' hypothesis, debunks Paley's Platonic teleology whereby organic traits are intentional designs of a supreme creator. However, by debunking Platonic teleology, it does not follow that Darwin has debunked natural teleology altogether. Platonic teleology is only one sort, Aristotelian teleology is an entirely different sort. Evidence from vestigial and 'odd arrangements' suggests that organic traits are not derived from a purposeful act of creation but rather organic traits are derived and modified from the traits of their ancestors through natural selection. That is, Darwin replaces the hand of creation with a non-intentional 'force', natural selection.

How is natural selection a teleological 'force'? I see remnants of two sorts of teleology operating in Darwin. The key to seeing both is within Darwin's concept of natural selection, which can be summed up as follows: as a result of individuals possessing different heritable abilities striving to survive and reproduce in local environments, comes an explanation for changes in trait composition of populations through time. Traits become prevalent in populations because they are useful to organisms in their struggle to survive. Aristotle's *functional* teleology is preserved through the idea that an item's existence can be explained in terms of its *usefulness* (Lennox 1993). What makes a trait *useful* is that it provides certain individuals an advantage over others in their own struggle to survive and reproduce. Secondly, the concept of individual striving to survive and reproduce plays the fundamental role in Darwin's explanation for the origins of organic diversity. The same concept reminds us of Aristotle's *formal* teleology—the striving for self-preservation. Usefulness is not a global valuation, a 'for the best' in Plato's sense, but an immanent feature of the relation between developing organism and their local

environmental conditions (including their competitors). Traits that allow the organisms possessing them to be 'better suited' to survive the struggle will be better represented in future populations. Likewise, Aristotle's 'usefulness' is a property of the individual's relation to the local environmental conditions. Recall the example: sharp teeth are in front for the sake of tearing. Sharp teeth contribute to the flourishing of organisms possessing them, whereby the flourishing depends on the carnivore's local environment.

There are significant differences between Aristotle's formal teleology and Darwin's. Compare Darwin's view of the *source* of trait variations that organisms come to possess with Aristotle's idea that the origin of traits exist for the sake of the flourishing of organisms possessing them. In Darwin's view, variants arise by 'chance'—that is, variants develop *independently* from any relation to the environment. Darwin's theory of the source of variation is distinctly unAristotlelian. In Aristotle's view, traits develop *for the sake* of the individual's self-preservation. In fact, Karl von Baer critiques Darwin on this very point (Lenoir 1982: 270). According to this critique, if 'blind necessity' is the only force operating, then the fundamental questions of biology—development, adaptation, and the like—will remain unintelligible. An explanation that strings together mechanical processes lacks the fundamental principle that connects the processes to a particular end (Lenoir 1982: 271). I interpret von Baer's criticism to be close to Aristotle's argument from regularity: the materialist lacks the principle that distinguishes one material process from any other. Consequentially, what distinguishes developmental processes that lead to living newborn from one that fails?

Another difference between Aristotle's and Darwin's teleology concerns Aristotle's concept of hypothetical necessity. Recall that, for Aristotle, an item's usefulness *constrains* the necessity of the materials. That is, *because* eyes are useful for seeing, the organic ingredients coalesce. The need to see necessitated the existence of eye materials (fluid, lids, and so on). For Darwin, this is exactly backwards: the materials constrain function. Natural selection operates on the materials (the variants) that are available to it. That's why pandas possess such an awkward mechanism for manipulating bamboo shoots. The panda's thumb is a modification of the enlarged radial sesamoid that the ancestors of pandas and its cousin species (bears and raccoons) possessed (Gould 1980: 23). The panda's thumb is a 'contraption', modified from the anatomy of what was available for selection to operate upon.

This last point, I think, begins to explain Asa Gray's remark (which I quote again): 'Darwin's great service to Natural Science in bringing back to it Teleology: so that instead of Morphology versus Teleology, we shall have Morphology wedded to Teleology' (quoted in Lennox 1993: 409; see also Amundson 1996: 32). The reference to 'Morphology' refers to a school of thought that advanced a 'unity-of-plan' theory of organic diversity. Accordingly, members of a taxonomic

group are accounted for in terms of resemblances between members of the same and other taxonomic groups. Traits that resemble each other across taxonomic groups are called 'homologues' and indicate a 'common plan' throughout nature.

Morphologists thought that picking out homologous structures constituted picking out essential categories in nature. That is, the existence of homologous structures indicates the fundamental laws of body plans.[8] However, Darwin wondered how to explain the prevalence of variants to the 'common plans'? To this he invokes natural selection. Natural selection operates over pre-existing structures competing for limited resources in a common environment. So, while structures pre-exist their adaptive uses, it is the process that produces adaptations that explain morphological change. (Note, mutations, migrations, genetic recombination, all explain the existence of variants to the common plan, but it is natural selection that makes some of these variants prevalent in certain populations.)

5. Conclusion

When we see appeals to teleology in science, it is crucial to identify what *kind* of teleology, and which kind of argument for it. While many scientists and philosophers of science have rightly rejected the Platonic *telos* with its arcane metaphysical trappings, other teleology in science is not wedded to such metaphysics. If biology has an ineliminable teleology, this is not so bad as long as it is one of the more restrained Aristotelian versions of teleology.

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[8] Some modern-day morphologists still hold this view for quite persuasive reasons. See the work of Goodwin.

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2. Evolutionary Biology and Teleological Thinking

Michael Ruse

ABSTRACT

Teleological thinking and language are things that fully permeate evolutionary biological science, even though they are absent from the physical sciences. Through an analysis looking back at the history of biology, I find the source of the difference to lie in the way(s) in which evolutionary biology, unlike the physical sciences, resembles the world of humans and their artefacts. I defend evolutionary biology from a number of criticisms suggesting that this teleology is a sign of weakness, arguing rather that the evolutionist faces problems different from the physical scientist and that teleological thinking is important and powerful.

There is something distinctive about biological language, particularly evolutionary biological language. There one finds talk of 'purposes' or 'functions' or 'ends' in a way missing from the physical sciences. In biology, it makes perfectly good sense to ask a question like: 'What function does the sail on the back of Dimetrodon serve?' Or: 'What is the purpose of the appendix in the human being?' Or: 'Do vertebrates have sex in order to spread new mutations?' None of this forward-looking language, commonly known as 'teleological' language—language where one is trying to understand the present or the past in terms of the future—seems generally appropriate in the physico-chemical sciences. No one would ask what 'purpose' or 'end' the planet Mars serves. Nor would one say that hydrogen combines with oxygen 'in order to' make water. Hydrogen does indeed combine with oxygen to make water, but it does not do so 'in order to make' water. Nor would one say that the 'function' of the sliding continental plates is to create earthquakes and volcanoes. Sliding plates do create earthquakes, but that is not their function. They do not have a function.

In this chapter, it is my intention to look at the teleological thinking of evolutionary biology, to ask about its nature. I want to see why teleological language seems appropriate in evolutionary biology, but not in the physico-chemical sciences; to ask whether in some sense such language is eliminable, and if indeed any such elimination would be desirable; and to find out if, in some sense, evolutionary biology is fundamentally and interestingly different