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Accommodating Species Evolution: Aristotle's Essentialism Revisited

by

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B.A., Philosophy, Peking University, 2010

A Thesis Submitted to The Graduate School at the University of Missouri – St. Louis in partial fulfillment of the requirements for the degree

Master of Arts in Philosophy

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PREFACE

In the fall of 2008 when I was a junior at Peking University, I attended a lecture series directed by Dr. Melville Y. Stewart on science and religion. Guest lecturers Dr. Alvin Plantinga, Dr. William L. Craig and Dr. Bruce Reichenbach have influenced my thinking on the relation between evolution and faith. In the fall of 2010 when I became a one-year visiting student at Calvin College in Michigan, I took a seminar directed by Dr. Kelly J. Clark on evolution and ethics. Having thought about evolution/faith and evolution/ethics, I signed up for Dr. Irem K. Steen's natural kind seminar which had a focus on evolution and essentialism in the fall of 2011 when I became a graduate student at UMSL.

This initiated the present project. In the seminar I studied various arguments from new biological essentialists against evolutionary theorists. While contemporary discussions are flourishing under the assumption that an essence is an essential property, I thought that Aristotle's original conception of essence might be different and might move the debate forward even more. I tried to see whether Aristotle has theoretical resources to respond to the vagueness problem in philosophy of species. I wish I could expand more on the significance of Aristotle's doctrine of four causes.

I took Dr. Jon McGinnis' Aristotle seminar in the spring of 2012. There I studied Aristotle's metaphysics more extensively, especially how his hylomorphism shapes his conception of essence. By this time I realized that Aristotle may not endorse the property essentialism favored by new biological essentialists. Given the causal and explanatory priority Aristotle ascribes to essence, I suspended property essentialism and tried to develop an alternative conception of essentialism. To explore the tension between Aristotle's essentialism and species evolution, I wrote a term

paper in which I reached an agnostic position regarding what initiates a change in the potentiality of matter. I wish I could examine deeper the tension between Aristotelian natural teleology and evolution.

In the fall of 2010 I did a research paper on evolution and natural teleology in Dr. Andrew Black's class philosophy of science. I struggled with whether Aristotle's teleology of individual organisms is compatible with the randomness of evolution, and whether Aristotle would think that evolution as a whole has a purpose. In my paper I forced myself to draw a distinction between two senses of nature which I now dislike because of its artificiality. I wish I could incorporate Aristotle's doctrine of the unmoved mover into my thinking.

When I started drafting a thesis on the relation between Aristotelian essentialism and species evolution, the biggest challenge is the paucity of literature. Many have written on Aristotle's metaphysics and philosophy of biology; many have written on evolution. Few have built a dialogue between the two. At the start this made it hard for me to see what the problem is. Books I found particularly helpful in forging connections are Allan Gotthelf's *Teleology, First Principles and Scientific Method in Aristotle's Biology*; David Charles' *Aristotle on Meaning and Essence*; James Lennox's *Aristotle's Philosophy of Biology*; Michail Peramatzis' *Priority in Aristotle's Metaphysics*; Jeremy Kirby's *Aristotle's Metaphysics: Form, Matter and Identity*; Michael Ruse's edited *Oxford Handbook of Philosophy of Biology*; Ernest Nagel's *Teleology Revisited and Other Essays in the Philosophy and History of Science*. I have not been able, however, to digest Mariska Leunissen's scholarship *Explanation and Teleology in Aristotle's Science of Nature* and John Dudley's scholarship *Aristotle's Concept of Chance*. I wish the limitations resulting from my

ignorance of their insightful perspectives will not become too big a hindrance to the readers' appreciation of the depth of the problem at hand.

This intellectual journey never lacks sphinxes and solitude. It is a normality to read articles after articles and books after books without being able to locate even one piece of information that is sensitive enough to my problem. I ended up gleaning flashes of insight in the literature that speak directly to my problem. Then I would try developing those insights into arguments to be used. The comfort is that this challenging yet creative writing experience has conferred me courage and cheers.

I am extremely grateful for the philosophy department at UMSL, which has academically and financially supported my education. I have been incredibly fortunate to have intelligent and invaluable feedback from Dr. Jon McGinnis, who has engaged me in extended talks and encouraged me in earnest thinking. I would like to thank my professors Dr. Eric Wiland, Dr. John Brunero, Dr. Andrew Black and Dr. Berit Brogaard, who have shaped my philosophical pilgrim. I owe my thanks to the philosophy department's administrative associate Mrs. Nora Hendren, who has breathed the enduring words of wisdom for my study and life.

ABSTRACT

In this paper I argue that Aristotelian essentialism is compatible with species evolution. My argument has two premises: (1) Aristotelian essentialism can describe what is going on with species evolution; (2) If Aristotelian essentialism can describe what is going on with species evolution, Aristotelian essentialism is compatible with species evolution.

To support my first premise, I suspend "property essentialism" and develop a teleological conception of Aristotelian essentialism in terms of matter and form as potentiality and actuality. I propose and explicate my "multiple-potentiality strategy" that matter has multiple potentialities. I apply this strategy to describe what is going on with species evolution. I draw a distinction between proximate potentiality and remote potentiality. To support my second premise, I refute the argument from non-actuality, the argument from randomness and the argument from functional reducibility.

I also show the inadequacy of the argument from goal-directedness, the argument from wellbeing and the argument from discernibility, all of which seem to count in favor of Aristotelian essentialism. I argue that my multiple-potentiality strategy can enhance these arguments.

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Introduction

"One of the most important things we have learned from Darwin (but some philosophers, alas, still don't get it)," says Daniel Dennett, "is that essentialism is simply a mistake" (2011:475). "If to continue a species is to continue replicating its form," James Lennox explains, "it does entail fixity" (2001:155). Elliott Sober contends, "essentialism about species is … a dead issue" (1980:249). Indeed, an "evolving essence" sounds absurd (Richard 2010:75).

New biological essentialists have tried to rescue essentialism. Richard Boyd claims that an essential property need be neither necessary nor sufficient for species membership. A property is essential if it belongs to a "homeostatic property cluster" (1999:1). Samir Okasha asserts that Darwinian evolution rejects intrinsic essentialism yet reserves relational essentialism (2002:191). An organism has species membership by interbreeding with other species members. Michael Devitt distinguishes the "taxon problem" from the "category problem" (2008:344),[1] and says that there are intrinsic essential properties if some "indeterminacy" is allowed (Devitt 2008:373). Yet new biological essentialists all assume that an essence is an essential property.[2]

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[1] The taxon problem is "what makes an organism an *F*?" The category problem is "what makes a group of *F*s a species?"

[2] All attempts have received criticism. Take Okasha's relational essentialism for example. It cannot explain law-like generalizations biologists make based on intrinsic properties. Merely saying a zebra interbreeds with another zebra does not offer an explanation of law-like generalizations such as "zebras have stripes" (Ereshefsky 2010). Interbreeding also fails to report the nature of a species. Even if it

In this paper I want to show that Aristotelian essentialism is compatible with species evolution without assuming "property essentialism." Aristotle did not entertain the idea of evolution, which would have appeared to him a "wild cosmological speculation" (Lennox 2001:178). Yet David Balme says, "there is nothing in Aristotle's theory to prevent an 'evolution of species,' *i.e.*, a continuous modification of the kinds being transmitted" (1972:97). Given that much of Aristotle's work in biology "has stood the test of time" (O'Rourke 2004:7), it is worthwhile to see how he might accommodate species evolution.

In Chapter One "Situating the Puzzle," I begin by recapping Charles Darwin's *Origin* and posing the leading question of our inquiry. Then I review Aristotle's distinction between accidental change and substantial change, and claim that species evolution involves the latter. Contra "property essentialists," I argue that the Aristotelian essence of a living thing is not an essential property of the living thing, but rather the formal nature of the living thing. I urge that Aristotelian essences of species are ontologically and biologically dependent upon matter. I formulate Aristotle's essentialism in terms of matter and form as potentiality and actuality.

In Chapter Two "Stating the Proposal," I offer my key to resolve the tension between Aristotelian essentialism and species evolution. This key—multiple-potentiality strategy—is explained and applied to answer our leading question posed in the beginning. Then I offer my compatibility argument—the central argument of

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tells us what makes a group of organisms one species, it does not tell us "in virtue of what" a species is a species of *F* instead of a species of *G* (Devitt 2008).

this paper—and draw a distinction between "proximate potentiality" and "remote potentiality" to defend the first premise.

In Chapter Three "Striking the Prosecutors," I examine the plausibility of the second premise in my compatibility argument. I differentiate two senses of compatibility on which the consequent of this premise can be read. I concede that the premise can be non-trivially true only if it works with the strong sense of compatibility. I will consider and counter arguments that count against the strong reading of the second premise. These arguments are the argument from non-actuality, the argument from normativity, the argument from randomness and the argument from functional reducibility. This critiquing process will show that the second premise in my central argument is very probable.

In Chapter Four "Stimulating the Protectors," I show the inadequacy of alternative arguments in support of my compatibility thesis. Arguments I examine include the argument from goal-directedness, the argument from wellbeing and the argument from discernibility. I show how my multiple-potentiality strategy can enhance these arguments. This is to provoke protectors of my compatibility thesis to move beyond their approaches and see the significance of my proposal.

Chapter One: Situating the Puzzle

A. Darwinian Evolution

According to Darwin, limitations of resources in the natural environment make the struggle for existence, both across and within species, the driving force of evolution (2009:65).[3] Without the struggle for existence population growth will be unchecked. Elephants, one of the slowest reproducing animals, can populate the earth by fifteen million in 500 years (2009:67). While mutations and variations in traits or phenotypic properties randomly occur without attending to the needs of organisms, certain novel traits are beneficial in the struggle for existence (2009:50). Individuals with greater fitness are more likely to survive and reproduce. Mechanisms of inheritance pass beneficial traits onto descendents (2009:64;84-86;106;159). Natural selection is the principle by which beneficial traits are preserved. Descendants from a common species can become increasingly divergent in traits and eventually different species (2009:112-115).[4] How can successive changes in traits of species members generate a change in the essence of a species? Let this be our leading question.

[3] Various attempts have been made to refine Charles Darwin's main point in *Origin* (Ruse 1975; Thagard 1978; Lloyd 1983; Recker 1987; Kitcher 1985; Waters 1986; Sintonen 1990; Hodge, 1992).

[4] There is a debate over whether the unit of evolution is individuals or species (Brigandt 2009:82,85; Sober 1980:370; Walsh 2006:433-434; Fisher 1930; Wright 1931; Hodge 1992; Morrison 2000). We need not enter this debate because it is a debate over epistemological contexts and pragmatic interests rather than metaphysical principles (Brigandt 2009:86; Dupré 1999).

B. Accidental and Substantial Change

Since evolution is a type of change, what is Aristotle's view on change?[5] Aristotle thinks that change is real and divisible into two kinds (Coope 2009:277). Firstly, there is accidental change—the "alteration" of properties of an object. Accidental change can happen, for instance, to quality (Chameleon from dark to bright) or quantity (Simmias from three-feet tall to five-feet tall). In an accidental change the "contraries" are "replaced" while the substance persists (Cohen 2009: 13; *Met*. XII. 2, 1069^{b}3-9).

Secondly, there is substantial change—the "generation/destruction" of an object (*Phys.* III.1 200^{b}33–4). A substantial change happens, for instance, when a bronze statue comes into being out of a lump of bronze, a house out of woods and bricks, or an oak out of an acorn. Since a statue comes not from the "contrary" of a statue (*Catg.* 3^{b}24), substantial changes do not happen on the level of opposite properties (Cohen 2009:7).

Yet Aristotle rejects the idea that nothing persists in a substantial change (*GC* 317^{a}33-317^{b}6). "Substances … also come to be from some underlying thing … [T]here is always something which underlies what comes to be" (*Phys*. 190^{a}32-^{b}5). If nothing at all persists through substantial changes, any change through which something does persist can only be deemed accidental (Cohen 2009:12). Since a lump of bronze underlies a change by which a bronze statue is generated, it could be argued

[5] Although several Aristotelian concepts – substances, matter, form, essence - may seem helpful, pertinent exegetical problems are many and huge. Rather than carving out the "exegetical space" and engaging in exegetical debates (Fine 2001:14), I will make "interpretive decisions" where it is necessary (Kirby 2008:8).

that the lump of bronze undergoes merely an accidental change by gaining the property of "being a statue" (*GC* 317^{b}17-19).

To defend the distinction between two kinds of changes, Aristotle distinguishes substantial forms from accidental forms (Oderberg 2011:94). The form of statue that a lump of bronze takes on is substantial, because it unifies a lump of bronze into a statue. The form of "being tanned" that Socrates takes on is accidental, because it does not unify Socrates into Socrates. "Something is a definite thing rather than a heap," Catherine J. Deavel says, "because the form unifies the matter as a substance … [T]he form is the *cause* of the unity of definite things" (2003:167). Given the difference between substantial and accidental forms involved in changes, the distinction between two kinds of changes is robust.

Accidental changes allow a further division because there are two kinds of accidents. Consider three features of Socrates: (1) being rational; (2) being able to learn grammar; (3) being pale. According to Aristotle, "being pale" is a non-necessary accident of Socrates, because Socrates is still Socrates even if he is not pale. "Being rational" is part of the essence of Socrates (Durrant 1975:596). Although "being able to learn grammar" is an accident of Socrates that is not part of his essence, it is necessary because it "flows from" Socrates' essence (Oderberg 2011:104). Charlotte Witt says, "An entity can have necessary properties that are not part of its

essence" (1989a:107).[6] A necessary accident is what Aristotle calls a "*proprium*" in *Topics*:

> It is a *proprium* of man to be capable of learning grammar; for if a certain being is a man, he is capable of learning grammar, and if he is capable of learning grammar, he is a man. For no one calls anything a *proprium* which can possibly belong to something else; for example, he does not say that sleep is a *proprium* of man. ($102^{a}20$-25)

Fran O'Rourke asks "whether a series of 'accidental changes' can amount to a change in the specific nature of the offspring" (2004: 27). B.A. Brody says "when a sufficient number of the right properties have changed, one says that there is now a new object … not a new state of the old object" (1967: 435) Notice, however, that we should not ask how changes in necessary accidents may generate a change in essence, if necessary accidents "flow from" the essence. Since species evolution involves substantial changes, our leading question concerns only how successive changes in non-necessary accidents can generate a substantial change in species, *i.e.*, a change in the essence of species.

C. Aristotelian Essentialism

1. Property Essentialism

Despite Aristotle's straightforward claim that "the essence of each thing is what it is said to be in virtue of itself" (*Met.*$1029^{b}10$-$1029^{b}16$; $1017^{b}23$; $1043^{a}22$; $1029^{b}22$;

[6] A non-necessary accident may nevertheless become necessary as the level of generality varies (Peramatzis 2011:198). "Having long legs" or "webbed feet" are not necessary accidents of a bird, but are necessary accidents of a crane (Lennox 2001: 174).

$1030^{b}5$; *Top*. $101^{b}38$-$102^{a}1$), clarification of this concept has been difficult. The prevailing view is "property essentialism" (Oderberg 2011:87) according to which an essence is an essential property. Alexander Bird defines essences of individuals as "properties that those individuals possess essentially" (2009:1). Essential properties are a set of necessary accidents "more closely tied" to what it is to be a thing (Cohen 1978a:395; Oderberg 2011:89).

Jeremy Pierce has observed that property essentialists face a "vagueness problem" (2011:10-15). There is no clear standard to privilege a set of necessary accidents as essential (Oderberg 2011). We do not know whether an IQ of 68, 69 or 70 is essential to being human (Hill 2007:22). More seriously, property essentialists conflate necessary accidents and the cause of necessary accidents (Witt 1989b:288). Aristotle takes essences as causally and explanatorily basic (*Apo* B.2 $90^{a}14$-15; B.8 $93^{a}3$-4).[7] But an essence cannot be both a set of necessary properties and their cause (Oderberg 2011:94). As a set of necessary accidents, essential properties cannot be causally responsible for themselves (Witt 1989a:106; 108). Property essentialists commit a category mistake (Durrant 1975:596) by overturning the explanatory priority of essence (Witt 1989b:298).

But what is an essential property if not an essence? Recall that Brody defines "essential property" as follows: "an object o_1 has a property P_1 essentially just in case o_1 has P_1 and would go out of existence if it lost it: just in case the loss of it would involve a substantial change." In contrast, "an object o_1 has a property P_1 accidentally

[7] A detailed account of the causal link is admittedly absent from Aristotle's works (Charles 2000:339).

just in case o_1 has P_1 but could lose it without going out of existence: just in case the loss of it would involve a mere alteration" (1973:354).

Yet it seems to me that an essential property so defined is, according to Aristotle, just a necessary accident. "If [the property essentialist] wishes, she can … maintain her devotion to contemporary usage by calling every feature of a thing a property of it," Oderberg says, "not much is to be achieved … except obfuscation … The essence of a thing is distinct from its properties" (2011:98). It was traditionally held that thunder has the essential property of "fire-quenching" which is causally responsible for thunder's being noisy, being accompanied by lightning, etc (Charles 2000:202). But Michail Peramatzis contends that "fire-quenching" is just part of the essence of thunder (2011:187). I hold likewise that "being rational" is not an essential property of humans, but part of the essence of humans.

2. Form and Matter

Having questioned property essentialism, I now turn to a positive account of Aristotle's essentialism. For Aristotle, each living individual is a hylomorphic compound. Essence is what it is to be a thing *formally*—substance without signate matter (*Met.* $1032^{b}11$-14). As such it is a principle of life that organizes the constitutive matter into a living thing (Yu 2001). The essence of a species is the principle of life for all the members of that species.

Species members are one in form. "For Aristotle, to speak of 'one form' or 'the same form' is to speak of a respect in which many matter/form composites are

indistinguishable" (Lennox 2001:153). Socrates and Callias are one in the human form despite the differences "in virtue of their matter" (*Met.* 1034^{a}5-1034^{a}9). Species members are one in form to emulate immortality (*GA* II.1 731^{b}31–5; Peramatzis 2011:196; Hankinson 2009:219). "That which comes into being is eternal in the way that is possible for it," says Aristotle, "now it is not possible in number ... but it is possible in form. That is why there is always a kind—of men and of animals and of plants" (*GA* II.1 731^{b}33-732^{a}1). Lennox adds, "an individual organism is eternal in form if it is the product of, and in turn has a natural disposition to produce an individual, the general essence-revealing account of which is identical with its own" (2001:146).

But a species-form cannot merely be a principle of life; otherwise one species-form is not different from another (Oderberg 2011:95; Shields 2007:292). Species-forms render matter of organisms determinate differently (*Met.* 1029^{a}9-30). There is no pure matter in the biological world. Matter stripped of any form is, according to Aristotle, not matter except homonymously: "the soul … is the essence of such and such a body … [I]f an eye were an animal, its soul would be sight … The eye is the matter of sight; if sight is lost, it is no longer an eye, except homonymously, in the way that a stone eye or painted eye is" (*DA* 412^{b}10–21).

Aristotelian essences as forms are ontologically dependent on matter. Even if a form of statue can persist without a particular lump of bronze or even without bronze in general, it will disappear if all constitutive matter of statues disappears. As Peramatzis observes,

> [A] form cannot be defined without mentioning *a range of* certain matter: e.g. being made of bulky, malleable, solidifiable, and wrought-able materials, the types of material feature appropriate to characterize essentially the relevant statue-form.(2011:173; my italic)

Aristotelian essences as forms are also biologically dependent on matter. Biologists no longer assume that the information in genes stand to organisms as form stands to matter (Goyette 2002; Pearcey 1996; Kass 1994; Stewart and Cohen 1994).[8] The information in genes is not a "blueprint" that dictates changes in phenotypic properties. Biologists have proposed instead that "changes in gene frequencies within a population are … the causal consequence of changes in individual phenotype" (Walsh 2006: 440). As Denis Walsh calls attention to "genetic accommodation,"

> For any novel phenotype, there may be within the population many *alternative* gene-regulatory networks, or systems of modules, capable of producing it; some will be more efficient than others, some will be more robust. Phenotypic accommodation exposes the latent genetic variation within the population. This variation is then subject to selection (2006:439).

Further, the matter of organisms can preserve the form of a species by providing subsidiary parts whose natural function is to increase the wellbeing of species

[8] West-Eberhard has proposed that "plasticity is the ability of an organism to react to an internal or external environmental input with a change in form, state, movement, or rate of activity" (2003:33). Yet one could argue that such plasticity belongs to matter instead of form. After all, Aristotle is cautious about attributing configuration or shape to form, "a dead body has exactly the same configuration as a living one; but for all that it is not a man. So also no hand of bronze or wood or constituted in any but the appropriate way can possibly be a hand in more than name. For… it will be unable to perform its function. (PA i.1 640b35- 641a4)

(Leunissen 2010:130). Given the ontological and biological dependence of form upon matter, I shall formulate Aristotle's essentialism but in terms of both matter and form.

3. Potentiality and Actuality

What is matter and what is form? I draw on Vasilis Politis' "process-based" understanding of the Aristotelian matter. To be matter is not simply to be material, but to be material "in the process of the generation of things" (Politis 2004:58; *GA* II.1 $733^{b}32$-$734^{a}6$). Specifically, matter is in a process to take on a substantial form (*Phys*. $194^{b}32$-5; $193^{b}13$-18). The matter of Socrates is not merely the flesh and bones of Socrates, but the flesh and bones that are becoming Socrates (*Phys.*$192^{b}34$-$194^{a}1$; $^{a}3$-7). Matter without form lacks the "dynamic structure which orients them by natural tendency" (O'Rourke 2004:24). Matter and form thus stand to each other as potentiality stands to actuality. "There must pre-exist something which *potentially* is," Aristotle says, "but *actually* is not" (*GC* $317^{b}15$-$317^{b}17$). For instance, bricks potentially are a house that is yet to come (Coope 2009:278). "In all possible contexts," Peramatzis says, "potentiality for change is the only or the most prominent part of [Aristotle's] conception of matter" (2011:146). Thus I define Aristotle's essentialism as follows:

> Aristotelian Essentialism $=_{defn.}$ The essence of a species is the form or formal nature that actualizes the potentiality of the matter or material nature of individuals in that species.

For any individual organism, having the essence of a species entails having the matter with a certain potentiality, the actuality of which is the form of that species.[9]

A substantial change happens when what potentially is becomes what actually is. Yet a change in the essence of species—a substantial change in species—has two stages: an individual that potentially is *F* first becomes what potentially is *G*, and then becomes what actually is *G* (Witt 1989a:130).[10] A substantial change in species is not an event in which a new species with one actuality directly replaces an old species with another actuality. That a rabbit supersedes a pigeon is a magic trick that happens not in nature. Essentialism will be magic if essentialists claim that what actually is *F* can become what actually is *G*. But essentialism seems more plausible if essentialists need only say how what potentially is *F* can become what potentially is *G*.

[9] Aristotle distinguishes between "first actuality" (the process) and "second actuality" (the result). But this distinction need not concern us here.

[10] Speciation can be allopatric, peripatric, parapatric, sympatric, artificial, or hybrid. Molecular phylogenetic studies indicate, for instance, that what potentially is a member of *Pinicola* may become what actually is a member of *Pyrrhula*. Both species belong to the clade of bullfinches.

Chapter Two: Stating the Proposal

A. Multiple Potentialities

I hereby offer the key—my multiple-potentiality strategy—to resolve the tension between Aristotelian essentialism and species evolution. The multiple-potentiality strategy aims to draw on the flexibility in the potentialities of matter. This is the crux of this strategy: Aristotelian matter has multiple potentialities such that what potentially is a member of species *F* can change into what potentially is a member of species *G*. This places much "responsibility" of resolving the tension on the significance of matter. Mariska Leunissen testifies,

> [T]he material nature of an animal has a much larger and more positive influence on the generation of animals and their parts than is usually attributed to it: the material nature does not merely constrain the realizations of parts necessary for the animal's life or being, but also creates possibilities for the formal contribution to the animal's wellbeing or even produces parts independently of the actions of the formal nature. (2010:131)

To illustrate, let us consider an example of inanimate things first. A raw gold supplier wants some gold chalices and so gives some gold to an artisan. The artisan makes lots of gold chalices. Yet the artisan also makes some gold necklaces for self-amusement.

We have some actual gold necklaces in the end. To become gold necklaces in actuality, the pieces of gold must once be gold necklaces in potentiality. Each piece of gold was also a gold chalice in potentiality, since the artisan can choose to turn each piece of gold into a gold chalice as intended by the supplier. Thus it is evident that all

pieces of gold in the artisan's hands have two potentialities only one of which is actualized. In some cases, a change in the artisan's goal initiates a change in the potentiality of gold. Thus what potentially are gold chalices become what potentially are gold necklaces, which further become what actually are gold necklaces.

Suppose the raw material supplier later discovers that the artisan has made some gold necklaces other than gold chalices. The supplier asks, "Is it out of my gold that you made these gold necklaces?" The artisan says Yes. The supplier wonders, "But my gold is supposed to be turned into gold chalices!" The artisan says, "Sometimes I make gold necklaces to amuse myself. And I used your gold."

The supplier is surprised to see an unexpected potentiality of his gold realized. It does not matter whether there is one gold necklace or ten necklaces. All it takes for the supplier to be surprised is one gold necklace, because one is enough to show the presence of an unexpected actuality of his gold.

Now consider a slightly different case. A raw gold supplier goes to an artisan with some gold and says, "Please make some gold chalices. And if some gold is unfit for chalices, make some gold necklaces out of them. If some gold is not even fit for gold necklaces, use them to make some gold leaves that can be used to adorn sushi. I'll leave it to your judgment which piece of gold is fit for what outcome." The artisan ends up making some gold chalices, some gold necklaces and some gold leaves to adorn sushi.

The new feature in this case is that the supplier already knows all three potentialities his gold has: gold chalice, gold necklace, and gold leaf. Since the

supplier leaves the judgment to the artisan regarding which piece of gold is suitable for what outcomes, the supplier does not have control over what potentialities will get realized. Nevertheless the supplier will not be surprised this time if in the end he sees some gold necklaces or gold leaves. It is worth noting, further, that the supplier will have this confidence: the gold chalices will be the artisan's first priority in considering what to turn a piece of gold into, the gold necklaces the second priority and the gold leaves the third priority.

Now consider the fundamental particles that make up the matter of living things. Such fundamental particles are physical and subatomic. These subatomic particles can change with respect to how they are arranged in space. Some but not all changes in the arrangement of subatomic particles will result in changes in the arrangements of atoms. If the atoms in question are those that make up genes, genetic changes will occur. Still, not all genetic changes will affect the potentiality of matter. Indeed, even in those cases where some genetic changes result in a change in the potentiality, it is admittedly far from clear to us what the intermediate links are. But in the present inquiry we do not have so much an epistemological responsibility of specifying how genetic changes can result in changes in potentiality, as we just have to make the metaphysical recognition that genetic changes sometimes give rise to new species. That biological fact alone suffices to show that genetic changes sometimes result in changes in the potentiality of matter, for without a change in potentiality in the first place, no change in actuality can ever obtain. Thus some genetic changes will cause changes in the potentialities of the constitutive matter of living things.

Accordingly, the constitutive matter will realize a different actuality other than the actuality which would have been realized had there not been a change in the potentiality. Given Aristotelian essentialism, once a different actuality is realized, a new essence is realized. To say it in a more "historically correct" way, once a different potentiality is being developed, it is already a new essence or form that is guiding the biological growth. Notice that our account is different from a rabbit-pigeon magic, because our explanatory chain starts from a change in the undetermined potentiality from an old one to a new one, and ends with a determined actuality which is the natural culmination of the new potentiality. In the rabbit-pigeon magic, what the magician does, at least in the audience's eyes, is to starts with an already determined actuality and, without any natural course of development, immediately ends with a new determined actuality.

A one-one correspondence certainly exists between one potentiality of the constitutive matter and one actuality of the constitutive matter. Nonetheless, we must keep in mind that no such one-one correspondence exists either between one way fundamental particles of the constitutive matter of organisms are arranged and one way genes can be, or between one way genes can be and one potentiality of the constitutive matter. This is why I used the word "some" twice in the preceding paragraph. The number of ways in which fundamental particles can be arranged exceeds the number of the ways genes can be, which in turn exceeds the number of all potentialities of the constitutive matter. It is very likely that all three numbers are infinite. But for the multiple-potentiality strategy to work, it does not have to be so.

The multiple-potentiality strategy still works even if some or all of the three numbers are finite. It is important simply to keep in mind that although a slight change in number, size or shape of fundamental particles will, strictly speaking, changes the way fundamental particles are arranged, such change need not (though it may) cause a change in the way genes are. Likewise, many different ways genes are can yield the same potentiality of matter. After all, not all genes have an impact on species essence, not to mention that genes that do have an impact on species essence may fail to be manifested.

B. The Dissolution of the Leading Question

At the end of the first section of Part I, I posed the leading question for our inquiry. I asked, "How can successive changes in traits of species members generate a change in the essence of a species?" Now seems a good time to answer this question.

According to my multiple-potentiality strategy, the reason why a change in the essence of a species happens is ultimately not to be found in observable successive changes in the traits of species, because it is changes in arrangements of fundamental particles rather than observable accidental changes that are the ultimate driving force why species evolve. Nonetheless biologists often use observable successive accidental changes at the phenomenal level as a guide to tell whether a new species has evolved. Biologists, of course, cannot be *always* wrong.

To relax the tension, notice first that it is perfectly possible for changes in fundamental particles to generate accidental changes on the phenomenally observable

level. In that case what goes on at the fundamental level and what goes on at the phenomenal level will not come apart. To be sure, the reverse is always true: accidental changes cannot happen without there being some changes in the arrangement of fundamental particles. Accidental changes which biologists find as relevant to decide whether species essences have changed are sometimes a useful guide, but they are just not the ultimate criterion of whether species evolution has happened. This is so because arrangements of fundamental particles can change without the biological matter manifesting phenomenal accidental changes at all or without manifesting them in an easily observable manner.

Suppose there is a change in the arrangement of certain fundamental particles which result in genetic changes that alters the potentiality of the constitutive matter of some organism. But imagine that no observable accidental changes occur. In this case there is a change in essence of species, which makes species evolve. But biologists cannot discover this, because there is no phenomenal evidence. This is one possible source of conflict between a biologist and an essentialist.

Suppose that some observable accidental changes occur as a result of some changes in the arrangement of fundamental particles. But imagine that no genetic changes occur, which makes it impossible for changes in potentialities of the constitutive matter to take place. In this case biologists observe something that should not be taken as decisive evidence for species evolution. Genetic studies should accommodate studies of physiological and anatomical features.

Now I want to draw attention to a hard case in which my answer to the leading question seems to have unfavorable bearings on biological practice.

> (HARD CASE) Imagine this combination of changes. Changes in the arrangements of fundamental particles first happen. Next changes in genes happen. Then easily observable accidental changes happen. But the potentiality of the constitutive matter remains unchanged.

What would biologists say when they encounter this combination of changes? It seems that they *can* say, "Farewell to Aristotelian essentialism! This species surely evolved. Look! We have new genes and new traits." But the "Aristotelian fact" is that species evolution has not occurred in the hard case, since no change in potentiality means no change in essence. Here lies the really serious conflict between Aristotelian essentialism and contemporary biologists' conception of what species evolution is. Unless I can find a way to settle this conflict, the compatibility advanced in this paper will undoubtedly fail.

There seems to be two possible approaches towards reconciliation. One might be called "compromised essentialism and uncompromised evolution," and the other "uncompromised essentialism and compromised evolution." Let us examine them in turn.

1. Compromised Essentialism and Uncompromised Evolution

If Aristotelian essentialists are willing, in the hard case, to compromise their position, what will the modified essentialism look like? Essentialists should concede that

species really evolved. Accordingly, there must have been a change in essence, which makes a change in potentiality necessary. But the hard case is set up such that there is no change in potentialities of the constitutive matter. The essentialists must explain how it is possible for essences to change without there being any change in potentialities of the constitutive matter. This is logically impossible on Aristotelian grounds. So the first approach is down.

2. Uncompromised Essentialism and Compromised Evolution

If biologists compromise their position, what will the modified conception of evolution look like? Biologists should concede that the species really has not evolved, despite all the scientific evidence pointing to the contrary. Is there any motivation for biologists to concede this point? There does not seem to be any. But since biologists' compromise involves no logical contradiction, here lies our hope for reconciliation.

To achieve the compatibility thesis, the biological side has to yield. In the hard case while the observed evidence tells biologists that a species has evolved, the species remains the same. Biologists may protest that unless essentialists have equally good evidence for their position, biologists ought not to yield. Although this may sound like a reasonable demand in its own right, it is not the job of an Aristotelian essentialist to point to biological evidence in order to justify essentialism. Aristotelian essentialism, as a metaphysical position, is never meant to threaten contemporary biological theory and practice. If biologists did not come with anti-essentialist metaphysical commitment, biologists would not insist that the phenomenal

appearance of evolution must overturn essentialism. Both essentialism and anti-essentialism, as metaphysical frameworks, can organize the scientific data found by biologists. After all, it is a metaphysical dispute as to *when* a hard case happens and *how* its occurrence can be discerned. For biologists, it is nothing unscientific to remain metaphysically neutral: *should* such an experimentally opaque hard case ever occurs, just make some room for essentialists so that they can pursue their metaphysical project. Hard cases are never meant to be biologists' headaches. Our leading question, or rather our leading confusion, gets dissolved at this point. I shall now turn to some positive construction.

C. The Combatility Argument

If there is a change in the matter from developing one potentiality to developing another potentiality, there will accordingly be a change from realizing one actuality to realizing another actuality. Then a change in essence will result. This is how species evolution is intelligible on Aristotelian grounds. In other words, Aristotelian essentialism is capable of describing what is going on with species evolution in its own terms. The central argument in this paper—my argument for the compatibility thesis—can therefore be formulated as follows:

> (COM-P1) Aristotelian essentialism can describe what is going on with species evolution.

(COM-P2) If Aristotelian essentialism can describe what is going on with species evolution, Aristotelian essentialism is compatible with species evolution.

Therefore, (COM-C) Aristotelian essentialism is compatible with species evolution.

Broadly speaking, what I have said from the beginning of this paper is an attempt to establish the plausibility of P1. That is, the whole process of "situating the puzzle" in Chapter One can be seen as part of my attempt to describe what is going on with species evolution. My multiple-potentiality strategy and my answer to the leading question in Chapter Two "Stating the Proposal," in particular, are aimed at bringing out a lesson about how the potentialities of matter can change and result in a change in species essence. This is also to describe, in Aristotelian terms, what is going on with evolution. But to firmly establish P1, let me say a few more words.

Whenever species evolve, it is thought that some *new* essence is realized. So whenever species evolve, there had been a change in the potentiality possessed by the constitutive matter as a result of a change in the way the fundamental particles were arranged.

But here is a worry. I claim that whenever species evolve there had been a change in the potentialities of matter. This claim seems to entail something odd: all the potentialities for every present species must already exist before anything evolved at all. To see how, recall that every present species has an essence that is the actuality of a potentiality. Now, if the variety of potentialities *merely* depends on the

arrangement of fundamental particles, we should accept that the matter of *any* living thing—which once existed, now exists, and will exist—must contain every possible potentiality. Presumably the fundamental particles of any living thing *can* be arranged in any way. Thus every possible potentiality is contained in the matter of any living thing. But then any living thing would have innumerous alternative potentialities to develop. Indeed, every potentiality for every essence that has existed and every essence that has existed are live options for just any organism. The biological boundary between species essences seems too conveniently crossable. Would evolution not be chaotic if descendent species can evolve back into ancestral species, or if species can easily take on the essence of something that belongs to a totally different genera? But according to the description I offered, there is nothing to stop evolution from being that chaotic. As long as the fundamental particles of a human fetus rearrange properly, the fetus will grow into a zebra.

I admit that on the multiple-potentiality strategy I develop, it must be possible for the matter of fish to have the potentiality to become a pigeon, or the matter of human to have the potentiality to become a zebra. To the opponent's credit, I would now make some qualifications about the language of "new" or "old" essences. Strictly speaking, every species essence, which has existed in history, already existed in potentiality of the matter of the first living thing at the beginning of evolution. There are, strictly speaking, neither "new" nor "old" essences or species forms. The language that old species evolved into new species is acceptable only in the following sense: this has been how evolution manifolds itself in a temporal order. There are

earlier comers and later comers into the natural world, and biologists call those earlier comers "old" species and later comers "new." But strictly speaking, both potentialities and actualities of the later comers are every bit as "old" as those of the earlier comers.

Having said so, I maintain that the multiple potentiality view will not mess up the order of evolution. To see why, let us draw a distinction between "proximate potentiality" and "remote potentiality." To introduce this distinction, consider the following scenario.

Suppose a group of passengers are boarding the flight AA1166 from Saint Louis to New York City. As scheduled by the airline company, the flight lasts 2 hours. Suppose we ask one passenger before boarding the place, "Do you think the plane potentially is to arrive at New York?" This passenger answers, "Why not? I paid $170 for the ticket! It had better arrive in New York, or I will miss my meeting and sue the airline." When we press for a direct answer, he says, "Unless there is something like a terrorist attack, the plane is not only potential to land on New York but will most likely land there in 2 hours." The confidence with which our interviewed passenger responds shows that there is a sense in which the plane is not merely potentially arriving in New York, but "very much" potentially arriving in New York. Notice, however, that there is a sense in which Flight AA1166 has the potential to land on Washington, or Los Angeles, or Paris, or Cairo, or probably anywhere on earth, provided that it has sufficient jet fuel and electricity.

Now, the sense of potentiality in which the plane is potentially landing in New York is "proximate" potentiality. In our case, it is proximate because of the schedule of the airline company. If nothing abnormal such as a terrorist attack happens, the plane will take its scheduled course and realize this potentiality. In contrast, the sense of potentiality in which the plane is potentially landing in anywhere on earth is "remote" potentiality. In our case, a remote potentiality of the plane's destination is more like a bare possibility that the plane has and is fairly unlikely to obtain if things go normally.

To explicate this distinction further, let us imagine a terrorist attack does happen and the plane is forced to land in Bermuda in the Atlantic Ocean. Suppose Bermuda is home to the terrorists hijacking the plane. They have other bases in Hawaii and Honolulu. Imagine the passenger we happen to ask is one of those terrorists. So we ask him, "Do you think the plane is potentially landing in New York?" Suppose that this terrorist passenger is well aware of the distinction between proximate potentiality and remote potentiality. He honestly answers, "So far as I can tell, this flight is proximately potential to land on New York. That is what almost everybody believes. But in fact, the plane is remotely potential to land on Hawaii, Honolulu and Bermuda. For this flight, I believe Bermuda is a potentiality less remote than Hawaii and Honolulu."

The reply shows that even among those remote potentialities there can be a hierarchical order of remoteness, given certain contexts and circumstances. From the eyes of the terrorists, although Bermuda is not the proximate potentiality of the plane,

it is not a potentiality as remote as Hawaii (certainly not as remote as Paris) either. Bermuda is a potential landing place whose remoteness is second to New York City and prior to other places.

With the distinction between proximate potentiality and remote potentiality spotlighted and stratified, let us come to the biological world. I hold that the constitutive matter of a living thing has multiple potentialities one of which is proximate. What counts as proximate in the biological world certainly depends on environmental constraints such as geographical location, climate, water, sunshine, presence of predators and preys, etc. But among all the environmental constraints the most decisive and most direct is the species form of an organism's ancestors. If your biological parents are members of the human species, your constitutive matter will have a proximate potentiality to become a human. In ordinary language, if your parents are human, you have human genetic makeup.

In the biological world, all non-proximate potentialities are likewise remote potentialities with different degrees of remoteness. The potentiality for the matter of a Puli dog has a remote potentiality to become a Pumi dog and a remote potentiality to become a Pyrenean Shepherd. But the potentiality to become a Pumi is a less remote one, since both Puli and Pumi originate from Hungary, yet Pyrenean Shepherd originates from France. The geographical difference between Hungary and France generally accounts for this order of remoteness of potentialities for a Puli dog. Still, the potentiality for the matter of a Puli dog to evolve into a whale is astronomically remote yet real.

In short, environmental constraints—most notably the essence of ancestors—have an impact on the arrangement of fundamental particles of a living thing. The possession of proximate potentiality ensures that the multiple-potentiality strategy does not mess up the order of evolution.

There is one additional note to make. Species evolution, as made intelligible on Aristotelian grounds, starts and ends with an individual. It is a change in the potentiality of the constitutive matter of an individual living thing that causes a substantial change to take place. So there must have been numerous unnoticed species evolution. Indeed, it can take long and laborious work for biologists to recognize that species evolution has actually occurred. It can take as long as several genetic drifts for biologists to recognize the presence of new species. Yet according to Aristotelian essentialism, a new species comes into being as soon as an individual living thing with a new essence comes into being. Thus new essences occur more frequently than new biologically recognized species occur. Enough has been said to show that the first premise in my compatibility argument is true or at least very probable.

Chapter Three: Striking the Persecutors

What about COM-P2? To recall, P2 says that if Aristotelian essentialism can describe what is going on with species evolution, Aristotelian essentialism is compatible with species evolution. More generally, we can abstract the following epistemic principle out of P2:

> (PRINCIPLE) If a system of thinking, *S*, can explain some event or process *L*, then *S* is compatible with *L*.

To establish P2, we need to establish this epistemic principle. Notice that it is not enough for *S* to merely describe *L*. *S* must be able to explain *L* in a cogent and coherent manner. To illustrate, Euclidean geometry can describe a round square. A round square is the set of all points in a plane that not only have a certain distance from a certain point, but also form four equal sides and four equal angles. But a round square is a self-contradictory concept and in reality there is no such thing as a round square. Euclidean geometry cannot be compatible with something self-contradictory. Hence Euclidean geometry is not compatible with a round square. Even if Euclidean geometry can describe a round square, the former cannot explain a round square, because a round square is nonsensical.

We have some *prima facie* reason to think the epistemic principle is true. If a system of thinking, *S*, can explain *L*, it shows that we make sense of *L* on the grounds of *S*. In other words, *S*-theorists can make sense of *L*. Now if *L* were indeed incompatible with *S*, *S*-theorists would not have made sense of something that is

incompatible with *S*. This is so because *S* would imply something that is in conflict with *L*.

Here is an objection. It seems that Christian theologians have a theory that can describe what is going on with sexual immorality. According to our epistemic principle, this shows that Christian theology is compatible with sexual immorality, which sounds odd. Maybe worse still, theism can describe what is going on with atheism. But it surely does not follow that theism is compatible with atheism. One cannot be both a theist and be an atheist. So the principle must be flawed.

This puzzle points to a general problem luring in the principle. I concede that there is indeed a sense in which theism is compatible with both sexual immorality and atheism. Just consider Psalm 139:12 according to which darkness and light are the same to God. It does not follow that God would encourage or embrace darkness. So there is a sense in which sexual immorality and the sexual morality are the same to the theist, which would both make sexual immorality compatible with theism and allow the theists to embrace and encourage only sexual morality. Likewise, there is a sense in which theism and atheism are the same to the (meta!)theists (*i.e.*, one interested in God in general), which would both make atheism compatible with (meta!)theism and allow the (meta!)theists to embrace and encourage only theism. The word of "metatheism" is used in order that it is not confused with the theism which stands in contrast with atheism.

Could it then be the case that Aristotelian essentialism is a "meta-theory" that is compatible with species evolution without embracing or encouraging species

evolution? That is, Aristotelian essentialism may be compatible with species evolution in the same way as God is compatible with darkness, or if you will, Satan with light. Maybe Aristotelian essentialism is just compatible with species evolution, but ultimately unfriendly towards species evolution. Maybe I have not shown anything other than a compatibility thesis in which the notion of compatibility is as thin as the compatibility in the sentence "a source of light is compatible with darkness" or "a theory of rightness is compatible with wrongness" in the meta-eyes of some meta-theorists. In short, there are two senses of compatibility:

> STRONG COMPATIBLITY =defn. *A* is strongly compatible with *B* just in case *A* is compatible with *B* and *A* encourages, embraces or is friendly towards *B*.
>
> WEAK COMPATIBLITY =defn. *A* is weakly compatible with *B* just in case *A* is compatible with *B* and *A* fails to encourage, embrace or be friendly towards *B*.

The question left for us is to examine whether the compatibility in the second premise is strong or weak. To appeal to the epistemic principle at this stage is no longer adequate, because the principle itself is open to two interpretations according to these two senses of compatibility. If Aristotelian essentialism is merely weakly compatible with species evolution, the second premise will be trivially true, which will make my compatibility argument no longer philosophically interesting albeit valid.

Here is how I am going to find it out. I will consider arguments from evolutionary theorists against Aristotelian essentialism. If there is anywhere to find

unfriendliness, this is where to find it. If any of their arguments succeed, it shows that Aristotelian essentialism by virtue of describing what is going on with species evolution might still be weakly compatible with species evolution. Then we would concede that the second premise is trivially true. But if none of the major arguments against Aristotelian essentialism succeeds, we will have a strong confidence that the second premise is true on the strong sense of compatibility. This confidence will be justified by the disappearance of all major unfriendliness.

Since we have defined Aristotelian essentialism in terms of potentiality and actuality, our conception of Aristotelian essence is teleological. The arguments we will examine are generally held to be not just against Aristotelian essentialism in general but against Aristotelian natural teleology in particular, which makes a confrontation with these argument even more desirable to me.

A. The Arguments from Non-Actuality

The argument from non-actuality is motivated by the following concern. The causal order in nature goes from things in the past to things at present and from things at present to things in the future. No backward causation is allowed in nature. According to Aristotelian essentialism, essences guide or determine the development of organisms.[11] If this were so, essences would play an explanatory role in the development of organisms. But if essences are the actualities which are the ends of the biological development, essences must exist after each stage of the biological

[11] Unless otherwise specified, I will use "guide" and "determine" interchangeably.

development. Hence essences cannot explain anything in the biological development that exists before essences are realized. The argument from non-actuality can be thus formulated:

(NAT-P1) The explanans precedes its explanandum in a causal explanation.

(NAT-P2) If means precedes ends, ends cannot be the explanans.

(NAT-P3) Means precedes ends.

(NAT-C1) Ends cannot be the explanans.

(NAT-P4) If ends cannot be the explanans, teleology is mistaken.

Therefore, (NAT-C) teleology is mistaken.

P1 seems true because causation happens in time. In a causal explanation, what already occurs or exists explains what is yet to occur or exist (Walsh 2008:116). If something has not yet occurred, its lack of reality makes it explanatorily impotent. If what is not yet existing explains what already exists, the causation is backward and reverses the temporal order of our world. P4 seems true because Aristotelian essentialism by virtue of its teleological nature appears to affirm a backward causation which can never happen. In a teleological explanation, the end state or *telos* has not yet existed. But an unactualized goal cannot explain anything. Teleology is mistaken because its order of explanation violates P1.

P3 seems trivially true. If I am on my way driving to the store, the movement of my car can explain my presence at the store in the future. My presence at the store in the future cannot backwardly explain the movement of my car.

One might try to reject P3 by saying that although ends cannot explain, mental representations of ends can explain (Walsh 2008:116-117). My presence at the store, as an unactualized goal, cannot explain the movement of my car. But my mental representation of my presence at the store, which is something happening right now, can explain the movement of my car. My representation motivates my body to drive the car to the store.

Three considerations render this objection unfavorable. First, Aristotelian natural teleology is not artificial teleology. No mental representation is necessarily involved in Aristotelian natural teleology. For Aristotle, the end, actuality, essence or formal nature of biological development is part of nature which contains a principle for motion and rest. Natural end is not the result of living things' mental activities or psychological states (*Physics* II 8, 199^{b}26-30; Henry 2012:39). A sheep need not mentally represent the essence of sheep at any moment in its life in order to be sheep at all. Living things are essentially what they are whether or not they mentally represent their essences.

Second, the objection runs into conflict with evolutionary thinking. In the "opportunistic" process of natural selection, nowhere shall we find essences of organisms predetermined by the mental representations of organisms (Ayala 2008:72-73). Biological organisms that are better adapted to their environments are simply preserved by nature. The evolved new species better fit with the environment. The very idea that essences are determined by means—whatever means it is—should be excluded from evolutionary thinking.

Third, the objection only reinforces P3 even if it succeeds. My mental representation of my presence at the grocery store exists before or (though a bit more controversially) simultaneously with the movement of my car. This will make my mental representation a means towards the movement of my car, which in effect makes my mental representation a means towards another means. As long as the objection works under the assumption about the temporal order of explanation, all it does, if anything, is to bolster P3.

P2 follows from P1. C1 follows from P2 and P3 by *modus ponens*. P1, P3 and P4 seem all true. The argument from non-actuality seems to go through.

Upon further reflection this argument suffers from ambiguity of reference. To what do the words "means" and "ends" refer? It is intuitively appealing to assume that the word "means" refer to whatever biological mechanisms through which the mature organism develops, and that the word "ends" refer to the forms, essences or goals. Notice that this argument would count against Aristotelian natural teleology only if we read the argument with this intuitively appealing assumption.

But this assumption is questionable. From an Aristotelian point of view, there is a sense in which the essences can be the "means" and the biological mechanisms can be the "ends." Since essences guide the biological development from beginning to end, it is not improbable to think that which and how mechanisms are used depends on essences. It is thus appropriate to think of essences as the means by which the biological mechanisms exist as ends.

But if mechanisms are ends, can we ever derive the mature organisms out of the mechanisms? Since the mechanisms are already the ends, it seems that the biological process cannot move on to its culmination. A human would constantly be in the process of becoming a human without ever being one.

This worry, however, stems from a conflation between the hylomorphic compound mature organisms and the essences or forms of mature organisms. The essences of mature organisms are the formal nature of mature organisms which are hylomorphic compounds. It may well be that essences are the means by which the biological mechanisms of development come into being as ends, and that the biological mechanisms of development are in turn the means by which the mature hylomorphic compound organisms come into being as ends. It is an illusion to think of essences as both the means and the ends of biological mechanisms.

Now that I have proposed the possibility that essences can be the means, I want to say why, on Aristotelian grounds, this is indeed the case. According to Aristotelian essentialism, essences of living things are the formal natures of living things. Essences of living things contain the principle of motion and rest for those living things. Living things, by virtue of having essences, can initiate motion in a direction that culminates in a mature being. Essences are responsible for the biological mechanisms by determining what mechanisms can be used and where used mechanisms are going. In this respect essences stand to mechanism just as means stand to ends, because means are responsible for ends by determining what ends are realized and how ends are realized.

The argument from non-actuality fails because P4 is false. P4 says, "If ends cannot be the explanans, teleology is mistaken." Now let us translate P4 in light of our foregoing discussion. So let "ends" refer to biological mechanisms. P4 becomes P4*, which reads

(NAT-P4*) If biological mechanisms cannot be the explanans, teleology is mistaken.

P4* is clearly false. This conditional simply does not obtain, because teleologists or Aristotelian essentialists have never been interested in making biological mechanisms the explanans. According to Aristotelian essentialism, it is the essence that is the explanans whose explanandum is the biological mechanism. If a proponent of the argument from non-actuality claims P4*, he just has no idea of what is at issue. If P4* is false, the argument from non-actuality is no longer good.

B. The Argument from Randomness

If essences guide or determine biological mechanisms, essences normatively require biological mechanisms. But the idea that evolution is normative seems hard to square with the view that evolution is random. It seems impossible to reserve one idea without unduly downplaying the significance of the other. This argument from randomness stems from this concern and can come in various versions. Now consider a simple version that immediately occurs to many people's mind.

(RAM-P1) If the evolutionary process is random, there is no natural teleology.

(RAM-P2) Evolutionary process is random.

Therefore, (RAM-C) there is no natural teleology.

Is P1 true? If evolutionary process is random, no predictable purpose should belong to the process. The evolutionary process should lead to no pre-destined place. There is not a *telos* of the process.

This brief reasoning is problematic, however, for two reasons. It is, strictly speaking, loose talk. There is nothing logically self-contradictory in saying that the evolutionary process attempts to follow and pursue the perfection and perpetuity of the Aristotelian Unmoved Mover while the evolutionary process fails this attempt by turning out random.

More seriously, it works under the wrong assumption that Aristotelian natural teleology pertains to the entire evolutionary process. But Aristotelian natural teleology is primarily of individual beings in the evolutionary process rather than of the process itself. Even if the whole evolutionary process is random, it is perfectly possible that each individual in the process has a completely normative teleological development. Suppose George makes 100 gold chalices and Alison randomly selects 30 out of the 100. The selecting process is as random as Alison wants. But the original 100 gold chalices are also as teleological as George wants. Since P1 is problematic, the simple version of the argument fails.

Now consider a refined version of the argument from randomness.

(RRAM-P1) If the development of individual living things is unpredictable, there is no natural teleology, *i.e.*, no normativity.

(RRAM-P2) The development of individual living things is random.

Therefore, (RRAM-C) there is no natural teleology.

Apparently P1 takes our challenge head-on. Whether the argument succeeds seems to hinge largely upon P2. Is P2 true? It seems true, at least to some extent according to evolutionary theory. Admittedly, the randomness invoked in this argument need never be so strong as to threaten the fact that certain biological outcomes occur "always or for the most part." For Aristotle observes, "all natural things come to be as they do either always or usually, whereas no result of luck or chance comes to be as they do either always or usually" (*Phys*. II. 8 $198^{b}34$-$199^{a}1$). Still, there are at least two fairly uncontroversial senses in which the development of individual living things can be conceived as random. First, among the genes possessed by the parents, there is some randomness in exactly which genes get duplicated and disseminated to the offspring. Second, there is some randomness in genetic mutations. It is noteworthy that mutations are not dictated by which effects are good for the organisms (Nagel 1979:300-301; Ayala 2008b:73). The two sources of randomness point to one fact: the offspring's genes can differ from parents' genes. P2 seems true.

But is P1, which apparently takes our challenge head-on, true? It is not clearly so at first sight. There are differences in genes that do not matter at all to whether the species evolve. For example, if the outcome of a genetic difference between a parent and an offspring is simply that the offspring will have a slightly longer nose, that genetic difference will, in normal circumstances, not yield a new species. This is so because, as we have seen, accidental changes do not count as a reason for substantial change. A slight difference in the size of nose is an accidental change. In normal

circumstances, it has no effect on whether the offspring is still of the same species. Further, we must also realize that genetic differences may have no manifestations whatsoever. Such a difference will not generate any substantial change either.

So let us get clear about what kind of genetic difference across generations really matters. What really matters are those genetic differences that are capable of producing a new species. If new *species* are able to evolve out of random genetic changes, it does seem that teleology for the individuals of the *old* species is sheer fantasy. But if old species do not have essences, we should not expect that new species have essences either. We should then admit that no teleology for individuals of whatever species (old or new) exists.

So far the argument remains forceful. But now I want to point out a questionable assumption behind P1:

> (ASSUMPTION) If something comes be through a random process, it has been unguided since the beginning of its existence.

But this need not be true. Something that is guided can still turn out random. An individual can be guided by an essence, but something random happens such that that individual takes on a new essence. Genetic differences, results of which are *new* species, can randomly happen with essences of *old* species guiding the process. To illustrate, consider the following analogy.

Suppose a Platonic philosopher-king, David, has a daughter, Diva. For the sake of illustration, let us say that David has the essence of philosopher-king. Now David wants Diva to be a philosopher-king ("philosopher-king" should be seen here

as an identity regardless of gender) in the future. So David raises Diva in every way he can control to put Diva on the track of a philosopher-king. For example, there are many pictures of philosopher-kings on the wall in Diva's bedroom. When Diva eats, she is instructed to eat like a philosopher-king. Admittedly there is still randomness in the education process. For example, Diva can let her cat decide whether she gets the scrolls of *Phaedo* or *Republic* for her 15th birthday gift. But overall the idea of being a philosopher-king in the future is guiding or supervising the growth of Diva. On the day of enthronement when Diva is 30 years old, everybody in town gathers to celebrate the event. Yet David is shocked to find Diva swearing to be a puppeteer. Diva testifies that ever since reading *Republic* she had loved that career.

Should we say then that Diva's education is unguided? No. It is guided, to every detail, by the essence of philosopher-king with the expectation that she will one day become a philosopher-king herself. But something random happens such that Diva gets on the track of becoming a puppeteer and since become guided by the essence of puppeteer, though it takes very long for David to realize it!

By analogy, an individual organism has a set of fundamental particles at birth. Though the elements of this set can change through time (as simply as by exhaling and inhaling), we are still sure that at birth, in order to be *living* at all, this set of fundamental particles must contain a potentiality that is leading towards and guided by an *essence*. As the organism is subject to environmental constraints in later stages of its development, it is subject to natural selection and hence the mechanistic power of evolution. At some point, as the result of random changes in the fundamental

particles, the constitutive matter consisting of fundamental particles undergoes a change in its potentiality, which then leads to a different actuality. The new actuality or essence becomes a new guidance for the development of the organism. There is nothing incoherent in this process.

This shows, I think, that the assumption behind P1 is false. According to Aristotelian essentialism, it is possible for biological organisms guided by old essences to come through a random process to be guided by new essences. Hence P1 is false. The argument from randomness does not work.

C. The Argument from Functional Reducibility

Let us now consider the argument from functional reducibility. Teleologists usually make their case by identifying some function of organisms and saying that functions testifies to the existence of *telos*. But it seems that for every explanation that specifies this teleological process, we can find a way to reduce it to a description of the process with the same content just by reversely focusing on the efficient causes. If there is no information loss in such reduction, teleological explanation is just one way to provide a causal explanation with a focus on the effects or consequences.

Consider Thomas Nagel's example: fish have gills to breathe. Here we have a function, namely the gills, and organisms, namely fish, and effects or *telos*, namely breathing. A standard teleological explanation will look like this:

The function (gills) is necessary for breathing.

In order to breathe, fish must have gills. Why are there gills? Gills are there to enable fish to breathe. But it seems that this explanation can be rewritten as this:

Without gills, fish cannot breathe. Hence, fish must have gills.

Nagel holds that the rewritten version neither makes nor implies teleology. Moreover, Nagel takes the following two explanations as equivalent in content (Ayala 1970:12):

Teleological: The function of *A* in a system *S* with organization *C* is to enable *S* in environment *E* to engage in process *F*;

Non-teleological: Every system *S* with organization *C* and in environment *E* engage in function *F*; if *S* with organization *C* and in environment *E* does not have *A*, then *S* cannot engage in *F*; hence, *S* must have *A*.

The organization refers to the physiological structure of fish, the system to fish, the function to gills, process to breathing, and the environment to just some water with dissolved oxygen. The argument from functional reducibility can be formulated as follows.

(RED-P1) If any functional account of why a part in a biological organism emerges can be translated into an efficient causal account, teleology is redundant.

(RED-P2) Any functional account of why a part in a biological organism emerges can be translated into an efficient causal account.

Therefore, (RED-C) teleology is redundant.

P1 is problematic, I think, because the teleology it rejects is in a narrower scope than what Aristotelian natural teleology is supposed to be. Aristotelian teleology pertains to the whole organisms rather than its parts. The fish example

focuses on merely one part, one function. Even if we can find equivalent explanations for one part or function in an organism, it does not follow that we can do the same to the entire organism. This is a significant point. To see why, consider an analogy.

We have a soccer team. Every player in the field is trying to score as a team. So the goalkeeper kicks off. The right back passes to the left midfielder, who passes a chest-high ball to the center forward, who does a short cross pass. One striker takes the pass and does a triangular pass with teammates. Then there is a lobbing pass and the striker does an overhead kick scoring a goal.

Now, every player in the system is one part of the system. It seems that we can have an efficient causal explanation of each player's move without any teleological content. But even if we can get that explanation, we still lack an account of why the whole team aims to score. That is not a question about why the last striker wants to score. Nor is about why the next individual player's move depends on the previous individual player's move (Toepfer 2012:116). That is a question about why the whole team moves the way it does such that the last one can be in that position to score. We may have an efficient causal account of parts without being able to make sense of the whole system unless we recognize the teleology of the team, which is to cooperate to score.

Nagel gives us an account that says in a non-teleological way why fish have gills. But Nagel has not told us why fish need to breathe at all. What Nagel gives us, at best, is that if fish need to breathe, fish must have gills. But Aristotle apparently

wants to say more. Aristotle wants to say that fish must breathe, because fish is a living thing and part of what it is for fish to live is for fish to breathe.

The proponent of the argument from functional reducibility might respond as follows. This argument from functional reducibility is supposed to offer a model. We illustrate this model with one part of a system. Once we get that, we can easily expand this model to the whole system. We just need to see the whole system as one big function. So here is a refined version of the argument to incorporate what Aristotle wants to say.

(RRED-P1) If any account of why the whole system has the function it has can be translated into an efficient causal account, teleology is redundant.

(RRED-P2) Any account of why the whole system has the function it has can be translated into an efficient causal account.

Therefore, (RRED-C) teleology is redundant.

Notice that in order for this argument to count against teleology, we have to read the word "function" in the argument as synonym of "essence" and "*telos*." So P2 is to be understood as this: there is an efficient causal account of why any organism has the essence it has.

Before asking whether RRED-P2 is true, we must be clear about what it takes to establish its truth. With the previous RED-P2, we can refer to some other parts within the system to construct an efficient causal account. But now that the function of the whole system is called into question, we can no longer appeal to any parts in that system. This reason is simple. We are asking after the efficient cause of the

function of something as large as the whole. This efficient cause must be sought outside the system. The parts in the system are called into question together with the system itself. We cannot appeal to parts as efficient cause of the whole system which has those parts, just as we cannot appeal to one player on a team to explain the function of the whole team which includes that very player. We must say, for example, that the coach of this team identifies the goal of the team as scoring as many as possible, since the coach is outside the team playing in the field.

But now it is unclear how RREC-P2 can be true. It is unclear how there can be any efficient causal account of why any organism has its essence that offers the same information as some teleological account. It is also unclear how such an account can be given. Suppose one can identify that efficient cause in something outside the system. Presumably this efficient cause is itself another biological organism, say, the parent. Then the question arises as to how this efficient cause has its essence. And the explanation will go backward to infinity. The result is some strong determinism that seems to square with neither evolutionary thinking nor Aristotelian essentialism. If P2 in the expanded version of the argument from functional reducibility is unjustified, the argument is no good.

Chapter Four: Stimulating the Protectors

With the major prosecutors struck, we now have a stronger confidence that COM-P2 is true. Recall that

> (COM-P2) If Aristotelian essentialism can describe what is going on with species evolution, Aristotelian essentialism is compatible with species evolution.

Now there are protectors of Aristotelian natural teleology who might think, however, that everything said so far is just an unnecessarily roundabout way to establish Aristotelian essentialism. They claim to have arguments that defend Aristotelian natural teleology much more straightforwardly. Let us examine some major arguments that have been proposed to establish Aristotelian natural teleology more directly. I name this section "stimulating the protectors," for I want to point out the inadequacy in each of the following protective arguments and draw protectors' attention also to the significance of my proposal.

A. The Argument from Goal-Directedness

According to proponents of the argument from goal-directedness, Aristotelian teleology is not to be understood as the idea that the development of every organism is directed at a specific goal. Aristotelian teleology is rather the idea that the development of every organism has a goal-directedness without being directed at any specific goal. Goal-directedness intrinsically belongs to an organism such that the organism produces in itself whatever is necessary for survival. This goal-directedness

alone is supposed to show that teleology is true. The argument from goal-directedness can be formulated as follows.

(DIR-P1) If organisms have goal-directedness, teleology is true.

(DIR-P2) Organisms have goal-directedness.

Therefore, (DIR-C) teleology is true.

It is a matter of definition and empirical evidence whether P2 is true. Under certain definition of "goal-directedness" it is more probable. Denis Walsh defines "goal-directedness of organisms" as "the capacity to produce those structures and processes required for their vital functions" (2008:119). If we run with this definition, and if we acknowledge such capacity as a result of empirical observation, we would not find P2 problematic.

But P2 is ambiguous. Its ambiguity does not stem from the vulnerability of any particular definition of goal-directedness. How can there be goal-directedness without there being some goal to be directed *at*? The argument takes a neat route by sidestepping this challenge. As a result, many prosecutors' concerns which we met in the last section will not make sense. For example, if there can be teleology without there being goals, the argument from non-actuality is completely nonsensical. That objection is attacking the very idea that the presence of the goal will invoke backward causation that defies the temporal order of our universe. But to ignore the talk of goals is simply to make that concern disappear. Likewise, if there can be teleology without there being goals, the argument from normativity does not make sense either. That objection is attacking exactly the idea that goals cannot be normative.

Is it not a good thing that objections are neatly resolved? Yes, provided that the idea of there being goal-directedness without any goal can make sense to us. But there cannot be goal-directedness without reference to any goals (Nagel 1979:311-312). To see why, consider an analogy.

A group of people are going on the street for demonstration. We ask them, "where are you going?" They answer, "we are not going anywhere, but can't you see that we are simply going?" A bit confused, we continue to ask, "Do you mean that you are going *around*?" They answer, "We are not going around, but we are going."

Now, we certainly see that they are going with legs and feet. We can even tell at this moment that they are crossing from Canal Street to Natural Bridge. But we cannot say that they have a destination, because they have no idea of where the destination is.

Here is an objection, though. Is not their demonstration still teleological? It does not seem to matter *where* they go. All that matters seems to be that they are *demonstrating* whatever they want to demonstrate. And that is their goal. That goal is clearly directing the group wherever they are going. The whole thing is teleological.

But this pushes the problem only a level back. Suppose we ask, "So what are you demonstrating?" In order for the goal-directedness-without-reference-to-goal strategy to work, they have to respond, "We do not know what we are demonstrating, but can't you see that we are simply demonstrating?"

Their question is tricky. I can see *that* they are demonstrating without knowing *what* they are demonstrating. The problem is, however, not whether *I* see or

know. The problem is whether, from an insider's point of view, anyone in the group knows *that* they are demonstrating. So suppose I ask one of the demonstrators, "Do you have the slightest idea of *what* you are demonstrating?" The answer must again be No, since there must never be any reference to any specific goal. But at that point, does the person still know *that* they are demonstrating?

One might say respond as follows. If I know that they are demonstrating, she must be able to know that they are demonstrating also. But the problem then becomes this: does the person know that *she* is demonstrating?

I think the answer to this last question must be No. This person does not know whether she is demonstrating, even if she has confidence that she is among a group of people who are demonstrating. Demonstration is a kind of activity such that if one does not know what one is demonstrating (goal), one is not participating in the demonstration. One can be walking with others, shouting with others, but that does not count as demonstration.

But then another objection comes. What about eating? Anyone can eat something without knowing what is being eaten, or what the goal of eating is. Why pick up demonstration particularly?

Yet this is not an objection. The point of my analogy is not to show it is not possible to do something without knowing its content. To read my analogy that way is to totally misinterpret it. The point of my analogy is show that if you are doing something without having the slightest idea of the goal, your action is not *teleological* for *you*. So you could be eating without knowing the goal of eating, but then your

eating is just not teleological. It can be biologically necessary or beneficial, but just not teleological. Because of the ambiguity in P2, the argument from goal-directedness does not work.

B. The Argument from Wellbeing

The argument from wellbeing can be seen as a response to our discussion of the argument from goal-directedness. I have argued that there is no goal-directedness without reference to some goals. Now here is a strategy to meet my challenge: let there be *some* goal and let us define it in a non-specific way. Still, make sure it is a goal that an organism can be said to pursue. This goal is "wellbeing." So it is not the case that organisms have no goals to be goal-directed at, but it is also not the case that organisms have goals as specific as species essences. Rather, an organism has a general goal towards wellbeing, or in Darwinian terms, towards the overall reproductive success (Ayala 1970:11), though it is entirely debatable whether the Aristotelian wellbeing just is Darwinian survival (Depew 2008:381). The idea is that once we identify the goal as wellbeing, we have teleology. The argument from wellbeing can be formulated as follows.

(WEL-P1) If organisms are goal-directed at wellbeing, teleology is true.

(WEL-P2) Organisms are goal-directed at wellbeing.

Therefore, (WEL-C) teleology is true.

Both evolutionary theorists and Aristotelians would agree with P2. But is not P1 trivially true? Even if we grant P1, what kind of teleology is being established by the

argument? To me, P1 is silent on how to differentiate the *telos* of one species from another. According to the teleology established here, the *telos* of one organism will be the same as the *telos* any other organism, regardless of whether the two organisms belong to the same species. This teleology is unable to differentiate species forms.

Perhaps the pitfall lies in understanding the wellbeing of an organism simply in Darwinian terms of survival. Aristotelian wellbeing must go beyond mere survival. Aristotelian wellbeing must be tailored to and sensitive to a specific kind of species, that is, an essence. To talk about wellbeing of organisms generally is just to use the term "wellbeing" in a thin sense.

But to specify what kind of wellbeing relative to each kind of species will make almost the entire weight of the argument fall upon P2. Given the right definition of wellbeing relative to essences, P1 would seem trivially true. Consider the refined version of the argument from wellbeing.

(RWEL-P1) If organisms are goal-directed at wellbeing relative to species, teleology is true.

(RWEL-P2) Organisms are goal-directed at wellbeing relative to species.

Therefore, (RWEL-C) teleology is true.

Notice, however, that if wellbeing becomes species-indexed, the argument has clearly departed from its initial motive. The initial motive of the argument from wellbeing was to define *some* goal in a non-specific way. This goal was found to be wellbeing of organisms regardless of species essences. Thus to make wellbeing species-indexed at this later stage will betray the motive of the argument.

Even if we consider the refined argument from wellbeing in its own right, the argument does not seem convincing. RWEL-P2 begs the question of whether teleology is true. If teleology were false, there would be no essences guiding the biological development. Consequently, there cannot be any wellbeing relative to essences, since essences themselves do not exist. According to Aristotelian essentialism, the concept of species entails the concept of species essences. If there cannot be wellbeing relative to essences, there cannot be wellbeing relative to species either. Hence the very concept "wellbeing relative to species" in RWEL-P2 depends for its legitimacy on the truth of teleology. One has to accept the conclusion first in order to see the truth of RWEL-P2. The refine argument from wellbeing therefore fails as it is subject to vicious circularity.

My multiple-potentiality strategy is alarmingly relevant here. If biological matter has multiple potentialities such that the matter can change from being potentially one thing to being potentially another thing, we have got exactly the flexibility desired by proponents of the argument from wellbeing. Yet the flexibility we have is not as vague as some general notion of biological wellbeing that leaves species essences out of sight. According to my multiple-potentiality strategy, an organism is goal-directed at a specific essence while this goal can change as a result of change in the arrangement of fundamental particles. This flexibility is good news for proponents of the argument from wellbeing, because they share with proponents of the argument from goal-directedness the same concern that Aristotelian natural teleology must not be stiff regarding the goals. Otherwise, fixity of species does not

square with evolution. Since I see the argument from wellbeing as a response to my critique of the argument from goal-directedness, the flexibility granted by my multiple-potentiality strategy should also be reasonably favored by proponents of the argument from goal-directedness.

C. The Argument from Discernibility

The argument from discernibility for Aristotelian natural teleology comes from Robert Friedman. To illustrate, Friedman introduces a "principle of indiscernibility of identicals": "An individual necessitarian explanation can render an individual teleological explanation straightforwardly superfluous only if the two explanations are explanations of the same thing" (1986:357). Here a "necessitarian explanation" should be understood as a mechanistic efficient causal explanation. If a teleological explanation and a necessitarian explanation explain the same explanandum, the teleological explanation is not doing any work.

It seems that this principle by itself is unfair to teleology. If a teleological explanation and a necessitarian explanation explain the same explanandum, it may well be that the necessitarian explanation is not doing any work. One should not reject teleology simply on the grounds that something else explains what teleology explains. But let us grant Friedman's principle and its implication.

Friedman cautions that his principle apparently contradicts Aristotle's saying that "it is possible for the same thing (*to auto*) to be the case both with some aim and from necessity." (*PA* II 11, $94^{b}27$-28) So Friedman poses a further question: in what

sense of the word "same" do teleological explanation and necessitarian explanation explain the *same* thing (1986:357)? Friedman differentiates two senses of "sameness":

> Strong Sameness: the sameness expressed in the principle of the indiscernibility of identicals.
>
> Weak Sameness: coincidental or accidental sameness.

Things "weakly" the same can be different according to the sameness in the principle of the indiscernibility of identicals. "Weakly same" things may not be "strongly same" (Friedman 1986:357). To illustrate, Friedman's example is worth quoting in full:

> Water birds have webbed feet because having webbed feet aids them in their daily lives by making it easy for them to swim (*PA* IV 12, 694^{a}22-b9). That is the purpose webbed feet serve. But they also have their webbed feet of necessity. How so? Earthy substance courses along in a bird's body. It courses downward, then in some cases it fills in the spaces between the bird's toes. (That seems to be the easy place to go.) Now the webs are coincidentally the same as the earthy things. Whereas one might argue it is necessary that some earthy thing form on the bird's feet, they need not be webs. Perhaps they could be just huge useless lumps. The present point seems to conflict with the claim that the birds have their webbed feet of necessity. The teleological explanation in this passage is an example in which a phenomenon is explained as belonging to a set of options, one of which is (hypothetically) necessary for an end. Teleological explanation, far from being mere window-dressing, tells us why water birds have webs on their feet instead of useless earthy growths.

> Thus we see that what necessity and teleology explain is not the same thing in the strong sense required by the indiscernibility of identical. (1986:359-360)

The significance of this example can never be overemphasized. The thing to be explained here is apparently *one* fact: water birds have webbed feet. Friedman says that water birds have webbed feet because of both teleology and necessity. Having webbed feet is teleological because having *webbed* feet helps water birds live well by making swimming easy. Having webbed feet is also necessary because having webbed *feet* happens as a result of "earthy substance" coursing downward. Clearly the teleological explanation explains the occurrence of *webbedness*, whereas the necessitarian explanation explains the occurrence of *feet*. Nevertheless webbedness and feet *coincidentally* come together in *one* thing, namely, the constitutive matter of the webbed feet. Hence although it appears that both the teleological explanation and the necessitarian explanation explain the *same* thing "webbed feet," in fact what they explain are *weakly* the same.

Let us consider the case counterfactually. Suppose teleology does not exist and hence the teleological explanation is superfluous. There would then be "a set of options" open to water birds regarding the exact shape of their feet. But there would be no basis for any one option to be developed. Given teleology, however, Aristotelian essentialists can almost be sure that the *webbed* feet will get developed.

An objection can be raised at this point. There are things in Friedman's account, such as webbedness, that are not taken care of by teleology. There are things, of course, that are taken care of by teleology. This difference renders the

explanandum not "strongly" the same according to the principle of indiscernibility of identicals. But this difference only allows Friedman to say *within an individual account* that the thing taken care of by teleology shows that teleological explanation is not superfluous. The benefit unfortunately goes only this far. Once we go beyond *that individual account*, we encounter possibilities in which things taken care of by teleology in that individual account is still necessitated in *another account*. This suffices to make the previous teleological explanation superfluous. To see how, notice that Friedman has not ruled out the possibility that there can be some necessitarian explanation for webbedness. After all, webbedness is just a physical shape of the water birds' feet. Necessitarian explanations that can explain physical shapes should not be hard to formulate. Indeed, prosecutors holding to the functional reducibility argument will likely maintain that there will be an efficient causal mechanism that explains the webbedness of the water birds' feet as well as any teleological explanation.

The real problem for Friedman is therefore that he allows some biological features to develop out of necessity regardless of teleology, thus making Aristotelian essences lose grip on those features. Opponents would thereby push Friedman one step further, arguing that everything can be explained by necessitarian explanations. If this is the real problem for Friedman, the real solution must be to explain every biological feature within a teleological framework, that is, to let teleology permeate every possible explanandum. Aristotelian essences must guide the entire biological development to every detail.

Protectors holding to the argument from discernibility will find relief in the multiple-potentiality strategy I proposed. There is deep resonance between their approach and mine. Essential to the argument from discernibility is the idea that "a set of options" regarding certain physiological features are available to the biological matter and teleology alone can decide which one is the best for an organism that belongs to a certain species. Admittedly, "a set of options" here does not strictly mean "multiple potentialities" in the sense I explicated. It seems more like that on each potentiality-actuality track, there will be a set of options regarding every physiological feature. But this should not prevent these protectors from, but rather should provoke them to, thinking one step further that there might multiple potentialities in the first place. The teleology and Aristotelian essentialism I explicate is just more thoroughgoing.

Chapter Five: Summarizing the Position

Aristotle's essentialism is compatible with species evolution. We have departed from property essentialism in order to search for a teleological conception of Aristotle's essentialism in terms of matter and form as potentiality and actuality. An Aristotelian essence should be conceived as a form or an actuality. It pertains to not only positive properties traditionally conceived as essential properties, but also a range of proximate potentialities. Species evolve just in case the essence of old species is replaced by the essence of new species. In order for a change in essences as forms or actualities to be possible, it is natural to suppose that a change in potentialities must be possible in the first place.

I have explored precisely this possibility by proposing that the constitutive matter of living things have multiple potentialities. Changes in the spatial arrangement of subatomic fundamental particles can generate changes in atoms, which can generate genetic changes that may cause a change in the potentiality of matter. New essences occur more frequently than new biologically recognized species occur.

Given this multiple-potentiality strategy, we have a way to describe what is going on with species evolution. Species evolve just in case the ways in which fundamental particles of the constitutive matter of living things change to the effect that a new potentiality of the constitutive matter comes into being. The organism is now on the road to, and under the guidance of, a new essence, which makes the organism a member of a new species. I have noted that the essences have existed all

along, yet it needs a first instantiation to be actually fulfilled in our world. My distinction between proximate potentiality and remote potentiality has illuminated the multiple-potentiality strategy.

Since we can describe what is going on with species evolution in terms of Aristotelian essentialism, I have taken the first premise in my compatibility argument to be true or at least very probable. The second premise in my compatibility argument is that the truth of the first premise shows that species evolution is compatible with Aristotelian essentialism. I have cautioned that the second premise is philosophically interesting only if species evolution is "strongly" compatible with Aristotelian essentialism. I have examined three counter-arguments—the argument from non-actuality, the argument from randomness and the argument from functional reducibility—to show that the main reasons to deny the non-trivial reading of the second premise are not good. That makes my second premise very probable.

I have also provoked supporters of my compatibility thesis, who take alternative routes, to think more carefully about their arguments. I have showed that three arguments—the argument from goal-directedness, the argument from wellbeing and the argument from discernibility—that aim to defense Aristotelian essentialism are inadequate. Yet my multiple-potentiality strategy can enhance these arguments in support of the compatibility thesis.

BIBLIOGRAPHY

Ayala, Francisco J. 2008a. "Reduction, Emergence, Naturalism, Dualism, Teleology: A Précis," in *Back to Darwin: A Richer Account of Evolution*, ed. John B. Cobb, Jr., Grand Rapids: William B. Eerdmans Publishing Company.

———. 2008b. "From Paley to Darwin: Design to Natural Selection," in *Back to Darwin: A Richer Account of Evolution*, ed. John B. Cobb, Jr., Grand Rapids: William B. Eerdmans Publishing Company.

———. 1970. "Teleological Explanations in Evolutionary Biology." *Philosophy of Science*, 37 (1): 1-15.

Ayers, Michael R. 1981. "Locke Versus Aristotle on Natural Kinds." *Journal of Philosophy* 78: 247-272.

Balme, D. 1987. "Teleology and Necessity." *Philosophical Issues* in *Aristotle's Biology*. eds. A. Gotthelf, J. B. Lennox. New York: Cambridge University Press, 275–85.

Barnes, J. 1984. (ed.) *The Complete Works of Aristotle*, Volumes I and II, Princeton: Princeton University Press.

Bird, Alexander. 2009. "Essences and Natural Kinds." In Robin le Poidevin (ed.), *The Routledge Companion to Metaphysics*. Routledge.

Brigandt, Ingo. In press."Explanation in biology: reduction, pluralism, and explanatory aims." *Science & Education*.

——.2009a. "Homology: homeostatic property cluster kinds in systematics and evolution" (with Leandro C. S. Assis). *Evolutionary Biology* 36: 248–255.

——. 2009b. "Natural Kinds in Evolution and Systematics: Metaphysical and Epistemological Considerations." *Acta Biotheoretica* 57: 77–97.

——. 2007. "When Traditional Essentialism Fails: Biological Natural Kinds" (with Robert A. Wilson and Matthew J. Barker). *Philosophical Topics* 35: 189–215.

——. 2003."Species Pluralism Does Not Imply Species Eliminativism." *Philosophy of Science* 70: 1305–1316.

——. 2002a. Review of *What Functions Explain: Functional Explanation and Self-Reproducing Systems* by Peter McLaughlin, Cambridge University Press, 2001. *Erkenntnis* 57: 123–126.

——. 2002b. "A fierce debate about our picture of evolution." Review of *Dawkins vs. Gould: Survival of the Fittest* by Kim Sterelny, Icon Books, 2001. *Metascience* 11: 246–248.

Boyd, R. (1999). " Homeostasis, Species and Higher Taxa" in Wilson, R. A. ed., *Species: new interdisciplinary essays*, MIT Press, Cambridge, MA.

Brody, B. A. 1967. "Natural Kinds and Real Essences." *Journal of Philosophy* 64: 431-446.

——. 1973. "Why Settle for Anything Less than Good Old-Fashioned Aristotelian Essentialism." *Noûs* 7: 351-364.

Cameron, Rich. 2010. "Aristotle's Teleology." *Philosophy Compass,* 5/12: 1096–1106.

Charles, David. 2000. *Aristotle on Meaning and Essence*. Oxford: Clarendon Press.

——. 1991. “Aristotle on Substance, Essence and Biological Kinds.” *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 7: 227-261.

Charlesworth, Brian and Deborah Charlesworth. 2003. *Evolution: A Very Short Introduction*. Oxford: OUP.

Chase, Michael. 2011. “Teleology and Final Causation in Aristotle and in Contemporary Science.” *Dialogue* 50, 511– 536.

Cohen, S. M. 1978a. “Essentialism in Aristotle.” *Review of Metaphysics* 31: 387-405.

——. 1978b. *Individual and Essence in Aristotle’s Metaphysics*. *Paideia* (Special Aristotle Edition):75-85.

——. 1992. “Review: Substance and Essence in Aristotle: An Interpretation of Metaphysics VII-IX. by Charlotte Witt.” *Philosophical Review*, 101 (4) : 838-840.

——. 2009. “Substances.” In *A Companion to Aristotle*, 197-212: Wiley Blackwell.

——. forthcoming. “Alteration and Persistence: Form and Matter in the *Physics* and *De Generatione Et Corruptione*.” In Christopher Shields (ed.), *Oxford Handbook of Aristotle*. Oxford University Press.

Cresswell, M. J. 1971. “Essence and Existence in Plato and Aristotle.” *Theoria: A Swedish Journal of Philosophy* 37: 97-113.

Dahl, Norman O. 2003. “On Substance being the Same as its Essence in Metaphysics Vii 6: The Argument about Platonic Forms.” *Ancient Philosophy* 23 (1): 153-179.

——. 1997. "Two Kinds of Essence in Aristotle: A Pale Man is Not the Same as His Essence." *Philosophical Review* 106 (2): 233-265.

Darwin, C. 1859/2009. *On the Origin of Species*, ed. with intro by William Bynum, Penguin Books.

Deavel, Catherine Jack. 2003. "Unity and Primary Substance for Aristotle." *Proceedings of the American Catholic Philosophical Association* 77: 159-172.

Dennett, Daniel. 2011. "Homunculi Rule: Reflections on Darwinian Populations and Natural Selection by Peter Godfrey Smith." *Biology and Philosophy* 26 (4):475-488.

Depew,David J. 2008. "Consequence etiology and biological teleology in Aristotle and Darwin," *Stud. Hist. Phil. Biol. & Biomed. Sci.* 39, 379–390.

Devitt, Michael. 2008. "Resurrecting Biological Essentialism", Philosophy of Science 75 (3): 344-382.

Dudley, John. 2012. *Aristotle's Concept of Chance: Accidents, Cause, Necessity, and Determinism*. NY: SUNY Press.

Dupré, J. 1999. "On the Impossibility of a Monistic Account of Species." In Wilson RA (ed) Species: new interdisciplinary essays. MIT, Cambridge, 3–22.

Durrant, Michael. 1975. "Essence and Accident." *Mind: A Quarterly Review of Philosophy* 84: 595-600.

Engelmann, Edward M. 2007. "The Mechanistic and the Aristotelian Orientations Toward Nature and their Metaphysical Backgrounds." *International Philosophical Quarterly* 47 (186): 187-202.

Fine, K. 1994. “Essence and modality.” *Philosophical Perspectives* 8, 1–16 (Atascadero, CA: Ridgeview Publishing Company).

Fisher, R. A. 1930. *The Genetical Theory of Evolution*, London: Dover.

Franklin, James. 1986. “Aristotle on Species Variation.” *Philosophy: The Journal of the Royal Institute of Philosophy* 61: 245-252.

———. 1989. “Species in Aristotle.” *Philosophy: The Journal of the Royal Institute of Philosophy* 64: 107-108.

Friedman, Robert. 1986. “Necessitarianism and Teleology in Aristotle’s Biology.” *Biology and Philosophy*, 1 (3):355-365.

George Henry Lewes. 1864. *Aristotle: A Chapter from the History of Science*. London: Smith, Elder and Co.

Gotthelf, Allen. 2012. *Teleology, First Principles, and Scientific Method in Aristotle’s Biology*. Oxford: OUP.

Goyette, John. 2002. “Substantial Form and the Recovery of an Aristotelian Natural Science.” *Thomist: A Speculative Quarterly Review* 66 (4): 519-533.

Granger, Herbert. 1989. “Aristotle’s Natural Kinds.” *Philosophy: The Journal of the Royal Institute of Philosophy* 64: 245-247.

——. 1985. “the *Scala Naturae* and the Continuity of Kinds.” *Phronesis: A Journal of Ancient Philosophy* 30: 181-200.

Grant, Edward. 2006. *Science and Religion, 400 B.C. to A.D. 1550: From Aristotle to Copernicus*. Johns Hopkins Univ. Press.

Griffiths, Paul. 2002. “What Is Innateness?”. *Monist* 85: 70–85.

Gunter, A.Y. 2008. "Six Scientific Alternatives to Neo-Darwinism," in *Back to Darwin: A Richer Account of Evolution*, ed. John B. Cobb, Jr., Grand Rapids: William B. Eerdmans Publishing Company.

Hartman, Edwin. 1976. "Aristotle on the Identity of Substance and Essence." *Philosophical Review* 85: 545-561.

Henry, Devin. 2012. "Optimality Reasoning in Aristotle's Natural Teleology," 1-57.

——. 2011. "Aristotle's Pluralistic Realism." *Monist: An International Quarterly Journal of General Philosophical Inquiry* 94 (2): 197-220.

——. 2006. "Understanding Aristotle's Reproductive Hylomorphism." *Apeiron: A Journal for Ancient Philosophy and Science* 39 (3): 257-287.

Hodge, M.J.S. 1992. "Darwin's Argument in the Origin." *Philosophy of Science*, Vol.59, No.3: 461-464.

Hill, Benjamin. 2007. "Substantial Forms and the Rise of Modern Science." *The Saint Anselm Journal (Journal of the Institute for Saint Anselm Studies, Saint Anselm College)* 5 (1): 1-23.

Hodge, J. 1992. "Biology and Philosophy (including ideology): A study of Fisher and Wright," in S. Sarkar, (ed.), *The Founders of Evolutionary Genetics*, Vol. 142, *Boston Studies in the Philosophy of Science*, New York: Kluwer, 231–393.

Irwin, T. and Fine., G. 1995. *Aristotle: Selections, Translated with Introduction, Notes, and Glossary*, Indianapolis: Hackett.

Kirby, Jeremy. 2010. "Aristotle's Metaphysics: Form, Matter and Identity." *British Journal for the History of Philosophy* 18 (5): 941-943.

——. 2008. *Aristotle's Metaphysics: Form, Matter and Identity*. New York: Continuum International Publishing Group.

Kitcher, P. 1985. "Darwin's Achievement," in N. Rescher (ed.), *Reason and Rationality in Natural Science*. Lanham, MD: University Press of America, pp.127-189.

——. 1993. *The Advancement of Science: Science without Legend, Objectivity without Illusions*. New York, Oxford: Oxford University Press.

Kluwer, A. Bottani. 2002. *Individuals, Essence and Identity: Themes of Analytic Metaphysics*, Academic Pub.

Lennox, James G. 2001. *Aristotle's Philosophy of Biology: Studies in the Origins of Life Sciences*. Cambridge University Press.

——. "Form, Essence, and Explanation in Aristotle's Biology", In *A Companion to Aristotle*, 348-367: Wiley Blackwell.

Leunissen, Mariska. 2010. "Nature as a Good Housekeeper: Secondary Teleology and Material Necessity in Aristotle's Biology," *Apeiron* 43 (4):117-142..

Lloyd, E. 1983. "The Nature of Darwin's Support for the Theory of Natural Selection," *Philosophy of Science*, 50: 112-129.

Loux, Michael J. 1979. "Form, Species and Predication in Metaphysics Z, H, and O." *Mind: A Quarterly Review of Philosophy* 88: 1-23.

Matthews, Gareth B. 1990. "Aristotelian Essentialism." *Philosophy and Phenomenological Research*: 251-262.

Mayr, Ernst. 1989. *Toward a New Philosophy of Biology: Observations of an Evolutionist*. Harvard University Press.

McKeon, Richard. (ed.) 2001. *The Basic Works of Aristotle*. New York: The Modern library

Mclaughlin, Peter. 2002. "What Functions Explain: Functional Explanation and Self-Reproducing Systems." *Erkenntnis: An International Journal of Analytic Philosophy* 57 (1): 123-126.

Morrison, M. 2000. *Unifying Scientific Theories*. Cambridge: Cambridge University.

Nagel, Ernest. 1979. *Teleology Revisited and Other Essays in the Philosophy and History of Science*. New York: Columbia University Press.

Needham, Joseph. 1959. *History of Embryology*. Cambridge: Cambridge University Press.

Oderberg, David S. 2011. "Essence and Properties." *Erkenntnis* 75 (1): 85-111.

Okasha, Samir. 2002. "Darwinian Metaphysics: Species and the Question of Essentialism." *Synthese* 131: 191-213.

O'rourke, Fran. 2004. "Aristotle and the Metaphysics of Evolution (in Greek)." *Philosophia: Yearbook of the Research Center for Greek Philosophy at the Academy of Athens* 34: 175-198.

Peramatzis, Michail. 2011. *Priority in Aristotle's Metaphysics*. Oxford: OUP.

Pierce, Jeremy. 2011. "A Realist Metaphysics of Race: A Context-Sensitive, Short-Term Retentionist, Long-Term Revisionist Approach." Ph.D. Dissertation.

Politis, Vasilis. 2005. "What Enables Us to Search for the Essence of Things? A critical response to David Charles, Aristotle on Meaning and Essence." *International Journal of Philosophical Studies* 13, 245-269.

——.2004. *Aristotle and the Metaphysics.* Routledge.

——.2003. "Essentialism and the Principle of Non-Contradiction in Aristotle's Metaphysics." Queen's University Belfast, Northern Ireland.

Recker, D. 1987. "Causal Efficacy: The Structure of Darwin's Argument Strategy in the Origin of Species," *Philosophy of Science*, 54:147-175.

Reiss, John O. 2005. "Natural Selection and the Conditions of Existence: Representational and Conditional Teleology in Biological Explanation." *History and Philosophy of the Life Sciences*, 27 (2): 249-280.

Richards, Richard A. 2010. *The Species Problem: A Philosophical Analysis*, Cambridge: Cambridge University Press.

Rothenberg, David. 2011. *Survival of the Beautiful*. NY: Bloomsbury Press.

Ruse, M. and Robert J. Richards. 2009. (ed.) *The Cambridge Companion to the "Origins of Species"*. Cambridge: Cambridge University Press.

Ruse, M. 1975. "Charles Darwin's Theory of Evolution: An Analysis." *Journal of the History of Biology,* 8:219-241.

Scaltsas, Theodore. 1994. (ed.) *Substances and Universals in Aristotles Metaphysics*. Cornell University Press.

——. 1985. “Substratum, Subject, and Substance.” *Ancient Philosophy* 5: 215-240.

Scaltsas, Theodore, D. Charles and M.L. Gill. 1994. (ed.) *Unity, Identity, and Explanation in Aristotle’s Metaphysics*. Oxford: OUP.

Sintonen, M. 1990. “Discussion: Darwin’s Long and Short Arguments.” *Philosophy of Science*, 57:677-689.

Singh, Rama S., Jianping Xu and Rob J. Kulathinal. 2012. *Rapidly Evolving Genes & Genetic Systems*. Oxford: OUP.

Sober, Elliott. 1980. “Evolution, Population Thinking and Essentialism.” *Philosophy of Science* 47: 350–383.

Spellman, Lynne. 1989. “Specimens of Natural Kinds and the Apparent Inconsistency of Metaphysics Zeta.” *Ancient Philosophy* 9: 49-65.

Stone, Abraham D. 2008. “Avicenna’s Theory of Primary Mixture.” *Arabic Sciences and Philosophy*, 18:99-119.

Thagard, P. 1978. “The Best Explanation: Criteria for Theory Choice.” *The Journal of Philosophy*, 75:76-92.

Toepfer, Georg. 2012. “Teleology and its constitutive role for biology as the science of organized systems in nature.” *Studies in History and Philosophy of Biological and Biomedical Sciences* 43, 113–119.

Walsh, Denis. 2012. “Mechanism and purpose: A case for natural teleology.” *Studies in History and Philosophy of Biological and Biomedical Sciences* 43, 173–181.

——. 2008. “Teleology,” in *Oxford Handbook of Philosophy of Biology*, ed. Michael Ruse, OUP.

——. 2006. "Evolutionary Essentialism." *British Journal for the Philosophy of Science* 57 (2): 425-448.

Ward, Arthur. 2011. "Against Formal Causation in Non-conscious Nature." *Logical Analysis & History of Philosophy / Philosophiegeschichte*, Vol. 14,170-184.

Waters, C.K. 1986. "Taking Analogical Inference Seriously: Darwin's Argument from Artificial Selection," *Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol.1986, Volume One: Contributed Papers, pp.502-513.

——. 2003. "The Arguments in the *Origin of Species*," in Jonathan Hodge and Gregory Radick (ed.), *The Cambridge Companion to Darwin*, Cambridge: Cambridge University Press, pp.116-139.

Wedin, Michael V. 2000. *Aristotle's theory of Substance: the Categories and Metaphysics Zeta*. Oxford: OUP.

West-Eberhard, M. J. 2003. *Developmental Plasticity and Phenotypic Evolution*, Cambridge: Cambridge University Press.

Wilson, Robert A. 2004. "Recent Work in Individualism in the Social, Behavioral and Biological Sciences." *Biology and Philosophy* 19 (3): 397-423.

Witt, Charlotte. 1989. "Aristotelian Essentialism Revisited." *Journal of the History of Philosophy* 27: 285-298.

Wright, S. 1931. "The Statistical Theory of Evolution." Reprinted in W. B. Provine (ed.), Evolution: Selected Papers, Chicago: University of Chicago Press, 1986.

Wood, Bernard. 2006. *Human Evolution: A Very Short Introduction*. Oxford: OUP.

Woods, M. J. 1975. "Substance and Essence in Aristotle." *Proceedings of the Aristotelian Society* 75: 167-180.

——. 1993. "Form, Species, and Predication in Aristotle." *Syntheses: An International Journal for Epistemology, Methodology and Philosophy of Science* 96 (3): 399-415.

Yu, Jiyuan. 2001. "The Identity of Form and Essence in Aristotle." *Southern Journal of Philosophy* 39 (2): 299-312.