Can Evolutionary Biology do Without Aristotelian Essentialism?

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1. Introduction

It is usually maintained by biologists and philosophers alike that essentialism is incompatible with evolutionary biology, and that abandoning essentialism was a precondition of progress being made in the biological sciences. These claims pose a problem for anyone familiar with both evolutionary biology and current metaphysics. Very few current scientific theories enjoy the prestige of evolutionary biology.[1] But essentialism – long in the bad books amongst both biologists and philosophers – has been enjoying a strong resurgence of late amongst analytical philosophers with a taste for metaphysics.[2] Indeed, to impartial observers it is likely to appear that both evolutionary biology and essentialism are as well supported in their respective domains as could reasonably be expected. There is thus at least a *prima facie* tension here between evolutionary biology,

[1] Stearns and Hoekstra rightly insist that "The ideas of evolution have survived many controversies and tests and are now considered as reliable as any ideas in science." *Evolution: An Introduction* (Oxford: Oxford University, 2005, 23).

[2] It all began with Kripke's classic *Naming and Necessity* (Oxford: Blackwell, 1972), although perhaps the laurel ought to go to Ruth Barcan Marcus – see her "Essentialism in Modal Logic" and "Essential Attribution" in *Modalities: Philosophical Essays* (Oxford: Oxford University Press, 1993). See also Alvin Plantinga, *The Nature of Necessity* (Oxford: Clarendon Press, 1974); Hilary Putnam, *Mind, Language and Reality* (Cambridge: Cambridge University, 1975); Kit Fine, "Postscript", in *Worlds, Times and Selves*. Fine and Prior (eds) London: Duckworth, 1977); David Wiggins, *Sameness and Substance* (Oxford: Blackwell, 1980); and David Charles, *Aristotle on Meaning and Essence* (Oxford: Clarendon Press, 2000). For a general overview of contemporary formulations of essentialist theses see Graeme Forbes, "Essentialism", in *A Companion to the Philosophy of Language*. Hale and Wright (eds). (Oxford: Blackwell, 1999, 515–533.

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metaphysics (of a reputable sort) and, as we shall see, pre-theoretical common sense.[3]

The question regarding the compatibility or otherwise of essentialism and evolutionary biology also touches upon the highly contentious, because often politicised, issue of human nature. Most assume in their pre-theoretical moments that there is something, a "nature", in virtue of which we as members of *Homo sapiens* are distinguished from the rest of the animate and inanimate world. And while we used to have recourse to theology, and latterly the great works of art and literature, for an understanding of this nature, it is now more commonly held that evolutionary biology and psychology are the more likely sources of reliable information on this score. But beneath the surface of this phrase "human nature" are essentialist assumptions, in particular, that there is such a nature that all human beings have that distinguishes us from everything else. So what is one to make of these apparent inconsistencies? Can biology, and evolutionary biology in particular, tell us anything about human nature? Or rather, does evolutionary biology tell us that there is no such thing as human nature at all?

To put my cards on the table immediately, I maintain that there is a human nature; that evolutionary biology has much to tell us about this nature; and that all this is compatible with Aristotelian essentialism. It is this final point which is the focus of attention in this paper. I will argue that far from being incompatible with essentialism, evolutionary biology in fact *presupposes* Aristotelian essentialism inasmuch as the truth of the former requires the truth of the latter. This claim puts me sharply at odds with orthodox philosophy of biology. But I believe this conflict can be resolved amicably once essentialism is properly understood. To make good this claim it is necessary to begin with an account of both theories. A further preparatory step is to lay out explicitly the standard incompatibilist arguments and some possible responses already mooted in the literature. I can then proceed to the core of the paper, the presentation of two arguments in support of the thesis that evolutionary biology *cannot*

[3] The resolution of such tensions is the bread and butter of philosophy. For an extended discussion of this understanding of the nature of philosophy see Stephen Boulter, *The Rediscovery of Common Sense Philosophy* (Houndsmill: Palgrave Macmillan, 2007, ch. 1); Nicholas Rescher, *Aporetics: Rational Deliberation in the Face of Inconsistency* (Pittsburgh: Pittsburgh University Press, 2009); and Nicolai Hartmann, *Grundzüge einer Metaphysik der Erkenntnis*. 5th ed. (Berlin: W. de Gruyter, 1965).

do without essentialism. After floating a suggestion as to what biological essences might be I revisit the original set of incompatibilist arguments to show that they are easily brushed aside once one is familiar with the outlines of Aristotelian essentialism and the metaphysical commitments of evolutionary biology.

I turn then to the characterisation of both theories.

2. Aristotelian Essentialism

An adequate understanding of any theory requires familiarity with the problems it is meant to address. This is certainly true of Aristotelian essentialism (from here on in just "essentialism" unless otherwise specified). It is also important for a proper appreciation of essentialism to compare it to the alternative solutions suggested by other metaphysicians (something rarely done in the philosophy of biology literature).

Aristotle's essentialism is the result of the attempt to provide a metaphysical account of what is implicit in our everyday dealings with the world. In particular the essentialist wants to maintain that:

(i) The world contains, amongst other things, mind-independent middle-sized items like minerals, plants, animals, and stars;
(ii) These items are irreducible;
(iii) These items can persist through some changes, but not all; and
(iv) These items are intelligible.

Traditionally the problem posed by this set of propositions has been understanding how real items can persist through change. Perhaps the easiest way to see the difficulty is as follows: If an item *a* persists through a change, then *a* prior to the change is the same item as *a* at then end of the process (*a* at time_{t1} is identical to *a* at time_{t2}). But by Leibnitz's Law if *a* is identical to *b* then any property of *a* must also be a property of *b*. But if *a* has undergone a change then it must have some property after the change that it previously did not have, or have lost a property it previously had. In either case not everything true of *a* at time_{t1} is true of *a* at $\text{time}_{t2;}$ so by Leibnitz's Law *a* at time_{t1} is not identical to *a* at time_{t2}, and so a has not persisted through the change but has been replaced by something else. Generalise this result and one ends up denying that change is possible.

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Aristotle's solution, designed to respect i–iv, is to accept the following claims:[4]

1. The world is primarily constituted by individual substances belonging to discrete natural kinds, each kind having its own essential properties.
2. F is an essential feature of kind K if and only if F is a feature used to define kind K.
3. The definition of a kind plays two important roles. First, the definition provides the existence and identity conditions of instances of the kind. These allow one to track an instance of a kind through its career and any changes it might undergo by allowing principled answers to questions of the form "is *a* the same as *b*?" Second, a definition stating the essence of a kind has an explanatory role in that it is adverted to when explaining why an instance of the kind has the properties and behaviour patterns that it does.
4. There are biological kinds.
5. (1) – (4) are grounded in the nature of things independently of our thought or representations of them.

Such a theory allows the essentialist to maintain the target theses at the expense of some qualification of Leibnitz's Law (it does not apply unqualifiedly across times). (1) and (5) do justice to the reality of middle-sized items mentioned in (i) and (ii); (2) and the first part of (3) accommodate the claim that these items can persist through some changes but not all by distinguishing between essential and non-essential properties, the loss of the latter being consistent with the continued existence of the items through the change, while the loss of the former marks the passing out of existence of the item in question; (2) and the second part of (3) marks a commitment to the intelligibility of these items mentioned in (iv). (4) simply points out that natural kinds are not restricted to items falling exclusively within the domains of physics and chemistry. Crucial to the position is the distinction between essential and non-essential properties. Only if such a distinction is recognised can an entity undergo a change without passing out of existence altogether:

[4] The literature on Aristotle's metaphysics is very extensive and extraordinarily sophisticated, and there is, unsurprisingly, room for rational debate regarding the details of his position. What I provide here, however, is relatively uncontroversial among Aristotle scholars. I follow the account given in Charles, op. cit. note 2.

accommodating this common sense view is the primary motivation behind essentialism.

Providing a metaphysics which allows one to uphold i–iv is difficult without recourse to essentialism; indeed every competing metaphysical system abandons one or more of these desiderata. For example, in asserting the mind-independent nature of middle-sized items the essentialist is at odds with Kant and all forms of constructivism. The essentialist's commitment to (ii) distinguishes him from Plato (who maintained, at one stage at least, that extra temporal and spatial Forms alone are ultimately real); from Democritus and other atomists (who reduce middle-sized items to aggregates of atoms, the latter alone being fully real); and from Spinoza (who maintained that there is only *one* ontologically basic item). (iii) distinguishes the essentialist from Heraclitus, modern day phenomenalists, and trope theorists (who deny the existence of *persisting* objects of any kind). The essentialist's commitment to (ii) and (iii) together distinguishes him from Parmenides, Plato, Heraclitus, Democritus and modern day perdurance theorists who deny that any change is possible in real entities, and from Spinoza who maintains that all changes are merely phase changes of one underlying substance. Finally the essentialist's commitment to (iv) distinguishes him from Parmenides, Heraclitus, Plato and the skeptics who all denied that the world of ordinary sense experience is fully intelligible. We shall enter into some of the details of these points below; but it is worth noting at the outset that the rejection of essentialism comes at a high price to ordinary common sense intuitions. If one is inclined to believe that individual horses and cabbages, say, are as real as anything can be; that an individual horse and individual cabbage can undergo some changes while remaining a horse or a cabbage respectively, while other changes bring about their respective ends; and if one believes that we can understand something of horses and cabbages (for example, that we can explain why horses have the standard vertebrate limb and cabbage plants can photosynthesise); then Aristotle's essentialism proves indispensable, for the other major metaphysical systems threaten precisely these sorts of claims.[5] Let this suffice as an account of Aristotle's essentialism, and let us now turn to a similarly brief account of evolutionary theory.

[5] It is not for nothing that Lawson-Tancred deemed Aristotle's "the received metaphysics of the Western world." (In Aristotle, *Metaphysics*. Translation by Lawson-Tancred (London: Penguin, 2004, xxiii).

3. Evolutionary Biology

Again let us start with the questions evolutionary theory is meant to address. Evolutionary biologists are particularly concerned to provide an understanding of biological diversity and organismal design. A word on each of these features of the living world is in order.

The Diversity and Disparity of the Living World

Biologists are impressed by the fact that there are so many different kinds of organisms built on such different body plans. The evolutionary biologist seeks to provide some way of making sense of this bewildering variety by finding order in the diversity. But the biologist is also impressed by the fact that this variety is limited. There are many logically possible organisms the biologist can conceive of in "design space" which she does *not* find in the real world. In fact it would appear that most logically possible organisms never become actual. Thus the biologist also wants to explain why the living world has the pattern it actually has, and why it is not more varied than it actually is. Why, for instance, are there no flying pigs or frogs, or grass eating snakes (there are vegetarian lizards, so why no vegetarians snakes?) If there are eusocial insects, why are there no eusocial birds? Why are there no species with 3 or more sexes? Why do organisms come in discreet packages – species – rather than all organisms looking the same, or each individual appearing radically different? Why, indeed, has the living world not produced any radically new body plans since the Cambrian 500mya?

Adaptation

A feature of the living world noted by all is the fact that organisms are usually, and often conspicuously, well-equipped to deal with their environment. How does this come about? An interesting wrinkle here, however, is that it is as often as not the fact that organisms display less than optimal adjustment to their environment that biologists want to explain. The human eye, for example, though historically used as an instance of intelligent design by a creator, is in fact rather poorly designed from an engineering point of view (retina is at the back rather than the front). Why should this be?

These are the big questions facing evolutionary biologists, and the theory of evolution is designed to address precisely these issues. With

these questions in mind we can turn to the distinctive claims of evolutionary theory. These are as follows:

1. Evolutionary change has occurred. The living world is not stable, with species coming into and passing out of existence.
2. All life on this planet descends from a single remote ancestor (i.e., there was no separate or special creation of each individual species) and Life has a branching pattern.
3. New species form when a population splits into two or more groups and these begin to adapt to different circumstances. (Usually a sub-population on the periphery becomes geographically, and so reproductively, isolated from the main population, and begins to adapt to their new and different circumstances.)
4. Evolutionary change is gradual, not rapid. Off-spring that differ radically from their parents due to significant mutation rarely if ever survive to reproduce. All change must be relatively conservative, and so significant changes to a lineage require many small steps taking many generations.
5. The mechanism of adaptive change is natural selection.

This set of claims has been called the "received" view, but there is debate about a number of these.[6] Most biologists accept (1) the fact of evolution, and (2) the branching pattern of evolution stemming from a single source (although the shape of life might more closely resemble a mosaic than a tree in single celled organisms). This is virtually universal. (3), the theory of speciation (Mayr's contribution), is highly regarded, but not as solid as (1) and (2). It is probably one way new species emerge, but it might not be the only way, or the most prevalent way. (4), the commitment to gradualism, is perhaps more firmly established than it once was now that the excitement that first surrounded Gould's theory of punctuated equilibrium has died down, but developments in evolutionary developmental biology have put this issue back on the table. (5) is the ingredient in the received view that has attracted most attention. It is subject to much debate, but most biologists agree that natural selection has at least some role to play in dealing with the explananda outlined earlier. At issue is whether it is the only significant force driving adaptive change, or whether it needs to be supplemented by other

[6] For further discussion see chapter 2 of Sterelny and Griffiths, *Sex and Death: An Introduction to Philosophy of Biology* (Chicago: University of Chicago Press, 1999).

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forces which might well be more powerful, and whether it can account for the general shape of Life. But for the time being we can say this:

The *fact* of evolution is established easily. It follows from three readily made direct observations of the living world:

a. *Phenotypic variety* (organisms are not identical, but differ within a specific range on a variety of features).
b. *Differential reproduction* (organisms do not reproduce in equal numbers. Some produce many more off-spring than their con-specifics, many much less, some not at all).
c. *Principle of heredity* (off-spring resemble their parents more than they resemble other con-specifics).

These facts guarantee that the traits found within a population will change from generation to generation. But if this change is to be adaptive, and if adaptive change is to play a role in speciation, then additional conditions must be met. The change needs to be cumulative, i.e., the same reproductive pattern must take place over many generations. Cumulative selection requires:

d. stability in the direction of selection (the same sorts of features need to be favoured over a long period of time)
e. each step on the adaptive path must be better than the last (there can be no retreat the better to advance in evolutionary processes)
f. The right ratio of mutation rate or available variation to selective pressure. If the selective pressure is too hard it will drive the variation rate down to nothing very quickly, eliminating the chance of further evolution (the experience of animal breeders); but if the selective pressure is too low, then it will not eliminate enough of the variations to make any significant difference to the gene pool as all will survive in equal measure.

Let this suffice as an account of the main claims of the received view of evolution. We can now proceed to the grounds for the claim that the two theories are incompatible.

4. The Incompatibilist Case(s)

It might not be immediately obvious from the foregoing accounts precisely why the two theories are thought to be incompatible. Many different reasons have been suggested. It is worth spelling out these different lines of thought explicitly.

Evolutionary Biology do Without Aristotelian Essentialism?

It is said that essentialism about biological kinds is *not* consistent with evolutionary biology for the following reasons:

1. Essentialism about species implies species fixism. But species fixism is inconsistent with the view that species evolve. So essentialism about species is inconsistent with evolutionary theory.[7]
2. Essentialism about species implies clear, non-bridgeable boundaries between species. But this is inconsistent with Darwinian gradualism on two counts. First, no set of properties, at either the level of the phenotype or genotype, has been identified as jointly necessary and sufficient for membership of any biological species. That is, in the field (as opposed to the philosopher's armchair) what one actually finds is such a degree of variation within any species that no clear boundaries between species are found but rather a merging or blending at the edges of one species into another. Second, this degree of variation is a precondition of one species gradually evolving into another, as is demanded by orthodox Darwinism. Evolution between species with clear boundaries would only be possible if nature proceeded by jumps (saltations). But saltations are impossible according to orthodox Darwinian theory.[8]
3. Moreover, even if the naturalist were to identify necessary and sufficient conditions for membership in a species this would not be to the point. For if an organism were to differ markedly either phenotypically or genotypically from its parents, it would still be classed as a member of the species to which the parents belong. This is inconsistent with essentialism because the properties the essentialist is willing to countenance as part of an organism's essence must be intrinsic and not relational.[9]

[7] This argument is found in Ernst Mayr, "Darwin and the evolutionary theory in biology", *Evolution and Anthropology: A centennial appraisal*. Meggers ed. (Washington DC: Anthropology Society of Washington, 1959), and *The Growth of Biological Thought* (Cambridge Mass.: Belnap Press, 1982). It is also expounded in David Hull, "The effect of essentialism on taxonomy: two thousand years of stasis. Part 1", *Br. J. Philos. Sci.*, (1965), **XVI**: 1–18. See also M.T. Ghiselin, (1981) "Categories, life and thinking", *Behav. Brain Sci.*, (1981), **4**: 269–283, 303–310.

[8] This argument is also found in Mayr, op. cit. note 7.

[9] That this latter point is required for the argument to have any force is not always spelled out explicitly, but John Dupré is clear on this. He doubts that descent is "even a candidate for an essential property" because this

4. Essentialism is not simply the view that organisms have an essence. It also maintains that this essence has an explanatory role within biology inasmuch as one can explain at least some of the properties of an organism by adverting to the essence of the species of which it is a member. But no essence *with explanatory power* has been identified by evolutionary biology (or any other branch of biology for that matter). Therefore, essentialism is inconsistent with evolutionary biology inasmuch as one claims while the other denies that there are biologically explanatory essences.[10]
5. It has been argued that biological essences, were they to be discovered, would have no explanatory role in evolutionary biology.[11] In the population thinking characteristic of evolutionary biology, to determine the effects of evolutionary mechanisms one need only advert to statistical laws about the interactions of the individuals in a population. One needs no knowledge of the particular properties of particular individuals. It is only properties of populations that are truly explanatory. "Describing a single individual is as theoretically peripheral to a populationist as describing the motion of a single molecule is to the kinetic theory of gases. In this important sense, population thinking involves *ignoring individuals*…"[12] But in ignoring individuals, one ignores their essences. So essences are explanatorily irrelevant to evolutionary biology.
6. It is assumed by essentialism that each and every organism has one and only one essence, the essence of the species of which it is a member. But it has been argued that current evolutionary biology favours species pluralism, i.e., the view that organisms can be grouped into several equally real species depending on the species concept employed.[13] What is more, it is claimed

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property is "purely relational". *The Disorder of Things: Metaphysical Foundations of the Disunity of Science* (Cambridge, Mass: Harvard University Press, 1993, 56).

[10] For an expression of this argument see Samir Okasha, "Darwinian Metaphysics: Species and the Question of Essentialism", *Synthese* (2002), **131**, 191–213.

[11] See Eliot Sober, "Evolution, Population Thinking, and Essentialism", *Phil. of Sci.*, (1980), **47**, 350–83.

[12] Op. cit., note 11, 370.

[13] See M. Ereshefsky, "Eliminative Pluralism", in *The Philosophy of Biology*. Hull and Ruse (eds). (Oxford University Press, 1998).

that the resulting species do not coincide. That is, it is not the case that reproductively isolated groups coincide with groups with common ancestors and groups subject to the same environmental selection pressures (groupings arrived at using the biological, phylogentic and ecological species concepts respectively). Since one and the same organism can fall into more than one group, and since no one of these groupings is privileged, it would seem that an individual organism can have more than one essence, contra essentialism.

But the incompatibility thesis has been contested on the following grounds:

1. Bernier argues that essentialism is not incompatible with evolutionary biology because species fixism, properly conceived, is not incompatible with one species giving rise to another distinct species via standard evolutionary processes.[14]
2. D. Walsh, relying on Pellegrin[15], D.M. Balme[16], and J. Lennox[17], argues that essentialism is not incompatible with evolutionary biology because essentialism properly conceived does not imply species fixism of any description. He writes: "On Aristotle's scheme essences or natures are not transcendent fixed "ideas"; they are goal-directed capacities immanent in the structure of the organism." These natures "…could change over time in just the way we have come to think that species do."[18]
3. Walsh argues, contra Sober, that evolutionary biology cannot rely simply on population thinking while ignoring individual organisms and their properties. While evolutionary change can be described as changes in gene frequency in a population (as Sober suggests) one cannot explain why such changes are

[14] See R. Bernier, "The Species as an Individual: Facing Essentialism", *Systematic Zoology* Vol. **33**, No. 4, (1984), 467.

[15] "Logical Difference and Biological Difference: the Unity of Aristotle's Thought", in *Philosophical Issues in Aristotle's Biology*, Gotthelf and Lennox (eds). (Cambridge: Cambridge University Press, 1987).

[16] *Aristotle's de Partibus Animalium and De Generatione Animalium I* (Oxford: Clarendon Press, 1972).

[17] "Material and Formal Natures in Aristotle's *de Partibus Animalium*" and "Kinds, Forms of Kinds, and the More and the Less in Aristotle's Biology", in *Aristotle's Philosophy of Biology* (Cambridge: Cambridge University Press, 2001).

[18] "Evolutionary Essentialism", *Brit. J. Phil. Sci.* **57** (2006), 431.

> adaptive without adverting to features of individual organisms, in particular their developmental systems and phenotypic plasticity. Since these features are plausibly regarded as the essential nature of organisms, and since explaining adaptations is part of the raison d'être of evolutionary biology, evolutionary biology cannot fulfil its explanatory ambitions without presupposing essentialism. "Recent evolutionary developmental biology shows that one cannot understand how natural selection operating over a population of genes can lead to increased and diversified adaptation of organisms unless one understands the role of individual natures (essences) in the process of evolution."[19] Therefore essentialism is not inconsistent with evolutionary biology.

This collection of arguments is not exhaustive, but it includes the most pressing points advanced on both sides of the debate. It is worth noting immediately that the incompatibilist arguments are not consistent. Some deny there are biological essences (1–3); others are willing to countenance essences but deny them explanatory value (4 & 5); still others claim that organisms can have *more than one* biological essence, each possibly having explanatory value in some context or another (6). The same can be said of the arguments on the other side inasmuch as there is a difference of opinion as to whether species fixism is indeed a problem. Some claim that it is not (1), while others, at least by implication, assert that fixism would be a problem if it were entailed by essentialism (2). I take these inconsistencies on both sides of the house to indicate both the complexity of the issues and the need to return to first principles. Now the first principle shared by both theories is a commitment to the reality of change in the living world. It is on this shared principle that I build two presupposition arguments intended to show that evolutionary biology actually requires the truth of essentialism.

5. Two Presupposition Arguments

As stated at the outset, I maintain that both evolutionary biology and Aristotelian essentialism have independently established claims on our allegiance. Consequently, on the assumption that truth is one, it is methodologically appropriate to start with the assumption that the tensions between the two are not genuine but merely *prima facie*. Of course if this thesis cannot withstand scrutiny one will

[19] Op. cit., note 18, 426.

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have to accept that the tensions are genuine and a choice between the two will be forced. It is my view that this choice can be avoided.

It is important at the outset to be explicit about my limited aims. I am not concerned here to defend directly either the received view of evolution or essentialism. The question here is only as to their compatibility. I want to know whether the truth of either would imply the falsity of the other. As far as the argument of this paper is concerned *both* evolutionary theory *and* Aristotelian essentialism *might very well be false*. I happen to think both are true, and that this position will be supported in some measure if I can but show that they are at least compatible.

With this in mind I now present two arguments which invite the conclusion that evolutionary biology presupposes Aristotelian essentialism. Both are based on considerations drawn from reflection on the very problem of change that motivated essentialism in the first place. The gist of these considerations is as follows: If organisms are ontologically irreducible to entities of physics and chemistry; if biological species are natural groups of such organisms; if such species can undergo some changes without passing out of existence; and if one is willing to accept that speciation and extinction events do occur, then essentialism is forced – for an entity can persist through change only if it retains its essential properties while shedding or gaining an accidental property. Now it would appear that the only claim in these reflections at which some biologists might baulk is the claim that species are natural groups. For the autonomy of biology as a science requires organisms to be ontologically irreducible to physics and chemistry.[20] Moreover, all agree that a species can, say, increase or decline in numbers, or broaden or decrease its

[20] Of course there are good grounds for maintaining that organisms are ontologically irreducible. Mayr himself goes to considerable lengths to establish precisely this point, identifying eight characteristics of living organisms that have no parallel in the inanimate world (op. cit. note 7, 1982, 36–59). And even those who expect that such a reduction will be effected eventually acknowledge that such a reduction would require significant changes to our understanding of physics and chemistry, and most likely include a commitment to downward causation. For further discussion see E.F. Keller, "It is Possible to Reduce Biological Explanations to Explanations in Chemistry and/or Physics", in *Contemporary Debates in Philosophy of Biology*. Ayala and Arp (eds). (Oxford: Wiley-Blackwell, 2010, 19–31), and John Dupre, "It is not Possible to Reduce Biological Explanations to Explanations in Chemistry and/or Physics", in *Contemporary Debates in Philosophy of Biology*. Ayala and Arp (eds). (Oxford: Wiley-Blackwell, 2010, 32–47).

range, i.e., change in some respect, without ceasing to exist. And of course no biologist is going to question the propriety of speciation and extinction events. The two arguments to follow are thus designed to show that evolutionary biology will have great difficulty in discharging its own self-imposed explanatory goals if it abandons the view that species are natural groups.[21]

An Argument From Diversity:

1. Evolutionary biology's fundamental claim with respect to biological diversity is that species have diverged to take advantage of the various ecological opportunities afforded to them. Ancestral species have given rise to distinct daughter species by a process of descent with modification, which results in the emergence of new biological forms and the expected degree of biological diversity. In short, biological diversity follows upon speciation events.
2. Setting aside questions regarding the various possible mechanisms of speciation, it is customary within evolutionary biology to take the following view of the origin of species. Once ancestral species A has cleaved into two new daughter species B and C, ancestral species A no longer exists, and daughter species B and C have come into existence (there has been two speciation events and one extinction). Moreover, B is not C, and neither is a continuation of A.[22]

[21] Of course these arguments are redundant for those who already accept that species are natural groups, the foregoing reflections on the problem of change being sufficient to force essentialism.

[22] That is, ancestral species A does not continue to exist in virtue of metamorphing into species B or C. Does this conflate sortal persistence conditions with diachronic identity conditions? Some metaphysicians want to distinguish the question "Under what conditions can x remain the kind of thing x currently is?" from "Under what conditions can x remain x?" Those who wish to preserve this distinction are motivated by the concern to allow for the possibility of metamorphosis of the sort associated with classical mythology, i.e., where Lucius, say, begins life as a human being, is transformed into an ass, and is ultimately returned to human form, all the while remaining Lucius. I think such scruples can be set aside here. For one, many will wonder whether the myths of metamorphosis are in fact fully intelligible (could Lucius really be an ass and remain Lucius?). For those whose intuitions prevent them from embracing metamorphosis as a genuine possibility sortal persistence conditions just are diachronic identity

3. This account of the origins of biological diversity presupposes that change is a real feature of the living world. In particular it presupposes that distinct species really do come into and pass out of existence. So speciation and extinction events are not illusory. Nor are they simply a function of our naming conventions – for mind-independent diversity cannot be explained by mind-dependent, i.e., non-natural, entities and processes. Furthermore, the biologist cannot maintain that speciation and extinction events are merely a function of a new arrangement of subatomic particles, or merely a phase change of an underlying substance, or temporal parts of an unchanging Tree of Life without abandoning the ontological irreducibility of organisms or the reality of change.
4. It is possible to maintain that A, B and C are distinct, natural species only if the existence and identity conditions of each are distinct.
5. This point is generalisable to cover all speciation and extinction events.
6. But the existence and identity conditions of *x* specify the Aristotelian essence of *x*. So,
7. Biological species, in virtue of having existence and identity conditions, have an essence.

The upshot of this argument is clear enough: The standard account of biological diversity provided by evolutionary theory presupposes essentialism. Note that this argument is built on the fact that species *do* come into and pass out of existence, a fact often thought to be inimical to essentialism. In fact quite the reverse is the case. Only if species have distinct essences can one say in a principled fashion that one species no longer exists and that two new distinct species have arrived on the scene, and one needs to be able to say this if one is to give the standard account of biological diversity.

An Argument From Organismal Design:

1. Evolutionary biology's fundamental claim with respect to organismal design is that many features of organisms are adaptations.

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conditions because the identity of x is determined by x's sortal. But these considerations can be set aside in the current context because no evolutionary biologist believes that speciation events are cases of metamorphosis.

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2. An adaptation is a derived character or trait that evolved because it improved relative reproductive performance.
3. Crucial to present purposes is the contrast between derived and ancestral characters. A trait or character is termed "ancestral" if it is possessed by an ancestral species shared by related daughter species. A trait or character is termed "derived" if it evolved after the ancestral trait in the lineage.[23]
4. To determine whether a trait is derived one needs to know something of the transition from the ancestral to the derived condition of the character. That is, one needs to know the trait's phylogenetic history.
5. To track the phylogenetic history of a trait the biologist employs phylogenetic trees.
6. For a phylogenetic tree to be genuinely illuminating it must represent real relationships obtaining between natural species.[24]

[23] The crucial point about adaptations is that they are features or characters that *at some point* in their phylogenetic history were derived. That is, for a trait to be an adaptation there must have been at one stage of its history a transition from the ancestral to the derived state. This does not mean that this trait ceases to be an adaptation if it is subsequently passed on without modification to another species after further cleavage in the lineage. Adaptations can be, and often are, ancestral traits with respect to a particular set of species, say species C, D and E, where C is a daughter species of ancestral species A, and D and E are daughter species of C.

[24] That phylogenetic trees are genuinely illuminating is assumed whenever they are employed in biochemistry, immunology, ecology, genetics, ethology, biogeography and stratigraphy. This assumption also underwrites a major methodological procedure in biology. Comparative analyses are only illuminating if the classification of the items being compared and their relationships are assumed to be accurate reflections of mind-independent biological reality. Thus phylogentic trees taken to represent mind-independent biological reality are necessary to comparative anatomy, comparative physiology, and comparative psychology. It is worth noting in this regard that realism about species is advocated by Darwin himself in the famous thirteenth chapter of *On the Origin of Species*. "All the foregoing rules and aids and difficulties in classification are explained, if I do not greatly deceive myself, on the view that the natural system is founded on descent with modification; that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent, and in so far, *all true classification is genealogical*; that community of descent is the hidden bond which naturalists have been unconsciously seeking, and not some unknown plan of creation, or the enunciation of general propositions, and the putting

7. The standard relationship represented by a phylogenetic tree is that of an ancestral species A cleaving into two or more daughter species B and C.
8. And as seen in the argument from diversity, the standard interpretation of this process assumes that after cleavage species A no longer exists, and species B and C have come into existence (there has been two speciation events and one extinction). Moreover, B is not C, and neither is a continuation of A.
9. Thus in order to maintain that a trait genuinely is an adaptation the biologist must assume that distinct, natural species really do come into and pass out of existence. That is, speciation and extinction events are not illusory, nor simply a function of our naming conventions – for mind-independent adaptations cannot be explained by mind-dependent, i.e., non-natural, entities and processes. Furthermore, the biologist cannot maintain that speciation and extinction events are merely a function of a new arrangement of subatomic particles, or merely a phase change of an underlying substance, or temporal parts of an unchanging Tree of Life without abandoning the ontological irreducibility of organisms or the reality of change.
10. It is possible to maintain that A, B and C are distinct, natural species only if the existence and identity conditions of each are distinct.
11. But the existence and identity conditions of *x* specify the Aristotelian essence of *x*.
12. In order to maintain that a trait is an adaptation the biologist must assume it is a feature of a species with an Aristotelian essence.

Again, the upshot of this argument is clear enough: The standard account of what it is to be an adaptation presupposes essentialism. Phylogentic trees can be genuinely illuminating only if they represent real relationships between natural groups which come into and pass out of existence. But it is only if species have distinct essences that

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together and separating objects more or less alike". *On the Origin of Species*. In *From So Simple a Beginning. The Four Great Books of Charles Darwin*. E.O. Wilson (ed.). (New York: W.W. Norton, 2006, 717). If there is any question about how one is to read these lines, Darwin underlines his realism with the claim that "This classification is evidently not arbitrary like the grouping of the stars in constellations" (op. cit., 711).

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one can say in a principled fashion that one species no longer exists and that two new distinct species have arrived on the scene. Thus the standard accounts of biological diversity and organismal design both presuppose essentialism.

6. What Are These Essences, And Are They Explanatory?

It would certainly smooth the path of the arguments from diversity and organismal design if some account of these alleged biological essences were forthcoming. I have not made any suggestions as yet as to what these essences might be, or whether these essences are genuinely explanatory. Space considerations make it impossible to enter into these matters here as fully as one would like; but I can at least make a plausible suggestion on this score.

My main suggestion regarding biological essences is that they are found not in the genotype or the phenotype but in the species specific developmental programmes that map genotypes onto phenotypes. The key claims in this suggestion are that (i) only a portion of an organism's genome determines its species (not all of it); (ii) that *developmental control genes* (i.e., genes that control the expression of other genes) determine the developmental pattern of an organism; and (iii) that these developmental patterns are "lineage specific", i.e., shared by individuals of the same biological species understood as a smallest diagnosable cluster of organisms related by ancestry and descent.[25] On this suggestion two organisms belong to the same species and have the same essence if they share the same developmental programme regardless of how else they might differ. If a population of such organisms maintains the same developmental programme over several generations then no extinction or speciation event has occurred, regardless of any other changes that might have taken place.

Perhaps the most striking thing about this suggestion is that its plausibility is granted even by those who are not usually considered friends of essentialism. John Dupré, for example, has written:

> It might reasonably be asked here whether these epigenetic mechanisms might not themselves serve as essential properties. And I think that if, as I speculated earlier, there are species for which these provide the best account of species coherence, we would have here perhaps the best candidates in biology for real essences.[26]

[25] See Stearns and Hoekstra for further discussion (op. cit. note 1, 137).
[26] Op. cit., note 9, 55.

One reason for taking species specific developmental programmes as serious candidates for biological essences is that they have great explanatory potential, an essential feature of Aristotelian essences. A developmental control gene can be seen as a selector switch that makes choices from a range of potential developmental fates. These switches are responsible for the "universal" properties of phenotypes. And these switch points allow for phenotypic alternatives that can become subject to selection pressures. Moreover, M.J. West-Eberhard has fixed upon these features of developmental programmes in the elaboration of her developmental plasticity theory of speciation. She writes:

> … developmental plasticity in trait expression within a parent population can predispose descendent sister populations to speciation by facilitating the intraspecific evolution of contrasting specializations. The individuals expressing these specializations begin to show breeding separation…This creates two breeding populations, each one with one of the contrasting alternatives *fixed*. Phenotypic fixation …promotes further divergence.[27]

The main lesson she draws from this line of thought is that "Phylogenetic gaps could have a developmental origin."[28] R. Raff, for one, would concur:

> Novel features arise in animal evolution as a result of modifications of developmental pattern.[29]
>
> Most of what goes on in the development of a new descendent species will utilise the same standard parts as the parent species. Novel forms will arise mostly from the modifications of existing modules in development.[30]

Now I cannot defend this thesis regarding biological essences here. It must suffice to make the suggestion, and draw attention to the attractions of the view. Of course there are outstanding questions that need to be addressed. Will this approach work for all organisms? Are developmental programmes as invariant as this proposal suggests? These are empirical questions best left to biologists. But we can say at least two things here. Even if this particular suggestion does not

[27] *Developmental Plasticity and Evolution* (USA: Oxford University Press, 2003, 528).
[28] Op. cit., note 27, 24.
[29] *The Shape of Life: Genes, Development and the Evolution of Animal Form* (Chicago: University of Chicago Press, 1996, 31).
[30] Op. cit., note 29, 360.

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hold up under scrutiny, something else will have to be found to play the role of essences if evolutionary biology is to meet its self-imposed explanatory objectives. Second, while its confirmation lies ultimately in the hands of biologists, it is to be noted that the claim that species specific developmental programmes are biological essences does not fall to any of the original incompatibilist objections rehearsed at the outset of our discussion, and this serves as a kind of corroboration. I conclude, then, with a brief review of those original incompatibilist arguments with this thesis in mind.

7. Replies to Incompatibilist Arguments

Some of the replies to the incompatibilist arguments will be clear enough from the foregoing discussion. For example, it has already been pointed out that there is nothing in Aristotelian essentialism that implies species fixism, i.e., that species cannot evolve. In fact essentialism is required to allow for genuine change in the living world. Similarly, we can reject the second objection on the grounds that an organism's species specific developmental programme is that in virtue of which it belongs to a particular species, happy that this allows for the full range of phenotypic variability found in real populations. Until this suggestion is defeated on empirical grounds there is, contra this objection, an empirically plausible candidate for the role of biological essences.

The third objection is curious in that it appears to undercut evolutionary biology itself. For if offspring are always placed in the same species as the parent regardless of genotypic, phenotypic or developmental differences, as the argument alleges, then speciation events would be impossible. This is an argument against the receive view of evolutionary biology, not essentialism.

As to the fourth objection, which granted essences house room within biology but denied them explanatory power, perhaps enough has already been said. One of the main attractions of the thesis that species specific developmental programmes are biological essences is precisely their explanatory power, so the objection is simply false.

To the fifth objection – Sober's argument that the properties of individuals can be ignored in population thinking, so the essential properties of individuals (if they existed) are not explanatory – it can be countered that the statistical properties of populations are ontologically dependent upon the properties of the individuals that make up the population. So at some explanatory stage the properties

of individuals must be factored in. Their essential properties will be among those adverted to in the course of this level of explanation. And there is no reason to think developmental programmes will not be involved, at least indirectly, in these explanations.

Finally, what are we to make of the claim that one and the same organism can belong to several, equally real biological species, so that one and the same organism can have several, equally real essences? This last objection falls foul of the principle of non-contradiction and so is charged with incoherence. If one and the same organism had more than one essence, then it would have more than one set of existence and identity conditions. But this would allow it to possess under one set of conditions a property which it does not have under another – a violation of the principle of non-contradiction. This result can be avoided in one of two ways: Either one can deny species realism, but at the cost of compromising the explanatory goals of evolutionary biology; or one might claim that two or more organisms can occupy exactly the same space at the same time, a claim few biologists would find intelligible.[31] It is much more plausible to avoid the contradiction altogether and maintain that each and every organism has one and only one developmental programme, and so each and every organism has one and only one essence.

So I conclude that the original incompatibilist objections leave unscathed the suggestion that biological essences are species specific developmental programmes. This in turn makes the acceptance of the two presupposition arguments easier to countenance. But the crucial point upon which all else depends is the commitment to the reality of change shared by evolutionary biology and essentialism. It is this shared metaphysical commitment that binds the evolutionary theorist to the essentialist.

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[31] Some metaphysicians are willing to allow two objects to occupy the same space simultaneously. The standard example being a lump of clay and a vase composed of the clay. When the vase breaks the vase no longer exists but the clay remains, which means the vase was not the clay, and the clay was not the vase. One way to understand this is to maintain that the clay and the vase are two distinct objects which overlapped at one stage of their respective careers. But no one to my knowledge believes that this model can be extended to embrace the overlapping of two or more distinct organisms.