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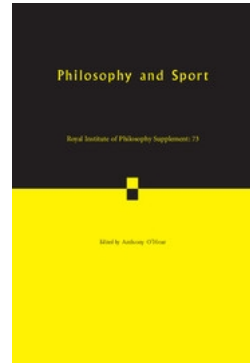
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Under Darwin's Cosh? Neo-Aristotelian Thinking in Environmental Ethics

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1. Standing on Darwin's shoulders; or is that on his toes?

As a first shot, one might say that environmental ethics is concerned distinctively with the moral relations that exist between, on the one hand, human beings and, on the other, the non-human natural environment. But this really is only a first shot. For example, one might be inclined to think that at least some components of the non-human natural environment (non-human animals, plants, species, forests, rivers, ecosystems, or whatever) have independent moral status, that is, are morally considerable in their own right, rather than being of moral interest only to the extent that they contribute to human well-being. If so, then one might be moved to claim that ethical matters involving the environment are best cashed out in terms of the duties and responsibilities that human beings have to such components. If, however, one is inclined to deny independent moral status to the non-human natural environment or to any of its components, then one might be moved to claim that the ethical matters in question are exhaustively delineated by those moral relations existing between individual human beings, or between groups of human beings, in which the non-human natural environment figures. One key task for the environmental ethicist is to sort out which, if either, of these perspectives is the right one to adopt—as a general position or within particular contexts. I guess I don't need to tell you that things get pretty complicated pretty quickly.

Some issues that energize environmental activists are essentially local in scale. Examples might include the pollution of a river by toxic waste or the building of a road through an area of natural beauty. It seems fair to say, however, that environmental ethics has become an important feature of the contemporary philosophical landscape mostly as a reaction to various high-profile environmental issues that confront humankind as a whole, issues that engage environmental activists world wide. The list includes

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disasters (or potential disasters) such as global warming, excessive deforestation, and the landslide extinction of large numbers of animal and plant species. But while it may be true that the latter class of issues has typically provided the real-world spur to environmentally oriented philosophizing, the core questions that more abstractly characterize the field of environmental ethics are not themselves essentially crisis-driven. What are the normative principles that regulate the ways in which human beings should intervene in the non-human natural world? Which, if any, non-human natural entities have independent moral status? Is it possible to generate stable ethical principles of an environmentally sensitive kind from a perspective on moral value which is purely anthropocentric? These sorts of philosophical questions would be worth asking even if the world were free from global environmental challenges.¹

As the title of this paper suggests, one of my present goals is to say something of interest to thinkers engaged with environmental ethics. I am, however, no ethicist—environmental or otherwise. The arguments I shall develop are launched entirely from within the intellectual borders of philosophy of biology. This might look like a case of unprovoked philosophical imperialism—but it isn't. Indeed, at the risk of sounding petulant, they (some environmental ethicists that is) started it, by (implicitly at least) making claims about the fundamental character of biological systems.

Here, then, is where we are going. I begin (section 2) by describing how a prominent position in environmental ethics—Paul Taylor's biocentric individualism—is committed to a particular explanation of the way in which the ethical norms that ought to regulate environmental decision-making might be based on biological facts. This explanation rests in turn on what is (I argue) a recognizably Aristotelian style of thinking about the biological realm. And that's where, on the face of it, the trouble lies. For if the received view of Darwinian theory and its place in evolutionary

¹ My description of environmental ethics has, of necessity, been very brief. For recent book-length introductions to the field, see, for example: R. Attfield, *Environmental Ethics: an Overview for the 21st Century* (Cambridge: Polity, 2003); J. Benson, *Environmental Ethics: an Introduction with Readings* (London and New York: Routledge, 2000); D. Jamieson (ed.), *A Companion to Environmental Philosophy* (Oxford: Blackwell, 2001); D. Schmidtz and E. Willott (eds.), *Environmental Ethics: What Really Matters, What Really Works* (Oxford: Oxford University Press, 2002); M.E. Zimmerman (ed.), *Environmental Philosophy: from Animal Rights to Radical Ecology* (NJ: Prentice Hall, Third Edition, 2001).

biology is correct, then there is a case that the Aristotelian thinking in question, and thus the ethical framework at issue, are utterly indefensible. I scout this conditional conclusion (section 3) by drawing on some old work due principally to Elliott Sober. Things then take (what I hope is) an unexpected turn. I claim (section 4) that recent work on the phenomenon of self-organization in biological systems might provide an alternative source of *support* for the supposedly discredited Aristotelian view in biology, and thus, by extension, for any position in environmental ethics which depends on that view. Faced with what appears to be a disconcerting choice—between (i) the mighty theoretical edifice of Darwinism, and (ii) an impressively rejuvenated Aristotelianism in biology and environmental ethics—I spend some time looking at exactly how the land lies in the disputed region of biological theory (section 5). I close by drawing some general conclusions for environmental ethics (section 6).

As I see it, then, this paper is, at heart, an exercise in the philosophy of biology, but one with consequences for the kind of considerations to which environmental ethicists might legitimately appeal. In my more mischievous moments, however, I am tempted to put a different spin on things, and to portray the argument as a sort of Trojan horse parked in the middle of philosophy of biology. To see why, let's focus on exactly how the central claims unfold, when seen from a narrower philosophical perspective. For a while things progress without much incident. Under cover of a critical response to a leading position in environmental ethics, I requisition and adapt for my own purposes an analysis, due primarily to Sober, according to which there exists a deep incompatibility between (i) a certain aspect of Darwinian theory and (ii) a generically Aristotelian account of biological systems (sections 2 and 3). If (i) is true, then (ii) is false—or so it seems—and who would dare deny Darwinism? At this juncture, however, I unleash a controversial thesis about the primary source of biological form, a thesis that locates that source in the phenomenon of self-organization during organismic development (section 4). As I shall argue, this thesis is recognizably neo-Aristotelian in character. Thus the conflict between Darwinism and Aristotelianism, far from being an interesting historical curiosity, appears to be back squarely on the biological agenda. The remaining task for this paper (when viewed from the present, narrower perspective) is to say something about the principles by which this apparent conflict might ultimately be resolved (section 5).

2. Wearing Aristotle's Boots

Earlier I identified the following as one of the core questions in environmental ethics: which, if any, non-human natural entities have independent moral status (are morally considerable in their own right)?² Let's say you believe the answer to this question to be that human beings alone have independent moral status, with the only moral status enjoyed by non-human natural entities being derived from human needs and interests. How might you justify this view? The most obvious strategy would be to claim that the possession of some particular property or combination of properties is necessary for independent moral status, and that humans alone possess that property or combination of properties. One might then expect psychological achievements such as being rational, being reflectively self-aware, and/or having the capacity for complex generative language-use to be prime candidates for the properties in question. But now let's say you are of a more inclusive ethical disposition, in that you believe the answer to the target question to be that a large sub-set of (and maybe even all) animals—human and non-human—enjoy independent moral status. In this case the properties just mentioned would be too restrictive to figure as necessary conditions here, although they might still be sufficient conditions. The default strategy for you now would most likely be to appeal to sentience, marked standardly by the capacity to feel pain. Sentience is a property that most people (including most philosophers) would be happy to attribute to many (although perhaps not all) non-human animals, but not to plants. Moreover, on the face of it, causing pain is a reasonable candidate for a morally reprehensible act. So sentience might be promoted as both a necessary (plants are plausibly ruled out) and a sufficient (most animals at least are plausibly ruled in) condition for independent moral status.

Those without experience of environmental ethics might think that this sort of animal-centred position is about as inclusive as the

² Wading into the debate over which entities have independent moral status is a convenient way of seeing how the specific philosophical position in which we are principally interested here gains its plausibility. The debate in question is complex, however, and I cannot do anything like proper justice to it here. Indeed, I shall do no more than touch on a small sub-set of the myriad issues and, aside from our target view, I shall content myself with greatly simplified versions of the alternative positions discussed. Anyone whose interest is aroused may follow up the details in the introductions to environmental ethics listed in note 1.

independent moral status club ever gets; but that would be a misconception. In environmental ethics it is not uncommon for theorists to extend independent moral status to plants.³ Once we take this bold step, it is no longer possible to adopt being sentient as necessary for independent moral status, although it may still be sufficient. (I am simply going to ignore the protestations of those brave and unembarrassed souls who maintain that plants are sentient, and who thus see no difficulty in maintaining the necessity of sentience.) So how are we to stake out this new boundary to independent moral status? The rather obvious move is to extend independent moral status to *each individual living thing*, a position known in the trade as *biocentric individualism*.⁴

For my money, the most worked out, systematic, and compelling version of biocentric individualism remains Paul Taylor's *attitude of respect for nature*.⁵ At the heart of Taylor's framework is the idea of an entity having a *good of its own*. If an entity has a good of its own, then it makes sense for us to speak in terms of what is good or bad *for* that entity, without us having to make reference to any other

³ Another way of extending independent moral status is to be a holist, and to hold that certain environmental wholes (e.g. species, ecosystems, the Earth) are morally considerable in their own right. Holism will not concern us in this paper. The introductions to environmental ethics listed in note 1 all discuss holism at some point.

⁴ Of course, someone who holds that each individual living thing is morally considerable in its own right isn't thereby committed to the thought that we would never be justified in harming any living thing, but only to the thought that when one is deciding upon a course of action, the independent needs and interests of each living thing affected by that decision must be taken into account.

⁵ See P. W. Taylor, *Respect for Nature: A Theory of Environmental Ethics* (Princeton, NJ: Princeton University Press, 1986); P. W. Taylor, 'The Ethics of Respect for Nature', *Environmental Ethics*, **3**, No. 3 (1981), 192–218, reprinted in *Environmental Philosophy: from Animal Rights to Radical Ecology*, M.E. Zimmerman (ed.) (NJ: Prentice Hall, Third Edition, 2001), 71–86. To be precise, Taylor restricts the application of his biocentric individualist framework to wild organisms, and so suggests that the moral status of domesticated organisms is a separate issue. However, this qualification is a questionable wrinkle that we can simply ignore. For a prior and less sophisticated example of biocentric individualism, see Albert Schweitzer's 'reverence for life,' as developed in his *Cultural Philosophy II: Civilization and Ethics* (London: A. and C. Black, 1929, Translated by John Naish from the 1923 German text). For a biocentric position that builds on Taylor's work, see J. Sterba, 'From Biocentric Individualism to Biocentric Pluralism', *Environmental Ethics*, **17**, No. 2 (1995), 191–207.

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entity. Consider my watch. In ordinary conversation we might happily talk in terms of it being good for this watch to be regularly serviced. However, a moment's reflection shows that if we really want to understand the meaning of this sort of statement, we will be forced to make reference to the purposes and/or the needs of some other (in this case, human) entity. This additional entity might be the designer of the watch (whose purpose was to bestow an accurate timekeeper on the world) or its current user (whose needs and goals, such as arriving at the railway station on time, are furthered by having a precision timepiece). In the final analysis, it is the goods of these other entities that are furthered by the watch being regularly serviced. By contrast, suppose I say that it would be good for my father to have a hernia operation. That statement will be true or false, depending on whether it really would advance my father's good to have such an operation, but unpacking the meaning here requires no reference to the purposes and/or needs of any entity in addition to my father. In familiar ethical language, then, a watch is merely a means to an end, and never an end in itself, whereas a human being, who may at times be a means to an end, is always also an end in his or her self.

So, for some entities, it is true to say that they have goods of their own; for others, it isn't. But where do we draw the line? According to Taylor—and here's where the biocentric individualism kicks in—for each *individual living thing*, it is true to say that that entity has a good of its own. What grounds this claim? Here it is useful to consider Taylor's analysis of butterfly life:

...once we come to understand [the butterfly's] life cycle and know the environmental conditions it needs to survive in a healthy state, we have no difficulty in speaking about what is beneficial to it and what might be harmful to it. A butterfly that develops through the egg, the larva, and pupa stages of its life in a normal manner, and then emerges as a healthy adult that carries on its existence under favorable environmental conditions, might well be said to thrive and prosper. It fares well, successfully adapting to its physical surroundings and maintaining the normal biological functions of its species throughout its entire span of life. When all these things are true of it, we are warranted in concluding that the good of this particular insect has been fully realized. It has lived at a high level of well-being. From the perspective of the butterfly's world, it has had a good life.⁶

⁶ Respect for Nature, op. cit. note 3, 66.

According to Taylor, then, the individual butterfly has a good life when (a) it undergoes the normal developmental process that butterflies standardly undergo, (b) it has a healthy adult life (in the context of the lives normally led by members of its species), (c) it successfully adapts to its physical surroundings, and (d) it maintains the normal biological functions of its species throughout its life. As far as I can see, satisfying conditions (a)-(c) constitutes part of what it means to satisfy condition (d). An organism couldn't be said to maintain the normal biological functions of its species throughout its life if it didn't undergo a normal species-specific developmental trajectory, have a healthy adult life, or successfully adapt to its physical surroundings. Here, then, is the key point: for each individual living thing, we can make sense of that organism as flourishing when, throughout its life, it succeeds in realizing the biological functions that are normal for organisms of that species, and as failing to flourish whenever it fails to realize those functions. It is because we always have this benchmark for what counts as the flourishing of a particular individual living thing that we can rightly speak of each individual living thing as having a good of its own.⁷

Four features of Taylor's concept of an entity's own good deserve emphasis:

1. What counts as the good of a particular animal or plant is fixed relative to the species of which that animal or plant is a member. As Taylor explains, in 'order to know what a particular organism's good consists in... it is necessary to know its species-specific characteristics. These characteristics include the cellular structure of the organism, the internal functioning of its various parts, and its external relations to

⁷ For Taylor, being an individual living thing may not quite constitute a necessary condition for an entity to have a good of its own. Parenthetically he raises the issue of artificial intelligence, and resolves to remain open-minded about a possible future in which we feel compelled to say of a robot that it genuinely has a good of its own, independently of its designer's purposes. Taylor's position here is not quite clear. If he were prepared to say that such a robot were literally alive, then he might hold that being an individual thing is a necessary condition for an entity to have a good of its own. But, in the following passage, Taylor hesitates to extend the concept of life to robots, and suggests that a different system of ethics might be required in such a case: 'If mechanisms (*organisms?*) of artificial intelligence were ever to be produced, another system of ethics might have to be applied to the treatment of such entities by moral agents' (Respect for Nature, op. cit. note 3, 125, emphasis added).

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other organisms and to the physical-chemical aspects of its environment. Unless we learn how the organism develops, grows and sustains its life according to the laws of its species-specific nature, we cannot fully understand what promotes the realization of its good or what is detrimental to its good.’⁸

2. Although Taylor is not entirely clear about the conceptual relation that obtains between a species-specific biological function and a species-specific characteristic, it seems, on the whole, that he conceives of species-specific characteristics as material factors that underlie or support some biological function. (The cellular structure of the organism, for example, fits this profile.). Re-reading the quotation immediately above through this lens, we can now see that, for Taylor, understanding organisms, and thus in what the goods of those organisms consist, requires two interlocking explanatory domains, that of biological function and that of material underpinning.
3. Whether or not an entity has a good of its own is independent of whether or not that entity is, even in principle, consciously aware of in what that good consists, and so may consciously organize its behaviour with the goal of furthering that good. In other words, for Taylor, sentience is not a necessary condition for an entity to have a good of its own. That’s why individual non-sentient animals (if there are any) and individual plants have a good of their own in just as robust a sense as individual sentient animals. This is, of course, exactly what one would expect from a biocentric individualist position.
4. Whether or not an organism is flourishing is a fully objective fact about that organism, a fact that is susceptible to human investigation once we have the requisite knowledge about the organism’s species-specific characteristics. This state of affairs means that human beings are, in principle, able to make judgments from the standpoint of an organism’s own good, even if that organism is not itself capable of making such judgments.

As we shall see, Taylor’s concept of an entity’s own good is far from the whole of his biocentric individualism. Indeed, sharp-eyed readers will have noticed that, so far, I haven’t even mentioned the notion of independent moral status. More on that soon. First though I want to take a brief stroll through some familiar historical territory, in order to substantiate the claim that Taylor’s concept of

⁸ Respect for Nature, *op. cit.* note 3, 68.

an entity's own good is recognizably and robustly Aristotelian in character.

Aristotle's term *psuche* is usually translated as 'soul.'⁹ This can be misleading, however, since to the modern ear the word 'soul' suggests a spiritual mode of existence; and that clashes unhelpfully with most of what Aristotle says about the *psuche*, which is resolutely naturalistic. (I say 'most of' here in view of Aristotle's notorious cave-in over the intellect, the one component of the *psuche* that he claims is immortal and eternal.¹⁰) In view of the shortcomings of the term 'soul' in this context, it is better, I think, to start with Aristotle's claim that each species of organism may be identified by a set of biological capacities that, under normal circumstances, any individual member of that species will come to express. Correlatively, each organism will have associated with it one of these sets of (what I shall call) life-capacities; and that set constitutes its *psuche*. The master-list of such life-capacities, from which the lists that specify particular *psuches* will be drawn, looks something like this: self-nourishment (including growth and decay), reproduction, appetite, touch, non-tactile forms of perception, self-controlled motion, imagination, and intellectual reasoning. Here the various life-capacities have been arranged in order of, as Aristotle would see it, increasing sophistication. This is not an idle presentational move, since, according to Aristotle, the possession of

⁹ Aristotle, 'De Anima (On the Soul)', *The Complete Works of Aristotle*, J. Barnes (ed.) (Princeton, NJ: Princeton University Press, 1984, Revised Oxford Translation, Volume 1), 641–92. The brief analysis of the *psuche* which I include here draws, in part, on the following paper of mine: M. Wheeler, 'Cognition's Coming Home: the Reunion of Life and Mind', *Fourth European Conference on Artificial Life*, P. Husbands and I. Harvey (eds.) (Cambridge, Mass.: MIT Press, 1997), 10–19. That paper constitutes a very different philosophical project (the goal of which is to show that the discipline of artificial life has the credentials to be the intellectual core of a distinctively biological cognitive science, one which holds that life and mind share a common set of organizational principles). Nevertheless, in that work I pursue issues that surface again here. In particular, my later discussions in this paper of (i) the Aristotelian nature of certain recent self-organization-based accounts of biological form and (ii) the implications of Kauffman's N-K model draw, in part, on that previous investigation.

¹⁰ 'De Anima' op. cit. note 9, Book 3, chapter 5. For discussion, see, for example, K. V. Wilkes' 'Final Embarrassed Postscript' (her words not mine) in her 'Psuche versus the Mind', *Essays on Aristotle's De Anima*, M. C. Nussbaum and A. Oksenberg Rorty (eds.) (Oxford: Clarendon, 1992), 109–127.

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any particular life-capacity presupposes the possession of the less sophisticated life-capacities from this list. So, for example, the possession of touch presupposes the possession of appetite, reproduction, and self-nourishment. On this picture, then, self-nourishment, the most primitive of the life-capacities, is possessed by every living thing. Moreover, it emerges as being necessary and sufficient for life. This, I think, is the right way to understand Aristotle's claim that 'the nutritive soul is found along with all the others and is the most primitive and widely distributed power of soul, being indeed that one in virtue of which all are said to have life'¹¹

Next we need to add in a well-known aspect of Aristotle's account of the *psuche*. Famously, Aristotle draws what he takes to be a widely applicable distinction between *form* and *matter*. To a first approximation, the form of an entity is its distinctive mode of organization. Thus Aristotle tells us that a statue's shape is its form, while its matter is the physical stuff (bronze, stone, or whatever) out of which it is made. The form of an axe is its capacity to chop, while its matter is the wood and metal out of which it is made. Moving into the biological world, the form of the eye is capacity to see, while the matter, according to Aristotle's ancient biology, consists largely of water. When Aristotle applies the form-matter distinction to whole living organisms, we are told that the form of a living creature is its *psuche*, its set of life-capacities; the matter is the organic body which underlies those capacities.¹² Against this back-

¹¹ 'De Anima' op. cit. note 9, Book 2, chapter 4, 415; p. 661 in the cited edition.

¹² Here I am ignoring all sorts of nuances and difficulties. For example, it is clear that while the canonical example of a form (a statue's shape) allows form to be interpretable as structure, other examples (an axe's capacity to chop, an eye's capacity to see) somehow involve an additional notion of function. My use of the phrase 'distinctive mode of organization' is supposed to fudge this distinction (which is why I called my characterization a 'first approximation'). The issue of form and function (and so functionalism) in Aristotle is now an industry in Aristotelian scholarship. (See many of the papers in the aforementioned Nussbaum and Oksenberg Rorty collection on *De Anima*. For an evolutionarily oriented take on the issue, see my 'Cognition's Coming Home: the Reunion of Life and Mind', op. cit. note 9.) In addition, Aristotle himself characterizes the relationship between form and matter in a different way when he turns from a non-biological to a biological context. Roughly, he suggests that the matter of a statue is only contingently informed by its shape, whereas the organic body is essentially informed by the relevant *psuche*. See, famously, J. L. Ackrill,

ground, an Aristotelian organism may be glossed as what Charles calls an 'interactive unity' of matter and form.¹³ One way of playing out this idea is as follows. On the one hand, the material (neurobiological/biochemical) aspects of an organism must be understood in terms of the biological forms (life-capacities) which those aspects generate and maintain. On the other, to do justice to this explanatory demand, one needs an account of organic matter as essentially a dynamic potentiality for generating biological form.¹⁴

The concept of the *psuche* also grounds Aristotle's own version of the idea that every organism may be said to have a good of its own. One can see Aristotle appealing to the idea of organisms having goods of their own when he says, for example, that 'mutilated or imperfect growths' occur when organisms fail to 'produce their species and rise to completeness of nature and decay to an end.'¹⁵ Given that the terms 'mutilation' and 'imperfect' clearly signal failures to flourish, it seems that the notion of a 'completeness of nature' is equivalent to the concept of an organism's own good. Moreover, when an organism 'rises to completeness of nature,' before decaying naturally to an end, it may be understood as having flourished by fully expressing the set of life-capacities associated with its species. Thus the good of an organism consists in the full expression of the appropriate species-specific set of life-capacities.¹⁶

¹³ D. Charles, *Aristotle on Meaning and Essence* (Oxford: Oxford University Press, 2000).

¹⁴ See A. Code and J. Moravcsik, 'Explaining Various Forms of Living', *Essays on Aristotle's De Anima*, M. C. Nussbaum and A. Oksenberg Rorty (eds.) (Oxford: Clarendon, 1992), 138-41.

¹⁵ '*De Anima*' op. cit. note 9, Book 3, chapter 9, 432; p. 688 in the cited edition.

¹⁶ I should confess that Aristotle's account of the *psuche* is not quite as straightforward as I have made out in the main text. For one thing, he gives different master-lists of life-capacities in different places. For another, there are exegetical disputes among scholars about exactly how the various life-capacities ought to be divided-up. Finally, the relationship of presupposition may not always be as straightforward as I have suggested. These admissions need not concern us here, however, because these fine-grained details of the *psuche*, while important in other contexts, do not bear on the argument of this paper. For a systematic analysis of the structure of the

'Aristotle's Definitions of *Psuche*', *Proceedings of the Aristotelian Society* 73 (1972-3), 119-33. For one response to this problem, see C. Shields, 'Aristotle's Psychology', *The Stanford Encyclopedia of Philosophy (Fall 2004 Edition)*, Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2004/entries/aristotle-psychology>

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There are obvious similarities between Taylor's notion of a set of biological functions and Aristotle's notion of a set of life-capacities. Both are to be unpacked as species-specific suites of biological traits, both determine in what the goods of particular organisms consist, and both need to be understood as specifying the formal (or functional) half of the form-matter (function-matter) unity that, on either account, constitutes an organism. But just how deep do the similarities go? My answer to this question will come in two parts. First I shall argue that while it is true that Taylor's ethical thinking endorses a fact-value distinction in a way that Aristotle's (arguably) doesn't, this divergence is not as important as it might initially appear. Crucially, both theories use the concept and the details of an organism's own good as the basis for specifying certain moral norms. This shared strategy is built on the principle that for an organism to have independent moral status, it is necessary that that organism can rightly be said to have a good of its own. Having identified this structural parallel, I shall argue (second part) that in order for ethical norms to be based on biological facts in this way, a certain understanding of biological systems—crucially, an Aristotelian one—must be in play. So it turns out that Taylor's position in environmental ethics implicitly buys into a fundamental feature of Aristotelian biology. And that's where the fun really starts.

Consider, then, the following question: how do we get from biology to ethics? For Aristotle, the distinction between biological (more generally, scientific) fact and ethical value did not loom large in the way that it does for many contemporary philosophers. Indeed, as far as the Aristotelian framework is concerned, it seems that the following position is licensed: once one has correctly identified the set of life-capacities associated with a particular species, one not only knows in what the good of an individual member of that species consists, and thus what would count as harming that individual (namely preventing that individual from coming to express fully its complete set of life-capacities), one also has a duty, in one's moral deliberations, to factor in the causing of such harm as a negative component.¹⁷

¹⁷ This point is nicely made by Des Jardins. See J. R. Des Jardins, *Environmental Ethics* (Belmont, CA: Wadsworth, 2001), 24–5.

psuche, see G. B. Matthews, 'De Anima 2. 2-4 and the Meaning of Life', *Essays on Aristotle's De Anima*, M. C. Nussbaum and A. Oksenberg Rorty (eds.) (Oxford: Clarendon, 1992), 185-93. Reprinted as 'Aristotle on Life,' *The Philosophy of Artificial Life*, M. A. Boden (ed.) (Oxford: Oxford University Press, 1996), 304–13.

For Taylor, by contrast, one cannot simply read off ethical norms from biological nature in this way. He argues as follows:

1. In order for an entity to be granted independent moral status, it must be true to say, of that entity, that it has a good of its own.
2. Each organism has a good of its own.
3. However, to say that an organism has a good of its own is a statement of biological (i.e. scientific) fact.
4. Ethical norms are not logically deducible from such facts.
5. So it is consistent to assert that a particular organism has a good of its own while simultaneously denying that moral agents have a duty (all things being equal) to promote or preserve that good.

In other words, an entity having a good of its own is a necessary but not a sufficient condition for that entity to be granted independent moral status. It is not a sufficient condition because there exists a gap between scientific facts and moral values. Nevertheless, Taylor does hold that each organism enjoys independent moral status. So what carries us across the fact-value divide? Here Taylor identifies four nature-regarding beliefs that, he argues, one ought to hold. Together these beliefs make up (what he calls) the *biocentric outlook* on nature. In banner headline terms, the beliefs in question are (i) that human beings, along with all other organisms, are members of a community of life on Earth, (ii) that organisms form webs of ecological interdependence, (iii) that each organism is a unique individual pursuing its species-specific good in its own way, and (iv) that humans are not inherently superior to other living things. The plausibility of, and the relations between, these four beliefs need not concern us here. Our interest is in Taylor's claim that once one endorses the biocentric outlook, a commitment to the independent moral status of individual living things becomes the *only suitable* moral stance to adopt. So once one adopts the biocentric outlook, one is rationally (although not logically) compelled to grant individual organisms independent moral status. In Taylor's framework, this means that one must regulate one's actions by reference to an affected organism's own good, that is, by reference to the ways in which the action in question promotes or hinders that organism in coming to express the scientifically identifiable set of species-specific biological traits in which its own good consists. In effect, this move forges a *non-demonstrative connection* between biological facts and moral values. Moral values are, as Taylor puts it, 'based on' biological facts.

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The common core of our two theoretical frameworks may now be revealed. For the sake of simplicity, let's stipulate that an action is to be considered in isolation from other actions, and in relation only to a single affected organism. Then, for both our theories, the moral permissibility or otherwise of an action, when performed by some moral agent (see below), will be determined by the (positive, neutral, or negative) effects which that action will have on the likelihood of an affected organism coming or continuing to express the distinctive species-specific set of biological traits in which that organism's own good consists. This shared strategy for specifying ethical norms by reference to biological facts (what I shall from now on call, simply, 'the shared strategy') rests on the similarly shared claim that it is a *necessary* condition for an entity to be morally considerable in its own right that that entity have a good of its own. The Aristotelian theory differs from Taylor's here by making the possession of such a good a sufficient, as well as a necessary, condition for independent moral status. This move renders the route from biology to ethics direct, of course, but, as long as there exists some alternative machinery for making the fact-value transition (in Taylor's theory this is the biocentric outlook), the sufficiency claim is not required for the target strategy to get off the ground. The necessity claim, however, is. In both theories, certain biological facts are always available to play the key norm-specifying role precisely because, for each individual living thing, there always exists a set of scientifically identifiable species-specific biological traits (those in which the good of that organism consists) that can be used as a kind of moral manual.

Given the shared strategy, to what understanding of biological systems are our two theories committed? This is where we run headlong into what Elliott Sober calls Aristotle's *natural state model*.¹⁸ As Sober explains, this model supplies us with a procedure for thinking about diversity and variation in nature. Aristotle

¹⁸ E. Sober, 'Evolution, Population Thinking, and Essentialism', *Philosophy of Science* 47 (1980), 350–83; reprinted in *Conceptual Issues in Evolutionary Biology* E. Sober (ed.) (Cambridge, Mass.: MIT Press, 1994, second edition, from which page numbers are taken), 16–89. See also E. Sober, 'Philosophical Problems for Environmentalism', *The Preservation of Species: the Value of Biological Diversity*, B. Norton (ed.) (Princeton: Princeton University Press, 1986), 173–95; reprinted in *Environmental Ethics*, R. Elliott (ed.) (Oxford: Oxford University Press, 1995), 226–47. In the latter paper, Sober argues that some positions in environmental ethics are problematic because they implicitly endorse the natural state model. More on this in note 25 below.

argued that all natural objects, including organisms, have a natural state towards which they will inevitably gravitate, in the absence of interfering forces. In other words, interfering forces obstruct the natural tendencies of natural objects to reach or to stay in their natural states. Diversity and variation in natural objects are thus conceived as deviations from the natural states of those objects, caused by the operation of interfering forces. For example, in Aristotle's physics, the natural state of all sublunar heavy objects is to be located at the centre of the Earth, although the natural tendency that such entities have to achieve this state is often thwarted by interfering forces. Similarly, and crucially for us, although the natural state of all organisms is to express their full set of life-capacities, interfering forces may frustrate the natural tendency that such entities have to achieve this state.

Interlude: In Aristotle's own thinking, the natural state model of biological systems was, of course, embedded within a strongly teleological picture in which the natural world *in general* was conceived as literally purposeful and as literally goal-driven. This perspective has largely been discredited by the advance of modern science and its philosophical bedfellows. It is worth noting here that the widespread rejection of the strongly teleological view of nature does not herald the demise of the natural state model in science. Indeed, if we put an Aristotelian gloss on Newton's first law of motion, then that law says that a body will remain in its natural state of being either at rest or in uniform motion unless it is acted upon by a force. (Here, any force counts as an interfering force.) So the natural state model remains enshrined in Newtonian physics, and no one who is thinking in a non-metaphorical key believes that it is the goal or purpose of a body to remain either at rest or in uniform motion.¹⁹ The message is that the strongly teleological dimension of Aristotle's own natural state model can, in principle, be discarded, leaving the rest of the model intact. Still, physics is physics and biology is biology. In biology, teleological language remains in force. The *purpose* of the heart is to pump blood, the male peacock's tail evolved to be large and decorated *in order to* attract mates, and so on. The standard trick, of course, is to reconceive one's teleology within a Darwinian framework. Ignoring all sorts of nuances and complications, the story goes like this. Where natural selection has been operative, individual organisms in the present generation will tend to express those phenotypic traits that have bestowed fitness

¹⁹ This Aristotelian gloss on Newton's first law of motion is also to be found in Sober; see Sober, 'Evolution, Population Thinking, and Essentialism', op. cit. note 18, 168–9.

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advantages on their ancestors. Such traits are adaptations; and the purpose, function or goal of an adaptation will be to carry out the fitness-enhancing task that it performed in ancestral populations. By way of this Darwinization, teleological concepts are underwritten historically, and are thereby made to behave themselves in relation to a physics that has discarded teleology altogether. I take it that Aristotle would most likely have approved of this naturalization of teleology. So that's not where the clash with Darwinism arises.²⁰

Back to the main plot: it is easy enough to see how what I am calling the shared strategy may lean on the natural state model of biological systems, so let's spell it out. Buying Aristotelian physics for a moment, there is a clear sense in which, for heavy objects (and that includes organisms treated purely as heavy objects), all interfering forces are on a moral par: since heavy objects (qua heavy objects) are not the kinds of entities that have goods of their own, none of the interfering forces that prevent those objects from reaching their natural states are ethically significant. By contrast, in the case of organisms, all of which have goods of their own, and all of which are morally considerable in their own right, some interfering forces are ethically significant, namely those interfering forces that emanate from the actions of moral agents. When the action of a moral agent frustrates the natural tendency of an organism to reach its natural state (to express the species-specific set of biological traits in which its good consists), that action, considered in isolation from other actions, and only in relation to that organism, ought to be judged morally reprehensible.

²⁰ To keep everything above board, I should confess that there is a tension between Taylor's biocentric individualism and a Darwinized teleology. Taylor often writes of organisms as *teleological centres of life*. This locution signals the belief (a component of the biocentric outlook, see main text) that each organism is a unique individual pursuing its species-specific good in its own way. In unpacking this idea Taylor explicitly resists a move that might seem to be on the cards following the proposed Darwinization of teleology, namely to identify the concept of an organism realizing its own good with the concept of Darwinian fitness (See *Respect for Nature*, op. cit. note 3, 121, footnote 7.) Taylor points out that some individual organisms (e.g. some social insects) sacrifice their lives (and thus their own goods) to enhance the probability that their genes will survive into future generations (thus increasing their inclusive fitness), and he observes that some human beings freely choose to forego having children (thus reducing their fitness) in order, as they see things, to realize a good life.

The connection between the shared strategy and Aristotle's natural state model of biological systems may be even tighter than I have just suggested. Indeed, unless it is true to say that each individual organism has a natural tendency to develop and maintain the very set of biological traits which putatively constitutes that organism's own good, it is hard (I think) to see how the strategy of delineating ethical norms by reference to such sets of traits is supposed to work at all. Put very crudely, the underlying dependency looks like this: if the organism's life isn't going somewhere, then nothing we might do to that organism can count as hindering the flourishing of that life, in which case the suggestion that such allegedly obstructive interference on our part ought to count as morally reprehensible is a non-starter. The shared strategy requires, in addition, that the 'somewhere' in question is the full expression of a distinctive set of species-specific biological traits. But if all this is right, then that strategy, and thus Taylor's biocentric individualism, *requires* that some version of the Aristotelian natural state model of biological systems be correct, a version in which the relevant class of natural states is fleshed out in terms of certain species-specific sets of biological traits.

The conclusion of this section is that a prominent position in contemporary environmental ethics, namely Taylor's biocentric individualism, is, at heart, a neo-Aristotelian venture. In the next section I review some powerful reasons for thinking that if modern evolutionary theory is true, then the requirement that we have just located at the base of this framework—the requirement that the Aristotelian natural state model of biological systems be correct—will not be met. In other words, as far as this paper is concerned, the Aristotelian natural state model of biological systems is the principal target of Darwin's cosh.

3. Against the Natural State Model

According to Ernst Mayr, Darwin's legacy was threefold. He presented a mass of evidence that evolution occurs, he proposed natural selection as the mechanism of evolutionary change, and (crucially given our present interests) he replaced typological thinking by population thinking.²¹ At root, the natural state model

²¹ Ernst Mayr, 'Typological versus Population Thinking', in his *Evolution and the Diversity of Life* (Cambridge, MA: Harvard University Press, 1976), 26–9; reprinted in *Conceptual Issues in Evolutionary Biology*, E. Sober (ed.) (Cambridge MA: MIT Press, 1994, second edition, from which page numbers are taken), 157–60.

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in biology is an example of typological thinking. There are species-*types*, identified as species-specific sets of biological characteristics. Individuals realize these species-types only imperfectly, due to the operation of interfering forces. Darwinian population thinking, by contrast, finds no place for types of this sort. The biological realm is not conceptualized as a place in which individual organisms have a natural tendency to realize some set of common characteristics that constitutes their generic species-type, or in which diversity is the product of interfering forces that deflect individuals from the path towards that state of species-wide uniformity. Rather, as Mayr puts it, '[all] organisms and organic phenomena are composed of unique features and can be described collectively only in statistical terms.'²² In other words, individual variation is the fundamental way of things—the base-line of biological nature.

One way to illuminate the deep differences between these approaches is to see how they would handle some data from developmental biology. So let's call on the geneticist's best friend, the fruit-fly *Drosophila*. There are usually about 1000 light-receptor cells in the *Drosophila* compound eye. Genetic mutations can reduce the number of receptors dramatically, but genetic events are not the only causal factors in the developmental equation. As Lewontin reports,²³ the final number of receptors also depends on the environmental temperature at which the flies develop. For example, if flies with the wild (statistically most common in nature) genotype develop at a temperature of 15° centigrade, they will end up with 1100 receptors; but they will have only 750 receptors if the

²² Op. cit. note 21, 158. Mayr's analysis gives us a template for how to explain biological nature. However, in the paper in question there is, intertwined with this explanatory template, a picture of the different metaphysical commitments that underlie typological and population thinking respectively. Mayr argues that for the typological thinker types are real while individual variation is an illusion, whereas for the population thinker varying individuals are real while 'types' (understood as statistical abstractions, as averages over populations of individuals) are not. Sober, rightly in my view, rejects both halves of this claim. (See Sober, 'Evolution, Population Thinking, and Essentialism', op. cit. note 18.) In the present context Mayr's questionable metaphysical picture need not be a cause for concern. His key insight concerning the explanatory priority of individual variation in population thinking does not depend on the dubious metaphysical window-dressing he supplies, and so may be formulated without it (which is what I have endeavoured to do in the main text). I take it that this is Sober's view also.

²³ R. Lewontin, 'The Organism as the Subject and Object of Evolution', *Scientia* **118** (1983), 63-82.

developmental temperature is as high as 30° centigrade. And things get more complicated once we allow, in addition, variations in the genotype, and consider the ensuing pattern of interactions with the relevant environmental factor. For example, *Drosophila* with a mutation known as *Ultrabar* always end up with less visual receptors than those with wild genotype. The same is true of *Drosophila* with a different mutation, *Infrabar*. However, the two mutant genotypes have opposite relations to temperature, such that the number of receptors possessed by *Ultrabar* flies decreases with developmental temperature, while the number possessed by *Infrabar* flies increases. In fact, if we make two plots of the number of light receptors against developmental temperature, one for *Ultrabar* and one for *Infrabar* (more on this idea in a moment), the two curves will cross over.

How is this developmental space to be conceptualized?²⁴ Let's begin with the natural state model. According to the strict interpretation of this model, there will be a unique number of light receptors that constitutes the natural phenotypic outcome for insects of this species, although interfering forces during morphogenesis may well mean that this number is often not realized. (In a more relaxed frame of mind, we might allow that the relevant natural state may be specified in a mildly disjunctive way, such that, for example, the natural state will be realized if the number of light-receptors takes any one from a limited, small range of values. This does not alter the fundamental character of the explanation, so, for ease of exposition, I shall continue to work with the strict interpretation.) Each of the mutation-driven, temperature-driven, or interactive variations in phenotypic form that we identified in the data above needs to be characterized as a deviation from some natural state—the natural phenotype. The most likely candidate for the natural phenotype is a compound eye with 1000 light-receptor cells (or some appropriately relaxed take on that phenotype). However, this is not the only option. There is no requirement in the natural state model that the privileged phenotype be statistically the most common.

Now let's turn to the approach recommended by population

²⁴ My brief analysis of *Drosophila* morphogenesis that follows is, in essence, the local application of a general theoretical analysis, advanced by Sober, of the different ways in which natural state thinking and population thinking approach development; see his 'Evolution, Population Thinking, and Essentialism', *op. cit.* note 18. In that paper Sober considers, only to reject, a number of different moves designed to reduce the tension between the natural state model and population thinking.

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biology. The population geneticist will appeal to the concept of a *norm of reaction*. We've just seen this idea at work. A norm of reaction is a curve generated by taking a particular genotype, and plotting changes in a phenotypic trait of interest (in our example, the number of receptors) against an environmental variable (in our example, the developmental temperature). In effect, a norm of reaction shows how an organism of a particular genotype would develop in different environments. So one might conceptualize our fruit-fly developmental space in terms of a set of norms of reaction. This way of thinking enshrines individual variation at the root of biological nature. Each norm of reaction identifies a range of possible developmental outcomes for a particular genotype. Moreover, there is a deep sense in which, in terms of our understanding of the fundamental character of biological systems, each of these outcomes, and each of the outcomes for each of the different possible genotypes, is conceptualized as being on an equal footing. Of course, it may be true to say of the fruit-fly not only (a) that there is a wild genotype, but also (b) that in its ordinary developmental ecology, the temperature is regularly within a small range of values. This might explain why the number of light-receptor cells in the *Drosophila* compound eye is usually about 1000. Nevertheless this situation, riddled as it is with statistical and environment-relative contingency, seems to fall short of establishing the dual presence of a uniquely privileged developmental outcome and an associated tendency for the organism in question to realize that outcome—the kind of constrained developmental profile that the natural state model requires.

These apparent problems with the natural state model reverberate into environmental ethics. If the third Darwinian contribution identified by Mayr is on the mark, and the base-line of biological nature really is that actual organisms are, at root, no more than points on a vast landscape of phenotypic diversity, rather than enforced offshoots from a path that leads to a preferred species-specific destination, then it is hard to give any conceptual weight to the idea that in perturbing the developmental trajectory of an organism, we are preventing it from realizing its natural state. Any philosophical strategy for specifying ethical norms that rests on that idea is thereby undermined; and that includes Taylor's biocentric individualism.²⁵ But have we got the base-line right? Our first

²⁵ As mentioned above, in his paper 'Philosophical Problems for Environmentalism' (op. cit. note 18, 233–40), Sober traces certain difficulties facing some environmentalist positions to their implicit adoption of the natural state model. Sober's target is the very general claim, plausibly

flirtation with contemporary developmental biology certainly suggests that we have; but perhaps all is not as it seems.

4. Kick-Starting Aristotelianism

I now want to suggest that we have been moving too fast, and that there is, in truth, growing support in contemporary biological science for something which looks very much like an Aristotelian natural state model of organismic development.²⁶ Self-organization is a phenomenon that is now recognized as being widespread in nature—and that includes human nature. Indeed, it appears that wherever we look (e.g. at chemical reactions, lasers, slime moulds, foraging by ants, flocking behaviour in creatures such as birds,

²⁶ I am not the only person to have claimed recently that modern biological science is inadvertently rediscovering supposedly discarded Aristotelian concepts and principles. For example, Denis Walsh has been arguing that contemporary evolutionary developmental biology explains why organisms have the particular phenotypes they do (and in particular, the organismal capacities that underlie the evolvability of organismal lineages) by appealing to a reciprocal relation between the goal-directed plasticity of organisms and the causal powers of their underlying developmental systems. According to Walsh, this reciprocal arrangement maps onto, and, in the end, plays the same fundamental explanatory role as, the kind of interactive unity between a biological form and its realizing matter that constitutes an Aristotelian organismal nature. See D. Walsh, 'Evolutionary Essentialism', unpublished conference paper given at Teleology, Ancient and Modern, University of Edinburgh, 16–18 August 2004. Although the analysis that follows in this paper exploits different aspects of Aristotelian philosophy of biology and of contemporary developmental biology, it is clearly an overlapping and complementary approach.

at work in a number of environmentalist positions, that what is morally reprehensible about an action that frustrates an organism's endogenous developmental tendency to reach its natural state is that any such action places the organism concerned in an unnatural state. As Sober points out, once development is conceptualized on the population biology model, the idea that any one phenotype is the only natural one is deeply problematic. The worry about neo-Aristotelian environmentalism that I present here clearly reprises Sober's critique in certain respects, although I have endeavoured to add fuel to the fire by showing in detail exactly how that natural state model underlies the detailed neo-Aristotelian structure of one prominent environmental-ethical framework. More importantly, as we shall see, I think the natural state model lives to fight another day, whereas Sober doesn't.

human infant walking, neural processing in the brain, traffic jams... the list is just about endless), there is compelling research to suggest that the concept of self-organization will contribute to our understanding of how things work. Biological systems, and more particularly organismic development, have, as we shall see, provided a particularly fertile breeding ground for self-organization-based thinking.²⁷ So what is self-organization? A system is said to self-organize when its components causally interact with each other so as to produce the autonomous emergence and maintenance of structured global order. The term 'autonomous' is here being used to indicate nothing more fancy than (i) that the global behaviour of the system in question is *not* being organized by some (inner or outer) controlling executive that dictates or orchestrates the activity of the individual components, and (ii) that those individual components do *not* make their contributions by accessing and following some comprehensive plan of the global behaviour, but rather by following purely local principles of causal interaction. Formal definitions aside, the best way to get a grip on self-organization is to consider an example. So let's take one from the arena that is of principal interest to us, namely organismic development.

To the untrained eye, the higher plants realize a bewildering and stunning variety of leaf arrangements. However, there are really only three generic forms present in nature. The most frequent of these is spiral phyllotaxis (phyllo-taxis = leaf-order). Spiral phyllotaxis is a pattern of organization in which successive leaves on the stem appear at a fixed angle of rotation relative to each other. Amazingly, natural instances of spiral phyllotaxis are such that only a very few angles of rotation are ever realized; and the most common angle of rotation to be found is 137.5° . How might one explain these facts? I shall focus on an account due to Brian Goodwin.²⁸

²⁷ For seminal appeals to self-organization in biology, see, for example: B. Goodwin, *How the Leopard Changed its Spots: the Evolution of Complexity* (London: Phoenix, 1994); S. Kauffman, *The Origins of Order: Self-Organization and Selection in Evolution* (New York: Oxford University Press, 1993). For typically lively and incisive discussion, see J. Maynard Smith, *Shaping Life: Genes, Embryos and Evolution* (London: Weidenfeld and Nicolson, 1998).

²⁸ Op. cit. note 27, 105–19. I have used this example a number of times before to introduce the idea of self-organization in biological development, but then it is such a good example. See, for example, M. Wheeler, 'Do Genes Code for Traits?', *Philosophical Dimensions of Logic and Science: Selected Contributed Papers from the 11th International Congress of Logic, Methodology, and Philosophy of Science*, A. Rojszczak, J. Cachro and G. Kurczewski (eds.) (Dordrecht: Kluwer, 2003), 151–4.

According to Goodwin, as leaf-tissue grows, it places pressure on an elastic surface layer of epidermal cells. This pressure causes the epidermal cells to synthesize cellulose microfibrils to resist the force. Where the next leaf will grow is determined by the fact that, as a result of exactly where the stress has been placed, and exactly how the cellulose defences are laid down, the resistance to growth will be stronger in some areas of the epidermal layer than in others. Thus the global phenotypic leaf arrangement results from a sequence of local causal interactions between (i) the growing leaves under the epidermal surface, and (ii) the barricades of defending cellulose microfibrils. To provide support for such a view, Goodwin cites modelling studies which show that the phyllotactic arrangements observed in nature are stable patterns produced by such a system. This done, the challenge is to explain why these arrangements are the *only* stable arrangements generated by that system. Here Goodwin appeals to a second model which demonstrates that if (a) the rate of leaf formation is above a critical value, and (b) the system starts with the most-commonly-found initial pattern of leaf primordia in the growing tip, then the developing plant will tend overwhelmingly to settle on spiral phyllotaxis with an angle of rotation of 137.5° . In other words, given certain parameter-values and initial conditions, the most common phyllotactic arrangement found in nature is the generic form produced by the self-organizing dynamics in the model. Moreover, with different values for certain key parameters in the model (e.g., the growth rates and the number of leaves generated at any one time), the other phyllotactic arrangements observed in nature may be generated from the same basic self-organizing dynamics.

Examples of developmental self-organization could be multiplied—Goodwin himself describes a good number of compelling cases—but you get the idea. The question for us is this: why is this way of understanding organismic development fundamentally Aristotelian in character? The immediate answer (although one that stands in need of refinement) is that developmental self-organization puts back on the theoretical map the supposedly heretical thought that organisms have natural states towards which they will inevitably gravitate, in the absence of interfering forces. The idea here has two facets: (i) developmental gravitation may be conceived in terms of the underlying principles of change that explain the generic dynamics exhibited by particular developmental self-organizing systems; (ii) natural states may be conceived as the stable states of emergent global order produced in such systems.

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For an extra nudge in Aristotle's direction, one might also add in the following thought. As mentioned earlier, Aristotle has an account of organic matter as essentially a dynamic potentiality for generating biological form. And that is precisely what one gets, if one understands organic development in terms of a certain sub-class of self-organizing physical systems.

It may seem that my flagship example of self-organized form doesn't line up too well with Aristotelian life-capacities, since while the latter takes forms to be species-specific, the emergent order in the phyllotaxis case (spiral phyllotaxis, or even spiral phyllotaxis with a certain angle of rotation) is seemingly more general, in that many species may realize the same generic pattern. In fact, we just need to be rather more subtle in our understanding of Aristotle. As Lennox points out, for Aristotle, biological kinds are 'a set of general differentiae, features common to every bird or fish, *qua* bird or fish... Birds, *qua* birds, have beaks, for example. Different sorts [species] of birds may have beaks of differing length, width, hue, hardness, curvature. It is these sorts of differences, throughout all the differentiae of the general kind, which differentiate one form of bird from another.'²⁹ Pursuing our parallel, it seems likely, then, that specific forms—a distinctive sunflower leaf-structure, for example—may be understood as local variations on more fundamental patterns of self-organization, variations determined by the ways in which genes, in particular, act so as to parameterize the self-organizing dynamics realized by the species of organism in question.³⁰

If Aristotelian natural state thinking in biology has indeed been successfully resurrected, then Taylor's biocentric framework for environmental ethics is also back on the map. Still, the observations that I have submitted so far, in favour of the view that self-organization-based developmental biology has Aristotelian credentials are manifestly the beginning, rather than the end, of a story. I can't hope to complete that story here. However, in the next section I shall attempt to take us part of the way, by clarifying the basic proposal, and by shoring it up against some *prima facie* objections.

²⁹ J. Lennox, 'Kinds, Forms of Kinds, and the More and the Less in Aristotle's Biology', in his *Aristotle's Philosophy of Biology* (Cambridge: Cambridge University Press, 2001), 162.

³⁰ Goodwin is one source for this conceptualization of how genes contribute to development. As he puts it: 'During reproduction, each species produces gametes with genes defining parameters that specify what morphogenetic trajectory the zygote will follow' (op. cit. note 27, 102). For further discussion, see M. Wheeler, 'Do Genes Code for Traits?' (op. cit. note 28).

5. Twists, Turns, and where the Road Runs Out

I have argued that the kind of developmental gravitation that must exist for Aristotelian biology to have any real purchase may be cashed out in terms of the underlying principles of change that specify the generic dynamics exhibited by particular developmental self-organizing systems. I have also suggested that Aristotelian natural states may be identified with the stable states of emergent global order produced by such self-organizing systems. But these claims need attention. As was clear from Goodwin's explanation of phyllotaxis, exactly which stable states of emergent global order are produced during development will typically depend on the values taken by the parameters of the system and by the initial conditions that obtain. This qualification might seem to be the population-biological fly in the natural state ointment. As we know, the natural state thinker needs it to be the case both that there is a privileged phenotype (the organismic natural state) and that each organism of the appropriate kind has a natural tendency to realize that phenotype. In response the population geneticist argues, with the apparent backing of mainstream contemporary evolutionary theory, that biological nature offers only norms of reaction (genotype-phenotype mappings in particular environments) and thus that the interlocking conditions required to support natural state thinking are simply not satisfied in the actual world. Now, given the way in which the population geneticist appeals here to the environmental embedding of development, one way of hearing the natural state thinker's predicament is that she wishes to specify what counts as the natural state of an organism (the privileged phenotype) independently of *any* developmental environment. Seemingly in this vein, Sober observes that the 'natural state model presupposes that there is some phenotype which is the natural one *that is independent of a choice of environment*.'³¹ If this interpretation were correct, the attempt to understand self-organization-based thinking as a rediscovery of the natural state model would be doomed to failure. For the developmental environment will typically be the source of some of the parameter values and initial conditions that will partially control exactly which states of emergent order will be generated by any particular set of self-organizing dynamics. Under these circumstances, it might seem that 'all' that the self-organization-based thinker is doing is

³¹ 'Evolution, Population Thinking, and Essentialism' op. cit. note 18, 179 (original emphasis).

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detailing the processes underlying particular norms of reaction; that is, she is 'merely' identifying the mechanisms by which the transitions from a specific genotype to specific phenotypes are realized in specific environments. She is not rediscovering Aristotelianism. And a good thing too, one might think. For if the Aristotelian theorist really is committed to the claim that the natural state of an organism is a privileged phenotype in that it may be specified independently of any developmental environment (with only deviations from that natural state being traceable to environmental influence), then she is guilty of radically misconceiving the relationship between organism and environment. As population genetics makes clear, every phenotype is a product of interactions between genetic and environmental factors; so no sense at all can be given to the idea of an environment-independent phenotype.

If natural state thinking is to be revived, it needs to free itself from the troublesome thesis of phenotypic environmental independence. In this context it is interesting that, in the very next sentence after Sober states this thesis, he glosses it as follows: the 'natural state model presupposes that there is some environment which is the natural environment for the genotype to be in, which determines, in conjunction with the norm of reaction, what the natural phenotype for the genotype is.'³² This is not equivalent to the environmental independence thesis. Indeed, Sober's putative gloss changes the picture in a highly significant way. On this new understanding, the natural state model incorporates environmental dependence, but makes the identification of a privileged environment (the natural one) part of the process by which the natural phenotype is picked out. In other words, all phenotypes are equal (with respect to environmental dependence), but one is more equal than others.

So how is this first-among-equals position to be secured? One option that suggests itself is to observe that some developmental environments will be statistically more common than others, and to claim that by virtue of their sheer numerical pervasiveness, the more common environments ought to count as the natural ones. But we have already rejected mere statistical prevalence as failing to secure the kind of constrained developmental profile that the natural state model requires. Another, seemingly more promising approach, is to hoist the fan of population genetics by her own

³² 'Evolution, Population Thinking, and Essentialism' op. cit. note 18, 179.

petard, and to appeal directly to Darwinian theory. The idea here is to exploit the concept (often used in adaptationist evolutionary psychology) of the *environment of evolutionary adaptedness* (or EEA) of a phenotypic trait.³³ Roughly, the EEA of a phenotypic trait is the historical environment to which that trait is adapted, the environment within which its fitness enhancing effects resulted in it being selected for within the population. Statistically speaking, the EEA need not be the most common historical environment. Moreover, as long as the organism in question remains viable, adapted traits may hang around long after their historically present fitness-enhancing effects have been neutralized by environmental change. (The persistence of the human sweet tooth in an environment rich with refined sugar is a nice example.)

The present suggestion results in a more complicated strategy than Sober's passing reference to a privileged developmental environment suggests, although the core idea remains the same. The natural phenotypic form is now relativized not to a single environment, but rather to a set of historical environments, each of which is the EEA of one or more of the relevant phenotypic traits. Other extant environments may result in different phenotypic forms being generated (if, for example, different environmental factors result in different parameters for the developmental self-organizing system). Nevertheless, we certainly seem to have a handle on the idea of a privileged (natural) environment, and thus, despite the environmental dependence of development, on the idea of a privileged (natural) phenotype.

In spite of any off-the-shelf, tried-and tested attractiveness that this proposal might seem to have, I'm afraid that it is far from unproblematic as a way of salvaging Aristotelian natural state thinking. One worry that, in the end, has only limited bite turns on the fact that Aristotle characterized biological modes of organization as *internal* to the entities concerned. In other words, the modes of organization in which we are interested, for the purposes of biological explanation, are not externally imposed upon biological systems, but rather are essential aspects of the intrinsic natures of those systems.³⁴ This feature of Aristotle's account is

³³ See C. Crawford, 'Environments and Adaptations: Then and Now', *Handbook of Evolutionary Psychology: Ideas, Issues, and Applications*, C. Crawford and D. L. Krebs (eds.) (Mahwah, NJ: Lawrence Erlbaum, 1998), 275-302.

³⁴ See, for example, M. Frede, 'On Aristotle's Conception of the Soul', *Essays on Aristotle's De Anima*, M. C. Nussbaum and A. Oksenberg Rorty (eds.) (Oxford: Clarendon, 1992), 93-107.

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difficult to square with the tabled appeal to Darwinian selection—difficult, but not impossible. The problem, on the face of it, is that, given a certain neo-Darwinian outlook that characterizes evolution as a process of random genetic mutation plus environmentally driven gene-sifting, the appeal to selection seems to shift the source of biological form away from the organism and towards the environment (of evolutionary adaptedness), the external location of the relevant selection pressures. This looks to be incompatible with Aristotelian ‘internalism’.

Fortunately the tension here can be relieved. First we need to remind ourselves of the rich, organism-centred processes of developmental self-organization that we are now taking to mediate the genotype-to-phenotype mapping. Second we need to adopt a certain interpretation of what Aristotle meant by ‘internal’. Given that we are rejecting the problematic thesis of phenotypic environmental independence, it seems we are free to read ‘internal’ as ‘autonomous’, in the sense introduced earlier, that is as indicating (i) that the global behaviour of the system in question is not being organized by some (inner *or* outer) controlling executive that dictates or orchestrates the activity of the individual components, and (ii) that those individual components do not make their contributions by accessing and following some comprehensive plan of the global behaviour, but rather by following purely local principles of causal interaction. Finally we need to characterize the influence of the environment on the organismic dynamics here in the right way. Fans of developmental self-organization often speak of factors that affect the behaviour of some system without themselves being affected not merely as setting parameters of the system, but as setting control parameters. In this term of art, the word ‘control’ is being used not to signal a process in which the states of the other elements of the system are specified directly by the value of the control parameter, or in which the control parameter ‘instructs’ those other elements as to how they should change. The idea, rather, is that variations in the values of a control parameter may have the effect of transforming the way in which the target system is changing over time.³⁵ This notion of a substantial influence on the underlying dynamics of the target system is fully compatible with the claim that the processes that are fundamentally responsible for the generation of biological form are

³⁵ See, for example, E. Thelen and L. B. Smith, *A Dynamic Systems Approach to the Development of Cognition and Action* (Cambridge, Mass.: MIT Press, 1993), 62.

organism-internal, *if*, that is, 'internal' is read as 'autonomous' in the way that I have suggested. Thus we can have the cake of appealing to the concept of an environment of evolutionary adaptedness, while happily consuming a notion of biological form in which such forms are robustly traceable to organism-centred processes.

Here is a more serious worry about the compatibility of our emerging neo-Aristotelian framework with the suggested appeal to selection. The fact is that, under certain circumstances, selection and self-organization may pull phenotypes in different directions. The seminal exploration of this possibility is due to Stuart Kauffman.³⁶ An example from Burian and Richardson's discussion of Kauffman's work will help to focus the issue.³⁷ Assume that the generic order of a particular self-organizing system under evolutionary influence is to be blue, but that selection favours red. After many generations of evolution, will blue persist in the population, even though it is being selected against, and to what extent will it be visible? Kauffman's work suggests that, given certain conditions, the answer is that blue (the generic order) will be common, even in the face of strong selection in favour of red.

Let's be more specific. At the heart of Kauffman's work is a formal tool for biological investigation known as the NK model. If we adopt an interpretation of the NK model such that the parameter N is the number of genes in each genotype, and the parameter K is the degree of epistasis, then, as K increases, the fitness landscape becomes increasingly random, such that the fitness values of genotypic neighbours are uncorrelated. Since evolution by mutation and selection will be unlikely to find global optima in this random space, sub-optimal generic forms will persist. If K is low, then the fitness landscape will be smooth and gradual, but may have very shallow inclines (if N is high), in which case only small fitness differences will be available for selection to exploit, or very steep inclines (if N is low), in which case small mutations will tend to have relatively large disruptive effects. In either case, one cannot expect to find populations converged at the fitness peaks,

³⁶ S. Kauffman, *The Origins or Order: Self-Organization and Selection in Evolution*, op. cit. note 27.

³⁷ R. M. Burian and R. C. Richardson, 'Form and Order in Evolutionary Biology', *PSA 1990: Proceedings of the 1990 Biennial Meeting of the Philosophy of Science Association ii*, A. Fine, M. Forbes, and L. Wessels (eds.) (East Lansing, Mich., 1991), 267--87. Reprinted in *The Philosophy of Artificial Life*, M. A. Boden (ed.) (Oxford: Oxford University Press, 1996), 146--72.

and sub-optimal generic forms will survive. The upshot is that, for a wide range of parameter values, the results of self-organization rather than those of selection will be dominant.

Now notice that our strong inclination, in describing this result, is to say that because of the power of endogenously driven self-organization, a natural biological form has persisted in the face of a strong selection pressure against it. On the plus side (for the neo-Aristotelian), this means that the idea of the wellsprings of biological form being autonomous and organism-centred ('internal' in Aristotle's terms) rewards a more straightforward interpretation that it has hitherto enjoyed. But there is a significant cost. First note that in Kauffman's mathematical model the only environmental factor is the selection pressure against the pre-specified generic order. In real organismic development, however, there will, as we have seen, be a range of additional environmentally determined parameters that will have an influence on exactly which phenotypic outcome results. To preserve a vanilla version of Kauffman's scenario these influences will need to be selectively neutral. Nevertheless, for the reasons that we have explored previously, the natural state model needs to take them into account. And our preferred strategy for identifying the natural phenotype in the midst of such environment-relative variation has been to single out that phenotype by way of the privileged developmental environment that is the EEA. In the Kauffman scenario, however, there is no EEA, since adaptation has not taken place. So that strategy doesn't even get a foothold. In short, *if* the results of the NK model are robust, and *if* analogues of Kauffman's theoretical evolutionary scenario are widespread in nature, then we cannot adopt a general strategy of identifying the natural phenotype by way of an EEA.

Of course there are some big empirical ifs here. For example, Harvey and Bossomaier have focused on a key assumption of Kauffman's NK model, namely that update is synchronous. They show that if this assumption is relaxed, then very different systemic behaviour ensues, behaviour that would cast doubt on the idea that Kauffman's conclusions about selection and self-organization could be generalized to asynchronous systems.³⁸ This result is potentially telling since, as Harvey and Bossomaier themselves observe, one might expect many biological systems to be asynchronous in character. Perhaps then there is, after all, light at the end of the

³⁸ I. Harvey and T. Bossomaier, 'Time Out of Joint: Attractors in Asynchronous Random Boolean Networks', *Proceedings of the Fourth European Conference on Artificial Life*, P. Husbands and I. Harvey (eds.) (Cambridge, Mass: MIT Press, 1997), 67–75.

tunnel for the strategy of identifying natural phenotypes by way of EEAs, and thus for a reconstructed 21st century version of the Aristotelian natural state model in biology.

6. Conclusion: the Prospects for an Aristotelian Environmental Ethics

It's been a while since environmental ethics occupied the foreground in this paper, so it is time to draw together the threads of what we have learned into something approaching a take-home message for that particular area of philosophical inquiry, delivered courtesy of philosophy of biology. It seems that environmental ethics, by its very nature, is going to be more attracted to a biological grounding for ethics than some of its philosophical near-neighbours. Of course, basing one's ethics on biological science—any kind of biological science—is always going to be a hazardous business fraught with dangers relating to exactly how that science and the conceptual theorizing that surrounds it will turn out; but that's life, at least for the naturalistically inclined. If I'm right, the biocentric environmental-ethical framework developed by Taylor is positioned precariously at a crossroads in biological theory. For, as we have seen, that framework depends on the Aristotelian natural state model of biological systems, a model that stands in a complex relationship with (a) Darwinian population biology and (b) the interface between self-organization-driven accounts of organismic development and mainstream evolutionary thinking about the power and ubiquity of Darwinian selection. The prospects for biocentric individualism of Taylor's stripe (and for any other environmental-ethical accounts that share its character) are contingent upon the outcomes of those debates. Faced with such uncertainty, the wildest of environmental ethicists may ultimately decide (or may have decided already) to resist the charms of an evolutionary grounding in favour of some other philosophical underpinning. Given the acute and pressing nature of the world's environmental problems, that's what I would do.³⁹

³⁹ For important discussions many thanks to Denis Walsh, Matthew Elton, Timothy Chappell, and audiences at the University of Dundee and the Royal Institute of Philosophy in London.