

Can Imitating Nature Save the Planet?

Over the last couple of decades, the idea has been gaining ground that imitating nature – biomimicry – is the key to saving the planet. The basic argument runs as follows. Other lifeforms have inhabited the earth for billions of years and over that time have learnt how to do many of the things that we need to do if we are to avoid global ecological catastrophe: generating renewable energy from the sun, recycling wastes in endless cycles, life-friendly chemistry, allowing biodiversity to flourish, and so on. By imitating or drawing inspiration from these natural beings and systems, we may be able to achieve much the same feats. Given the intuitive plausibility of this ‘biomimicry argument’, there can be little doubt that it calls for serious attention, including its theoretical and philosophical aspects and implications.

Until very recently, however, non-technical discussions of biomimicry have been limited primarily to popular science books (e.g., Benyus 1997; Forbes 2005; Harman 2013) and review articles (e.g., Ball 2001; Vincent et al. 2006; Bhushan 2009; Vincent 2009). Further, when non-technical debates have occurred, they have often taken the form of polemics about terminology and classification. What are the differences between biomimicry, biomimetics, bionics, and bio-inspiration (Iougina et al. 2014; Speck et al. 2017)? Can they all be grouped together under a single term, such as ‘biom*’ (Hoeller et al. 2013) or ‘biologically informed design’ (Iougina et al. 2014)? Does biomimicry include the imitation of ecological phenomena or do we need to talk here of ‘ecomimicry’ (Marshall and Loveza 2009)? Unavoidable as these debates are, they leave unanswered the more philosophically and existentially significant questions raised by biomimicry. Fortunately, this situation has begun to change in the last few years, as philosophers have begun to show a sustained interest in the topic (e.g., Mathews 2011; Bensaude-Vincent 2011; Dicks 2016; Blok and Gremmen 2016), bringing biomimicry into dialogue not just with the philosophy of science and technology, but also with questions of ontology, epistemology and ethics. But there has not, as yet, been any concerted attempt either to set out the key research questions of the philosophy of biomimicry or to provide a unified space for its discussion. These, then, are the two prime objectives of this special issue. Drawing on the key publications of the last five to ten years, this editorial will set out what we believe are the basic research topics and questions of the philosophy of biomimicry, and these will then be explored and developed in a series of articles by some of the leading voices in the field.

A first key philosophical topic is the very idea of technology as imitation of nature. One thing that has been largely missing from the science and engineering literature is recognition that this idea stretches back to the very origins of Western philosophy – to such thinkers as Democritus, Plato and Aristotle. So, while scientists and engineers have noted important inventions of the past

based on natural models, usually accompanied by generic comments to the effect that humans have always looked to nature as a source of inspiration (e.g., Vogel 1998; Ball 2001), rarely have they analysed the history of the *idea* of nature imitation, as discussed by the great thinkers and philosophers of the past. An important contribution to this topic was made in 1957 by the German philosopher, Hans Blumenberg (2000), who set out how the ancient idea of man as imitator of nature was replaced, from the modern period onwards, by the idea of man as creator. This raises a first important question. If, over a half century later, we are on the verge of a ‘biomimicry revolution’ (Benyus 1997), is this revolution ultimately just a return back to the historical norm or is contemporary biomimicry something quite different from the nature imitation of the past?

Also important to a philosophical understanding of the idea of technology as imitation of nature is the question of how the process of imitation (*mimesis*) is to be theorised and conceptualised. A first set of questions concerns the abstraction of natural models. What types of models may we abstract from nature (e.g., forms, materials, process, systems, strategies, functions...) and is it sufficient simply to imitate one or other of these for something to count as biomimetic or must a deeper logic be involved? Should we, for example, be aiming to imitate not just the products of nature (*natura naturata*) but also, and perhaps more importantly, the generative processes by which nature brings things into being (*natura naturans*) (Blok 2016)? A second set of questions concerns the imitation or *mimesis* of natural models. Does *mimesis* involve a kind of submission to nature and thus also a renunciation of the characteristically humanist values of autonomy and creativity (Kaplinsky 2006)? Or is it possible to conceptualise *mimesis* in such a way that it may be understood as allowing for, and perhaps even enhancing, our creative freedom (Blok and Gremmen 2016; Dicks 2016; 2017a)?

A second major philosophical issue is the question of how biomimicry understands nature, or perhaps rather how it ought to understand it. A quick perusal of the science and engineering literature reveals regular references to nature as a collection of ‘design solutions’ (Benyus 1997; Vincent et al. 2006; Harman 2013). So, just as Kant (2007) placed the concept of *Technik der Natur* (natural technology) at the centre of his philosophy of biology, arguing that it was only by analogy with technology that we could meaningfully understand the workings of living beings, so the question arises as to whether biomimicry views nature in technological terms, in which case it may be necessary to talk of what Bensaude-Vincent (2011) calls ‘reciprocal mimesis’; technology provides the model for how we understand nature and nature the model for the development of new technologies. But this would not imply that biomimicry necessarily reduces nature to a collection of imitable technologies. A fundamental question for the philosophy of biomimicry, then, is whether it is possible to put forward a concept of nature that is compatible with and perhaps

even conducive to biomimicry, but which also accords to nature some sort of independent or autonomous being and existence (Mathews 2011; Dicks 2016; Blok and Gremmen 2016).

Ontological questions are closely linked to epistemological ones. Traditional epistemology has assumed a relation to nature as an *object* of knowledge, something about which we learn. But in biomimicry we relate to nature first and foremost as a *source* of knowledge, something from which we learn (Dicks 2016; 2017b) – a shift that Blok and Gremmen (2016: 204) think involves a transition away from the ‘domination and exploitation’ of nature and towards an approach characterised rather by ‘learning and exploration’. Further, as the following remarks of Benyus suggest, this new epistemological relation to nature may potentially allow us to overcome our ontological separation from nature:

[in biomimicry] we come not to learn *about* nature so that we might circumvent or control her, but to learn *from* nature, so that we might fit in, at last and for good, on the Earth from which we sprang. (Benyus 1997: 9)

Could it be, then, that biomimicry holds the key to a radical shift away from the traditional Cartesian belief that knowledge possessed by human subjects of natural objects makes possible their mastery and possession to the view that it is in the first instance nature, not humans, that possesses knowledge, and that by learning from that knowledge we may also learn how to overcome modern dualism and instead see ourselves as but a ‘species among species’ (Benyus 1997: 8)? Or does the need to theorise nature as something separate from us, to which we can only approximate by imitation, imply the need for a new, non-Cartesian form of dualism (Blok 2016; Dicks 2018)?

The third key topic for philosophical investigation is biomimicry’s relationship to questions of sustainability and ethics. It has been widely recognised in the more technical literature that simply to imitate nature is insufficient to achieve sustainability (Reap et al. 2005; Kennedy et al. 2015). But beyond the relatively technical question of the conditions under which imitating nature would give rise to sustainability, there lies another more philosophically challenging question: could it be that imitating nature will make human civilisation sustainable but at the expense of the rest of life on earth (Mathews 2011)? This question suggests that a non-anthropocentric ethics may be required to set constraints on the technological imitation of nature (Mathews 2011; Blok 2017). Two approaches are possible here. The first, which has been implicit in environmental ethics since its inception (e.g., Rolston 1975; 1979), consists in the view that a non-anthropocentric ethics must be worked out independently, primarily by means of ratiocination, and then applied as the ethical standard by which biomimetic technologies are judged. We cannot, from this perspective, get from how nature is to what we ought to do. The second option, which has often been favoured by philosophers of biomimicry, may be traced back

to the principle of ‘nature as measure’ (Benyus 1997; Jackson 2011), which holds that nature provides standards – even ethical ones – against which the rightness of our actions may be judged. From this perspective, which Blok and Gremmen (2016) call the ‘strong concept’ of biomimicry, we may learn from nature not just how to do things, but also what we ought to do (Dicks 2017c). Controversial as this second option may seem, the biomimetic approach of being open to what nature has to teach us suggests that it is at the very least worthy of exploration.

With a view to investigating these three topics in a single discursive space, we invited a small selection of established researchers in the philosophy of biomimicry to contribute to this special issue. The first article, by Hub Zwart, offers an excellent introduction to many of the key issues in the philosophy of biomimicry. Zwart begins by discussing a paradox: how can biomimicry be both very old and very new? His answer involves dialectics. Ancient biomimicry centred on the imitation of outward form. As modern biological science developed, however, it turned away from the study of form (morphology) towards understanding the basic logic or formula (*logos*) of living systems, including their genetic code and biomolecular workings. Then, as this understanding increased, it gave rise to the idea of imitating this logic, and thus also recreating living systems artificially, as is the case in the BaSyC project of creating a synthetic cell, which Zwart sees as paradigmatic for contemporary biomimicry. He also argues, however, that the artificial imitation of living systems, whether biological or ecological, would also make these systems much more like human technologies, for they would be designed in a streamlined way in order to accomplish tasks set by humans. Drawing on Bensaude-Vincent, Zwart thus argues that biomimicry cannot be separated from ‘technomimicry’: modelling nature on technology. This in turn raises ethical questions about our motivations for imitating nature, which Zwart addresses through a discussion of the central character of Ian McEwan’s *Solar*, Michael Beard, who, despite his apparent goal of saving the planet through the invention of artificial photosynthesis, is woefully unethical. Imitating nature, Zwart concludes, must be complemented by an appropriate ethics.

Bernadette Bensaude-Vincent’s contribution credits Benyus with the idea that imitating nature is the key to achieving sustainability (i.e., the biomimicry argument). But she also detects in Benyus’s writings an ‘implicit metaphysical programme’, which, she thinks, has been made explicit by philosophers of biomimicry and is decidedly ecocentric. She then goes on to examine three fields of research in which nature imitation plays an important role, arguing in each instance that, despite some similarities, these fields are generally far removed from the ecocentrism characteristic of the philosophy of biomimicry. Starting with synthetic biology, she notes that despite the apparently biomimetic aim of synthesising living systems artificially, much synthetic biology is ultimately more technomimetic than biomimetic: the goal is to make living systems like

technology, not the reverse. The BioBricks programme, for example, is dominated by a 'Lego metaphor', according to which the brick by brick assembly of living systems will afford us greater control of them. Bensaude-Vincent then turns her attention to materials chemistry, arguing that the simplistic idea that nature has already found the solutions to our problems is untenable, for our problems are markedly different, which explains why materials chemists cannot simply transfer natural solutions over to technology, but must instead engage in complex processes of translation. Further, she also notes that there is little focus in materials chemistry on integrating nature-inspired solutions within their broader ecological context. Lastly, Bensaude-Vincent turns her attention to soft robotics, arguing that it conforms to one important objective of the 'strong metaphysical programme' of biomimicry: relinquishing dominance and control over nature. But soft robotics does this, she claims, not to further the ecocentric goal of fitting in on earth, but in order to develop lifelike technologies that exhibit 'unpredictable emergent properties' and which could potentially be harnessed to many different purposes. At least when it comes to innovation based specifically on biology, there would thus appear to be relatively little concern for the ecocentric idea of fitting in on earth.

Freya Mathews considers that biomimicry has the potential to underlie a global ecological civilisation. But she also thinks it contains a 'fatal ambiguity'. Biomimicry could lead either to a radical decoupling from nature, as advocated by eco-modernists, or to a 'bio-synergistic' scenario, in which humans collaborate actively with other life forms. For the latter scenario to come about, however, would require a 'bio-inclusive' ethos which extends the ethical domain so as to include non-human living beings. But whence, she asks, would such a bio-inclusive ethos come? Adopting a modified form of historical materialism, Mathews argues that it could not emerge simply by ratiocination, as practised by traditional environmental ethicists, but would need to emerge through practice. To this end, she argues that we must place at the centre of our practices not the traditional Marxist concept of production, which first emerged with the development of agriculture, but rather the concept of provisioning. The question, then, is not how we produce things, but rather how we may be able to coax natural systems into providing us with things. Mathews then goes on to propose a number of ingenious examples that well illustrate this bio-inclusive approach to biomimicry, including kelp farming in the open oceans, extensive (as opposed to intensive) fish farming, and rewilding.

The final paper, by Henry Dicks, takes as its starting point the idea that we may derive ethical standards from nature. Noting that the standards set out by Benyus in her explication of the principle of 'nature as measure' concern not just the traditional technological norm of effectiveness or efficiency, but also the norms of appropriateness and sustainability, Dicks argues that it is these norms that give the principle of nature as measure a distinctly ethical dimension. He then goes on to explore the philosophical basis of these norms,

arguing that the standard from which they derive is the ‘way of being’ of Gaia, which consists in providing a home for the earth’s present inhabitants. To take nature as measure would thus be to measure our own way of being against the standard set by Gaia. Dicks then goes on to argue that this geocentric ethics of ‘being like Gaia’ allows us to resolve (or dissolve) three important problems in environmental ethics: the well-known deficiencies associated with both biocentrism and ecocentrism; how to reconcile within a single ethical framework the traditional environmental goals of preservation and restoration with the continued existence of artificial systems supporting humans; and the insurmountable theoretical and practical difficulties involved in assuming that we have ethical obligations to future generations. Perhaps it is only by being like the planet that we will save it.

HENRY DICKS

Université Jean Moulin Lyon 3

VINCENT BLOK

Wageningen University

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