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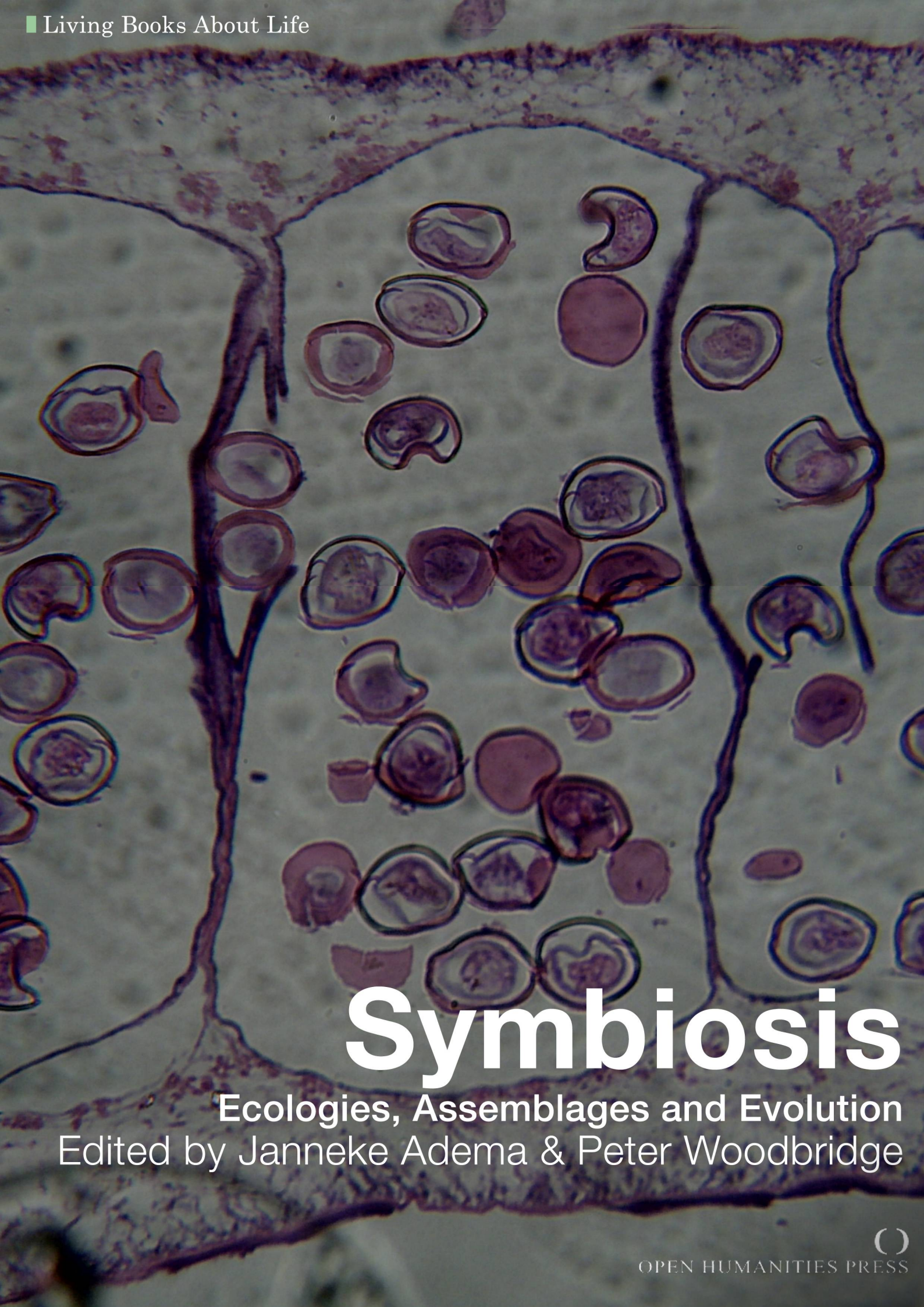

Symbiosis

Ecologies, Assemblages and Evolution

Edited by Janneke Adema & Peter Woodbridge

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Symbiosis: Ecologies, Assemblages and Evolution

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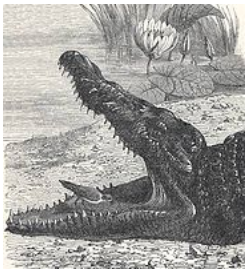
Introduction: symbiosis as a living evolving critique





Different species, interacting in a symbiotic fashion, living together over a prolonged period of time, eventually co-evolving into new species: this vision of the biological phenomenon of symbiosis has created a strong impression—both of symbiosis as a metaphor and a material reality—of species in an intimate relationship together, cooperating in spite of differences, of becoming something else and transgressing boundaries. This idea has turned the concept of symbiosis, in its many guises and definitions,[1] into a breading ground for a posthuman, biologically and ecologically informed critique. Less focused on the biological process of symbiosis as such, our focus in *Symbiosis: Ecologies, Assemblages and Evolution* is more on how symbiosis can be used as a means to argue for an alternative worldview and even a

better world. Interestingly, Angela Elizabeth Douglas notices a similar effect in her book *The Symbiotic Habit* (2010), where she talks about the growing importance of 'applied symbiosis research'. Douglas refers above all to how research into symbiotic processes has the potential to help solve some of the practical problems mankind is facing through anthropogenically induced effects, such as climate change and environmental disasters; and in this way influence and improve (our) ecosystem(s) and make the world in which we live much healthier (Douglas, 2010: viii).

This living book consists of a number of examples of how symbiosis has been deployed. For instance, as a critique of the mainstream Darwinian idea of evolution as struggle; of the anthropocentric worldview that operates within the sciences and society at large; and of the idea of organisms or objects as static and isolated entities. Given the way in which symbiotic processes offer seeds for alternative worldviews, research on symbiosis has been taken-up as providing evidence for becoming as an infinite creative process, for the (animal, microbal, machinic, and/or virtual) other as an integral part of the multiple I, and for the integrated cooperation of living and non-living affects as one interconnected mesh.

Otherness, process, multiplicity and cooperation

For the biologist Lynn Margulis, (endo)symbiosis has been the major theme around which she has developed her—for some quite controversial—evolutionary biological research. In her book *Symbiotic Planet: A*

New Look at Evolution (1999), Margulis states that in science there are still many (hidden) assumptions to the effect that man is the center of things and resides in the middle of the chain of evolution, 'below god and above rock' (Margulis, 1999: 8-9). However, as Margulis has argued in her revolutionary work on the importance of endosymbiosis for evolution, all life forms can be seen to have evolved from microbes, from (the interactions between) bacteria. In some cases symbiosis even evolves into symbiogenesis, when certain forms of long-term living together lead to the appearance of new species or new organs. Here, organisms merge with other organisms, acquiring their gene sets in the process (Margulis, 1999: 8-9). Margulis' main claim, for which she draws on earlier work by the biologist Ivan Wallin amongst others, is thus that in most cases evolutionary novelty arises as a consequence of symbiosis, which goes directly against (or, in a less radical view, compliments) a Darwinian 'nucleocentric view of evolution as a bloody struggle of animals (Margulis, 1999: 19-20). Margulis' claims concerning symbiosis, and her use of the concept of symbiosis, have been seen as somewhat controversial and extreme within mainstream evolutionary biology, not only because of her insistence on symbiosis and evolutionary cooperation as an alternative theory to that of Darwinian struggle, but also due to her insistence that it was not just plants an animals that evolved from the interaction of microbes [2], but all life-forms. And as she herself puts it, 'the idea that new species arise from symbiotic mergers among members of old ones is still not even discussed in polite scientific society' (Margulis, 1999: 7).

What makes Margulis even more suspect in some

biological circles is the way her theory of symbiosis and symbiotic evolution has been adopted by New Age-inspired environmental and deep ecology movements; and how most importantly her use of symbiosis in biological discourse has been connected with James Lovelock's Gaia hypothesis. The latter proposes a holistic view of the earth (Gaia) as a self-regulating whole of organic and inorganic matter, operating as a close unity by means of a feedback system. This idea is visible in many present-day ecosophies. However, the mixing of a near spiritual and religious rhetoric with scientific facts was not deemed intellectually serious by many biological researchers, and was regarded as being too harmonious and too regulated (instead of an unconscious mechanism), according to the 'struggle as survival' evolutionary strand of neo-darwinians.[3]

Symbiotic becomings

Developments in modern biology, including the new emphasis on the importance of symbiosis for evolution, played an important role in what has come to be characterized as poststructuralist and posthuman thinking. In particular, biologically oriented 'earthly processes' (as opposed to transcendental ideas) and new evolutionary theories were an influential reference point for the construction of the geophilosophy of Deleuze and Guatarri, in which the latter argue for a 'virtually limitless connectivity between heterogeneous beings' (Chisholm, 2007). However, Dianne Chisholm, in her reading of Deleuze and Guattari's geophilosophy, strongly contrasts their theories with ideas connected to the Gaia hypothesis or holism. From Deleuze and Guattari's perspective, disparate processes of symbiosis

and evolution don’t resolve into a synthetic unity; rather, as Chisholm states, their philosophy ‘deterritorialize(s) Gaia's unified field’ (Chisholm, 2007).

Deleuze and Guattari use symbiotic processes in another way to ground their philosophy. Aspects of their symbiotic critique can be seen to be directed against ideas of classification by filiation, stable identity (instead of identity as becoming) and the single unified entity (as opposed to the self as a pack of multiplicities and assemblages). Using the concept of symbiosis, Deleuze and Guattari first of all critique modern science and the way it is only able to think in terms of filiations, of mimesis.[4] This critique of classification is also visible in Margulis’ work where she uses symbiosis to problematize the mainstream way of classifying species. She argues against oversimplified and dangerous categorizations into ‘plants, animals and germs’, arguing that in many cases differences between plants and animals are not that easy to make and, as she puts it, a ‘more scientific’ division can also be made between prokaryotic cells and eukaryotic cells, crushing the age-old divide between plants and animals (who are far more alike then they are presented as being in mainstream classifications) (Margulis, 1999: 56). Different, distinct kingdoms are thus, in the terminology of both Deleuze and Guattari and Margulis, hard to establish and maintain.

Deleuze and Guattari adopt a similar approach of using the concept of symbiosis to help critique classification and genealogical evolution when they discuss their idea of neoevolutionism. In a neoevolutionist approach

classifications are not made according to filiation, or by imitating or identifying with something/someone, but by ‘transversal communications between heterogeneous populations’ (Deleuze and Guattari, 1988: 239). Chisholm summarises Deleuze and Guattari’s neoevolutionism as follows: ‘Instead of specific genealogical lineages of origin, selection, reproduction, and evolution, they map a non-teleological and unpredictable network of symbiotic alliances, trans-species affiliations, symbiogenesis, and co-evolution’ (Chisholm, 2007).

Deleuze and Guattari thus propose a non-classification of becoming, preferring the term ‘involution’ for evolution between heterogeneous terms, as an alternative to ‘evolution’ (Deleuze and Guattari, 1988: 238-239). They specifically use symbiosis to explain their idea of becoming (which is rhizomatic and is directed against thinking in genealogies), where symbiosis can be seen as the underlying basis of their "creative involution." As they state: ‘Becoming produces nothing by filiation; all filiation is imaginary. Becoming is always of a different order than filiation. It concerns alliance. If evolution includes any veritable becomings, it is in the domain of symbioses that bring into play beings of totally different scales and kingdoms, with no possible filiation’ (Deleuze and Guattari, 1988: 238-239).

The critique of a static individual is something that is again also visible in biological research, where symbiosis has been used to challenge the boundaries of an organism. Margulis also states that every individual consists of multi-unit symbiotic individuals, as they

continually merge to regulate their reproduction to generate new populations. She, like Deleuze and Guattari, speaks about how every 'individual organism' in a 'species' is 'really a group, a membrane-bounded packet of microbes that looks like and acts as a single individual' (Margulis, 1999: 11). This directly relates to Deleuze and Guattari's idea that every animal is a band or a pack, which is very important for the concept of human becoming-animal, being fascinated by both the multiplicity outside us (the pack of animals) and the multiplicity that is already dwelling inside of us (Deleuze and Guattari, 1988: 239-240). Deleuze and Guattari's non-classification of symbiotic becoming can be seen as a viral evolution, based on contagion (instead of heredity), where animals as packs originate, develop and transform by means of viral contagion (Deleuze and Guattari, 1988: 241).

Their vision of an individual is that it consists of an infinite multiplicity, where multiplicities made up of heterogeneous terms continuously transform or cross over into each other. Multiplicities co-functioning via a viral logic of contagion then enter into assemblages. Becoming and multiplicity basically mean the same thing in Deleuze and Guattari's philosophy, and here again they use symbiosis to define and explain one of their core concepts:

> Since its variations and dimensions are immanent to it, it amounts to the same thing to say that each multiplicity is already composed of heterogeneous terms in symbiosis, and that a multiplicity is continually transforming itself into a string of other multiplicities, according to its thresholds and doors (Deleuze and Guattari, 1988: 275).

The concept of assemblage as applied in Deleuze and Guattari's geophilosophy, can thus be seen to do away with the nature-culture distinction. Assemblages also incorporate non-organic matter. Tools as instruments get incorporated into and are inseparable from the assemblage, creating a machinic phylum. In this manner humans are also related to non-living/non-organic beings through assemblages. An assemblage keeps different types of objects, heterogeneous elements, together; objects and elements that continuously enter into relations with one another, where the affects of a body enter into composition with other affects. This entering of affects again has a symbiotic character:

> We know nothing about a body until we know what it can do, in other words, what its affects are, how they can or cannot enter into composition with other affects, with the affects of another body, either to destroy that body or to be destroyed by it, either to exchange actions and passions with it or to join with it in composing a more powerful body (Deleuze and Guattari, 1988: 256).

Chisholm remarks that these kind of machinic assemblages, or symbiosis with inorganic life, are the vitalist element behind creating more life in a non-reproductive way. Symbiotic couplings or machinic assemblage between unlike things create something other than themselves, something more creative (Chisholm, 2007).

Symbiotic systems and ecologies

In both systems theory and media studies a symbiotic critique following the idea of machinic assemblages can be seen to have gained ground, arguing for the importance of seeing non-organic processes and nature-culture assemblages as inherent to information-processing entities. In research into media ecologies media are seen, in a symbiotic fashion, as cooperating open systems, producing something more through their interactions than (the sum of) their separate parts. Thus Matthew Fuller, in his book on *Media Ecology*, uses Deleuze and Guattari's concept of the machinic phylum to describe the tension between the discrete parts of a specific medium or a specific media ecology and their multiplicitous becomings. From this point of view, media should be seen as complex dynamical systems (ecologies), as networks of objects and processes, and it is their interconnectedness that we should be interested in (Fuller, 2005: 6). Similarly, Jussi Parikka, in his volume *Insect Media*, is interested in the intertwining of animals and technology. Like Fuller, he is not interested in studying media as fixed substances but in their becomings (exploring media archaeology). These machinic assemblages are in Parikka's work not merely metaphoric suggestions, but function as a means to rethink the material basis of media and how matter can be seen as an active agent. Media can thus be seen as 'a realms of affects, potentials and energetics' (Parikka, 2010: xxvii). Media bodies emerge as part of the environments in which they are embedded, interconnected through their intensive capabilities. In this sense, as Parikka states, we (humans, animals, insects, bacteria) are all media and are of media, arguing for a vision on media ecologies that is more inclusive (Parikka, 2010: xxvii).

Van Loon argues for a similar emphasis on the material basis of media over and above merely metaphorical imagery, when he discusses the importance of symbiotic processes to any understanding of the interactions in (complex) systems theory. Not only does biology and science as such use symbiosis as a metaphor too, Van Loon argues that political processes are no less real than let's say bacteria. As he states:

> The point to make here is simply that if we understand that the basic process in symbiosis is a form of interaction between two or more different information processing systems, that in turn work to manipulate and modify their environment according to better their chances of survival, than it should become clear that this includes both organic and inorganic information-processing systems (Van Loon, 1999).

Van Loon explains how in systems theory, symbiosis has been used to show how evolution through associations can explain how new organisms 'emerge' far more effectively than natural selection. In opposition to a systems theory based on natural selection, Van Loon argues that such a politics of survival can be seen as fascist as it privileges the autonomy of the individual over that of the community. Complex systems always arise through symbiosis as they are assemblages of information-processing devices. Van Loon goes on to show how community as it emerges, functions and evolves via a symbiotic parasite politics, a parasite politics that can be seen as the essence of a community. Here he regards the parasite as 'the other' that makes up the community-in-difference (Van Loon, 1999).

This living book forms another machinic assemblage between heterogenous and discrete information-processing entities. Within it you will find a collection of media resources, interacting in and within a wider media ecology, resources that apply symbiotic critique within their particular networks. That is to say, they use symbiotic processes to argue for a different worldview. Brought together in this living book they merge and form symbiotic alliances from which they will continue to evolve.

Evolution, ecology, posthumanism and augmentation

This living book is divided in four sections. The first part of *Symbiosis: Ecologies, Assemblages and Evolution* looks at symbiosis as an evolutionary process, the second part at the relationship between symbiosis and ecology, the third at the role symbiosis played in discourses on the posthuman. The fourth part of the book then provides a more speculative glance into a future of augmented and virtual reality and an evolving symbiosis between the virtual and the real.

Part one of *Symbiosis: Ecologies, Assemblages and Evolution*, which focuses on *Symbiosis and Evolution*, contains two articles that serve as both an introduction to, and an example of, symbiosis. The first of these, 'How Symbiosis can Guide Evolution', is an example of the use of the concept of symbiosis to battle by (neo)Darwinism inspired theories of evolution. It describes the creation of a computational model that shows how the formation of symbiotic relations in a given ecosystem influences genetic variation. It is

followed by Fabio Lucian and Samuel Alizon's 'The Evolutionary Dynamics of a Rapidly Mutating Virus within and between Hosts: The Case of Hepatitis C Virus', which looks at the evolution of the Hepatitus C virus in a within-host environment, describing the parasitic relationship of the virus with the host-body.

The second set of articles in the part on *Symbiosis and Evolution* then looks at the process of endosymbiosis (symbiosis inside the body/cell) in particular. The article by Xu et al. looks at the evolution of symbiotic bacteria in the human intestine and the article by Wernegreen looks at the interactions (via associations or genetic conflicts) of bacteria within and with insects, and the possibility of genetic manipulation in this evolutionary interaction.

Finally, the third set of articles in the part on *Symbiosis and Evolution* looks at the origin of the theory of symbiogenesis, incorporating the seminal 1927 book Symbionticism and the origin of species by American biologist Ivan Wallin, which made the then highly controversial claim that cells evolved by symbionticism, by the formation of microsymbiotic complexes. In this book Wallin describes the emergence of mitochondria as the incorporation of independent bacteria inside of existing cells, which evolved to what we now know as organelles. In an overview article, biologist Lynn Margulis goes back to the origin of the theory of symbiogenesis (and to Wallin and his Russian colleagues) to explore the roots of her own work and the development of her groundbreaking Serial Endosymbiosis Theory (SET) at the same time.

The second part of this liquid book looks at the

relationship of symbiosis with ecology. In the opening section on community ecology, the article 'The Roles and Interactions of Symbiont, Host and Environment in Defining Coral Fitness', looks at the complex interactions between the coral host, the algal symbiont, and the environment, and the role symbionts play in this community ecology with respect to the community's (the coral holobiont's) fitness, and their ability to determine what the effects of global climate change on this ecology might be. An important aspect of many discourses surrounding ecology is the upkeep of the level of biodiversity and complexity of a given system or ecology. The article by Toft, Williams, and Fares, looks at this aspect of biodiversity as a measure of the health of ecosystems and the role symbiosis (especially with respect to the way proteobacteria interact with insects) plays in generating species diversity.

Symbiosis also plays a role in those discourses surrounding ecology that go beyond a single community or ecological system to focus instead on the ecosystem that makes up the world as a whole. The notion of the world functioning as one big ecosystem is reflected in Timothy Morton's work and the importance he gives to the idea of interconnectedness. Echoing processes of symbiosis, his concept of the Mesh is set up against nature-culture distinctions, but focuses on the interconnectedness of existence, seeing existence as first of all a co-existence.

Symbiosis has also been influential in the previously mentioned Gaia hypothesis. Here symbiosis, ecology and interconnectedness are taken to a point of spiritual culmination where the whole biosphere can be seen as a

single complex planetary system consisting of organic and inorganic components. In The Systems View of Life, a chapter from his book The Turning Point, Capra looks at these interrelationships from a systems point of view, seeing living organisms as open systems, functioning in their interactions with others and their environment on different levels of the overall system. Stephen B. Scharper, in his overview article on Gaia, reviews theories by Lovelock, Margulis and others that have concentrated on the idea of the earth as a living organism. He focuses amongst other things on the way Gaia combined scientific discoveries with a 'religious imagination'. Timothy Morton, in his podcast on Lynn Margulis and Gaia, notes the differences between her view on symbiosis and the way it was adopted in Gaia Theory.

This part of the book on *Symbiosis and Ecology* ends with Matthew Fuller's Media Ecologies, in which he adapts the concept of ecology to media, showing how media as interacting objects, and media systems, function as ecologies. Like different species interacting in a symbiotic way to create new species, Fuller shows how a mobile phone, for instance, can be seen as a 'media assemblage'.

The third part of the book on *Symbiosis and Posthumanism*, looks at the influence of symbiosis on thinking about non-organic matter and its interactions with organic matter. Symbiosis has played an important role in discourses on the posthuman: for instance, in Lickliders seminal speculative paper on the possibilities of man-machine symbiosis. Schalk updates Licklider's article, using contemporary developments in

computing and information processing to show how Licklider's utopian vision was not so much utopian as making a case for technological improvements. Schalk argues that brain-computer symbiosis or partnerships are a logical step in the course of our evolution.

The next section on *Symbiotic Intelligence* expands on the possibility of symbiotic intelligence by combining computing with (neural) networks. The article that opens this section, Forming Neural Networks Through Efficient and Adaptive Coevolution, by Moriarty and Miikkulainen, discusses a novel neuroevolutionary approach to mobile robotics using the Symbiotic Adaptive NeuroEvolution system (SANE). It argues for the benefits of using co-evolutionary algorithms to solve complex control problems. The importance of dynamic or distributed problem-solving, of 'collective decision making' and symbiotic intelligence is also discussed in Johnson's overview of symbiotic intelligence and human-net interactions.

Another aspect of the importance of symbiosis is discussed in the paper by Bhan et al. on human-animal symbiosis resulting in chimeras (human-animal hybrids). This article discusses the importance that the development of chimeras could play in vaccine development, were it not for the strong ethical problems involved in this form of symbiotic evolution.

The last section in this part of the book looks at machine-nature interactions. Here Schhuppli's article 'Of Mice Moths and Men Machines', describes the coevolution of machine's with living matter through the example of Hopper's bug, arguing that mutations, chaos and viral infections are necessary for systems to survive

and evolve. Jussi Parikka, in his essay on digital monsters and binary aliens, goes deeper into this discourse of the viral as a negative control-issue in the present capitalist system. He shows how on the other hand capitalism itself is integrally viral. Parikka explores these contradictory themes of the viral as the enemy of capitalism and at the same time integral to its logic of expansion, positioning them as two intertwined discourses.

The final part of the book on *Symbiosis and Augmentation* looks at possibilities for both augmenting man with machinic prosthetic tools via neural networks, and for augmenting reality with overlaid or augmented virtual worlds. The article 'Exploiting co-adaptation for the design of symbiotic neuroprosthetic assistants', by Sanchez et al. looks at the incorporation via the brain of neuro-prosthetic tools through neurological networks. This can be seen as an example of human-tool symbiosis where, through the cognitive space of the brain, tools can be used as extensions or 'enhancements' of the body.

The book's final part ends with a poetic experiment involving text and bacteria and with two descriptions of media art, which experiment, with the symbiosis between the real and the virtual. 'Carrier Becoming Symborg', which is the title of a piece and text by Melinda Rackham, looks at the viral merging of biological code and source code. Her electronic literature piece about the Hepatitis C virus describes both life and literature as an infectious viral agent. Meanwhile Mitchell Whitelaw examines the work of Any Gracie and other examples of the bio/tech hybrid in

media art, and talks about the importance of symbiosis in Gracie's work: we when, for example, he creates augmented worlds in which real and virtual bacteria interact (in Autoinducer_Ph-1). Christian Bök in 'The Xenotext Experiment', describes his proposal for having a text living as a parasite within the cells of another life-form, by encoding a short verse from a poem into a sequence of DNA in order to implant it into a bacterium.

Epilogue: The Symbiotic Book

We should stress that this living book is also a symbiotic book. It is a merging and co-habitation of different media-species, a mash-up of text and video, sound and images, pixels and living, material tissue. The digital medium has in many ways made it possible for the book to become increasingly infected with foreign (non-textual) elements as it evolves into something different; into a becoming which might even lead to the disappearance of the book as we currently know it and to the rise of a new symbiotic book-evolved hybrid species.

In this context this symbiotic book on symbiosis also constitutes a tool for a critique which is directed at visions of the book which position it as a static, stable entity, a lifeless thing made out of dead trees. As a concept the symbiotic book argues for the book as becoming, as infinitely transforming and interacting and crossing over into other books and other discourses, a machinic assemblage of various discrete media entities, all of them interconnected. In this vision the

networked, liquid books in the Living Books About Life series form an ecology of information, one that growes stronger and expands in mutual cooperation. Cooperation as books, as 'lifeless entities', or non-organic matter, also takes places with and via the living, with the human assemblages who create the books, feed into them, and make them part of the networks through which they algorithmically spread over the web, keeping the book alive, keeping it social.

The symbiotic book crosses boundaries, between the life sciences and the humanities, but also between the scholarly world and society at large, thus making it open for infection, for re-use, for remixing and change. The symbiotic book still has borders, though. Evolution is a slow process, heavily influenced by environmental and cultural barriers. Nevertheless, maybe some genetic modification might be beneficial in this respect.

Endnotes

1. About the lack of a uniform definition with respect to symbiosis, see: Douglas, A.E. (2010) The Symbiotic Habit. Princeton: Princeton University Press, 4-5.

2. Margulis explains how symbiosis over a prolonged period of time led first to the evolution of complex cells with nuclei and then from there led to the evolution of other organisms such as fungi, plants, and animals (Margulis, 1999: 6).

3. For an overview of scientific criticism on the Gaia hypothesis, see: Scharper, S.B. (1997) Redeeming the Time: A Political Theology of the Environment. New York: The Continuum International Publishing Group Inc., 53-54.

4. As they state: Natural history can think only in terms of relationships (between A and B), not in terms of production (from A to x). Deleuze, G and Guattari, F. (1988) A thousand plateaus: capitalism and schizophrenia. Minneapolis: University of Minnesota Press, 234-235.

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Articles

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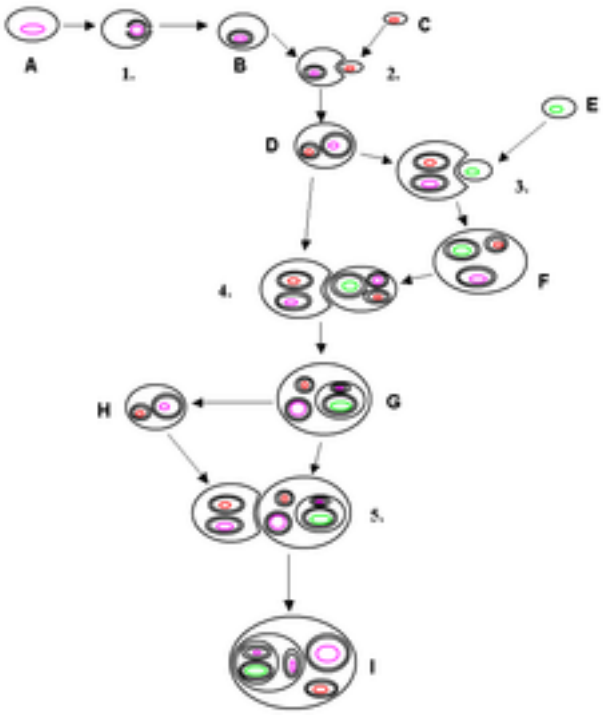
Watson, R. A. and Pollack, J. B.
How Symbiosis Can Guide Evolution

Fabio Lucian and Samuel Alizon
The Evolutionary Dynamics of a Rapidly Mutating Virus within and between Hosts: The Case of Hepatitis C Virus

Wired Science
Green Sea Slug Is Part Animal, Part Plant

Endosymbiosis



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Evolution of Symbiotic Bacteria in the Distal Human Intestine

Jennifer J. Wernegreen
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Symbiogenetics

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Community Ecology

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Biodiversity and complexity

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Carrier becoming symborg

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Christian Bök
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Attributions

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