A-life, Organism and Body: the semiotics of emergent levels

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Abstract

This paper comments upon some of the open problems in artificial life (cf. Bedeau et al 2000) from the perspective of a philosophy of biology tradition called qualitative organicism, and more specifically the emerging field of biosemiotics, the study of life processes as sign processes. Semiotics, in the sense of the pragmaticist philosopher and scientist Charles S. Peirce, is the general study of signs, and biosemiotics attempts to provide a new ground for understanding the nature of molecular information processing and sign processes at higher levels as well. Although we should not expect in Peirce to find any answers to the theoretical challenges and open questions posed by 'Wet' Artificial Life, his semiotics (along with emergentist theories and cyborg studies) provide inspiration and conceptual tools to deal with the problems of life, mind, and information in the physical universe.

Introduction: Organicist philosophies

Artificial Life research raises philosophical questions, just as cognitive science involves philosophy of mind. No clear demarcation line can be drawn between science and philosophy; every scientific research programme involves metaphysical assumptions and decisions about how to interpret the relations between experiment, observation, theoretical concepts and models (this was also evident when Artificial Life originally was formulated by C.G. Langton in the late 1980s; cf. Emmeche 1994). Yet we should not conflate questions that may be answered by science with questions that by there very nature are conceptual and metaphysical.

The aim of this paper is to address from the perspective of biosemiotics a subset of the open problems (as described by Bedeau et al. 2000) raised by Artificial Life research, including 'wet Alife', about the general characteristics of life; the role and nature of information; how life and mind are related; and their relations again to culture and machines. Biosemiotics as the study of communication and information in living systems may provide some inspiration and conceptual tools for inquiry into these theoretical and philosophical issues. Firstly it is apt briefly to introduce organicism as a main stream position in philosophy of biology, and also a variant called qualitative organicism, and then introduce biosemiotics as a non-standard philosophy of biology.

Neither qualitative nor mainstream organicism are specific research paradigms; they are more like general and partly intuitive stances on how to understand living systems in the context of theoretical biology.

Organicism. In its mainstream form (cf. Emmeche 2001) organicism endorses these theses: (a) non-vitalism (no non-physical occult powers should be invoked to explain living phenomena); (b) non-mechanicism (living phenomena cannot be completely described merely by mechanical principles, whether classical or quantum); (c) emergentism (genuine new properties are characteristic of life as compared with 'purely' physical non-living systems) implying ontological irreducibility of at least some processes of life (though methodological reductionism is fully legitimate); (d) the teleology of living phenomena (their purpose-like character) is real, but at least in principle explainable as resulting from the forces of blind variation and natural selection, plus eventually some additional 'order for free' (physico-chemical self-organization). What is studied within an organicist perspective as emergent properties are seen as material structures and processes within several levels of living systems (developmental systems, evolution, genetic and biochemical networks, etc.), all of which are treated as objects with no intrinsic experiential properties. Mayr (1997) acknowledged his position as organicist, and main stream organicism is widely accepted among biologists, even though the position was often mixed-up with vitalism (see also El-Hani & Emmeche 2000, Gilbert & Sarkar 2000). Accordingly, there are no principled obstacles to the scientific construction of life and mind as emergent phenomena by evolutionary or bottom-up methods.

Qualitative organicism. This is a more radical position differing from main stream organicism in its appraisal of teleology and phenomenal qualities. It emphasizes not only the ontological reality of biological higher level entities (such as self-reproducing organisms being parts of historical lineages) but also the existence of qualitative experiential aspects of cognitive behavior. When sensing light or colors, an organism is not merely performing a detection of external signals which then get processed internally (described in terms of neurochemistry or information processing); something more is to be told if we want the full story, namely about the organism's own experience of the light. This experience is seen as real. It may be said to have a subjective mode of existence, yet it is an objectively real phenomenon (Searle 1992 emphasized the ontological reality of subjective experience; yet, most of the time only in a human context). As a scientific stance qualitative organicism is concerned not only with the category of 'primary' measurable qualities (like shape, magnitude, and number) but also with inquiry into the nature of 'secondary' qualities like color, taste, sound, feeling, and the basic kinesthetic consciousness of animal movement. A seminal example of qualitative organicism is Sheets-Johnstone 1999. The teleology of living beings is seen as an irreducible and essential aspect of living movement, in contrast to mere physical change of position. This teleology is often attributed to a genuine form of causality ('final causation', cf. Van de Vijver et al. 1998), and qualitative organicism's assessment of the 'reality' of an instance of artificial life will partly depend on how to interpret the causality of the artificial living system.

Biosemiotics. The study of living systems from the point of view of semiotics, the theory of signs (and their production, transfer, and interpretation), mainly in the tradition of the philosopher and scientist Charles Sanders Peirce (1839-1914) but also inspired by the ethologist Jakob von Uexküll (1864-1944), has a long and partly neglected history in 20th Century science (Kull 1999 for the history, Hoffmeyer 1996 for an introduction). It re-emerged in the 1990s and is establishing itself as a crossdisciplinary field attempting to offer alternatives to a gene-focused reductionist biology (much like one of the aims of Artificial Life, and indeed inspired by it), by gathering researchers for a new approaches to biology, or a new philosophy of biology, or ultimately with the hope to bridge the gab between science and the humanities. The semiotic approach means that cells and organisms are not seen primarily as complex assemblies of molecules, as far as these molecules — rightly described by chemistry and molecular biology — are sign vehicles for information and interpretation processes, briefly, sign action or *semiosis*.

A *sign* is anything that can stand for something (an *object*) to some interpreting system (e.g., a cell, an animal, a legal court), where 'standing for' means 'mediating a significant effect' (called the *interpretant*) upon that system. Thus, semiosis always involves an irreducibly triadic process between sign, object and interpretant. Just as in chemistry we see the world from the perspective of molecules, in semiotics (as a general logic of sign action) we see the world from the perspective of sign action, process, mediation, purposefulness, interpretation, generality. Those are not reducible to a dyadic mode of mechanical action-reaction, or merely efficient causality. The form of causality governing triadic processes is final causation. Organisms are certainly composed of molecules, but these should be seen as sign vehicles having functional roles in mediating sign action across several levels of complexity, e.g., between single signs in the genotype, the environment, and the emerging phenotype.

Biosemiotics is a species of qualitative organicism for these reasons: (i) It holds a realist position regarding sign processes of living systems, i.e., signs and interpretation processes are not merely epistemological properties of a human observer but exists as well in nature, e.g., in the genetic information system (El-Hani et al. 2004). (ii) Biosemiotics interprets the teleology of sign action as related to final causation (Hulswit 2002). (iii) The qualitative and species-specific 'subject' of an animal (i.e., its *Umwelt* understood here as a dynamic 'functional circle' of an internal representation system interactively cohering in action-perception cycles with an environmental niche) can to some extent be studied scientifically by the methods of cognitive ethology, neurobiology and experimental psychology, even though the experiential feeling of the animal is closed to the human Umwelt (on Umwelt research, see papers in Kull 2001). (iv) Signs have extrinsic publicly observable as well as intrinsic phenomenal aspects. We can only access the meaning of a sign from its observable effects, a good pragmaticist principle indeed, but observation of the phenomenal experiences of another organism may either be impossible or highly mediated. However, reality exceeds what exists actually as observable. (v) Even though sign activity generally can be approached by formal and logic methods, sign action has a qualitative aspect as well. Due to the principle of inclusion (Liszka 1996) every sign of a higher category (such as a legisign, i.e., a sign of a type) includes a sign of a lower category (e.g., a sinsign, i.e., a sign of a token. A type has somehow to be instantiated by a token of it, just like any sign must be embodied). A symbol is not an index, but includes an indexical aspect, which again involves an icon. All signs must ultimately include (even though this might not be pertinent for their phenomenology) qualisigns, which are of the simplest possible sign category, hardly functioning as mediating any definite information, yet being signs of quality and thus having a phenomenal character of feeling (Peirce preferred a type-token-tone trichotomy for the type-token dichotomy; a tone is like a simple feeling). The argument (v) may strike a reader not acquainted with Peirce as obscure, but it is a logical implication of the ontological-phenomenological basis of Peirce's semiotics and points to an interesting continuity between matter, life and mind, or, to phrase it more precise, between sign vehicles as material possibilities for life, sign action as actual information processing, and the experiential nature of any interpretant of a sign, i.e., the effects of the sign upon a wider mind-like system (Emmeche 2004).

To recapitulate, the biosemiotic notion of life is a notion of a complex web of sign and interpretation processes, typically with the single cell seen as the simplest possible autonomous semiotic system.

Synthetic biosemiosis? Computers are semiotic machines (Nöth 2003) and computers or any other adequate medium, such as a complex chemistry, can in principle function as a medium of genuine sign processes. Not all sign processes need to be biological, although all signs seem to involve at some point in their semiosis interpreters who typically would be biological organisms. Remember the distinction above between the interpretant as the effect or meaning of a sign and the interpreting system (or interpreter) as the wider system in which semiosis is taking place. So, what then is the biosemiotic stance regarding true synthetic life or 'wet' artificial life? To answer this question, we have to consider, though more carefully than can be done here, (a) three non-exclusive notions of 'life'; (b) the relation between the notions of organism, animal, body, and the general embodiment of various levels of signs processes; and (c) the semiotics of scientific models. This necessity of a precaution in assessment of the degree of genuineness of synthetic life in other media is related to another organicist theme: The thesis of irreducibility of levels of organization, or, as we shall interpret that thesis here, levels of embodied sign action.

'Life' in *Lebenswelt,* biology and ontology

Synthetic life provokes, of course, the general question "what is life?", partly because of an intuition we (or some people) have from our ordinary life, as the German philosophers would say, from the *Lebenswelt* (lifeworld) of human beings, that life (like death) is a basic conditions we as humans hardly can control, know completely, or create. Now science seems to teach us otherwise. A contribution to clarify the issue is to be aware of the fact of the existence of at least three, non-exclusive notions of life. I will briefly sketch these:

Lebenswelt life: A set of diverse, non-identical, culture-specific notions (determined by intuitive, practical, ideological, or social factors) of what it is to be 'alive', what life and dead is, why being alive and flexible is more fun than being dead and rigid, and so on. Science is distinct from, but not independent of, forms of the human Lebenswelt (just as scientific concepts can be seen as presupposing and being a refinement of ordinary language). For biological relevant notions of life, we can talk about 'folk' and 'experiential' biology (Emmeche 2000).

Biological life: The so-called life sciences are not interested in the life of the Lebenswelt as a normative phenomenon, but in the general physical, chemical and biological properties of life processes, as conceived of within separate paradigms of biology. This leads to several distinct 'ontodefinitions' of life (Emmeche 1997) such as life as evolutionary replicators, life as autopoiesis, or life as sign systems (and probably many more). However, advances in biotechnology and biomedicine will tend to mix up, 'hybridize' or create new boundary objects (*sensu* Star & Griesemer 1989) between the domains of bioscience and a lifeworld deeply embedded in technoscience.

Ontological life: Depending upon the ontology chosen, an ontological notion of life is marked by distinctions to other, similarly general and essentials domains of reality. Take the ontology of Peirce, for instance. Here life is of the category of Firstness, it does not only include life in organisms, evolution or habit taking (which are of the category of Thirdness); life is seen as an all-inclusive aspect of the developing cosmos, on par with spontaneity and feeling: "insofar as matter does exhibit spontaneous random activity (think of measurement error or Brownian motion), it still has an element of life left in it" (Reynolds 2002, 151).

Biosemiotics typically does not use Peirce's broad ontological notion of life, but construes a notion of life derived from contemporary biology, as mentioned, life as organic sign-interpreting systems. But biosemiotics entails a thesis of the reality of ideal objects, including possibilities like a fitness space, virtuality in nature, or tendencies in evolution and development, and so "the possibilities for final causes to prefer one tendency over another. Thus biosemiotics entails an ontological revolution admitting the indispensable role of ideality in this strict sense in the sciences" (Stjernfelt 2002, 342).

The invention of synthetic 'wet' life may affect all the three non-exclusive preoccupations with understanding life, that is, life within a cultural context, life as studied by science, and life as a metaphysical general aspect of reality. To approach how this may come about, we must analyze some levels of embodied life from the perspective of an emergentist ontology.

Level-specific forms of life and embodiment

As a species of organicism biosemiotics is an emergentist position. However, it is not so often that emergent levels of sign processes have been explicitly discussed (von Uexküll 1986, Kull 2000, El-Hani et al. 2004). The account given here should be seen as preliminary; the important point is not the number of levels (more fine-grained analyses may be done) but the very existence of separate levels of embodied sign action. See also Table 1.

The body of physics	The body of biology	The body of 'evo-devo'-research	The body of zoology	The body of anthropology	The body of sociology
Complex dissipative, self-organizing structures	**Physiologic-homeostatic units with a genetic code-plurality, and irritability**	**Vegetative swarm of cells coordinating multicellular communication with multiple organic codes**	**Self-moving, action-perception cycles, animation, kinesthetics**	**Language, culture-specific Lebenswelt**	**The life in societal institutions, habitus formation**

Table 1. Ordering relations between forms of embodiment. The epistemic dimension (top row) is shown by organizing those forms according to different domains of science each constituting its own objects; the ontic dimension (bottom row) is implied by an underlying ontology of levels of organization in Nature. Increasing specificity from left to right; for each new level the previous one is presupposed.

The emerging forms of embodiment of life could be suspected merely to reflect a historically contingent division of sciences, an objection often raised against simple emergentists level ontologies. Thus one should pay respect to the fallibilist principle and never preclude that new discoveries will fundamentally change the way we partition the levels of nature. The point is that from the best of our present knowledge we can construct some major modes of embodiment in which 'life' and 'sign action' plays crucially different roles, and in which we can place such broad phenomena as life, mind, and machines. Reflexivity is allowed for, so even the scientific description of these phenomena can be placed in this overall scheme of processes. A consequence is that wet artificial life is seen as a *hybrid* phenomenon of 'the body of biology' and 'the body of sociology', as will be explained below.

The emergent modes of embodiment, increasing in specificity (Table 1) are one-way inclusive and transcending: The human body *includes* the animate organism, which again presupposes multicellularity and basic biologic autopoiesis (but not vice versa). A human body (e.g., the body of a child, a soccer player, or a diplomat) as studied by anthropology is something more *specific* (i.e., in need of more determinations) than its being as an animal, thus transcending the mere set of animate properties (as having an Umwelt) and organismic properties (like growth, metabolism, homeostasis, reproduction), just as an organism is a physical system, yet transcending the basic physics of that system. That an entity or process at an emergent level *Z* is *transcending* phenomena at level *Y* has two aspects. One is epistemic, i.e., "*Z*'s description cannot adequately be given in terms of a theory generally accounting for *Y*, even though this *Z*-description in no way contradicts a description of the *Y*-aspects of *Z*". The other is ontological, i.e., "crucial properties and processes of *Z* are of a different category than the ones of *Y*, even though they may presuppose and depend on *Y*". Thus, a Z-entity is a highly specific mode of realizing an Y-process, not explained by Y-theory. The organism is a physical processual entity with a form of movement so specific that physics (as a science) cannot completely account for that entity. The organism is a very special type of physical being, as it includes certain purposeful (functional) part-whole relations, based upon genuine sign systems of which the genetic code is the most well-known but not the only example. Here is a brief characteristics of the levels.

'Life' as self-organization far from equilibrium

Physics deal with three kinds of objects; first, general forces in nature, particles, *general bodies* (matter in bulk), and the principles ('laws') governing their action; second, more specifically the structural dynamics of *self-organized bodies* (galaxies, planets, solid matter clusters, etc.); third, physical aspects of *machines* (artifacts produced by human societies and thus only fully explainable also by use of social sciences, like history of technology). One has often seen attempts to reduce all of physics to a formalism equivalent to some formal model of a machine, but there are strong arguments against the completeness of this programme (Rosen 1991), i.e., mechanical aspects of the physical world are only in some respects analogous to a machine. Some of the general properties of bodies studied in physics have a teleomatic character (a kind of directedness or finality, cf. Wicken 1987), which may be called 'thermo-teleology', as this phenomenon of directedness is best known from the second law of thermodynamics (a directedness towards disorder), or from opposing self-organizing tendencies in far from equilibrium dissipative systems. Often when physicists talk about 'life' in the universe the reference is to preconditions for biological life such as self-organizing non-equilibrium dissipative processes, rather than the following level.

Life as biofunctionality - organismic embodiment

A biological notion of *function* is not a part of physics, while it is crucial for all biology. Biofunctionality is not possible unless a living system is self-organizing in a very specific way, based upon a memory of how to make components of the system that meet the requirement of a functional (autopoietic and homeostatic) metabolism of high specificity. For Earthly creatures this principle is instantiated as *a code-plurality* between a 'digital' genetic code of DNA, a dynamic regulatory code of RNA (and other factors as well), and a dynamic mode of metabolism involving molecular recognition networks of proteins and other components (see the semiotic analysis by El-Hani et al. 2004). Symbolic, indexical and iconic molecular sign processes are all involved in protein synthesis. The symbols (using DNA triplets as sign vehicles) seem to be a necessary kind of signs for a stable memory to pick out the right sequences for the right job of metabolism. This establishes a basic form of living embodiment, the single cell (a simple organism) in its ecological niche. This presupposes the workings of 'the physical body' as a thermodynamic non-equilibrium system, but transcends that general form by its systematic symbolic memory of organism components and organism-environment relations.

Biosemiotics posits that organismic embodiment is the first genuine form of embodiment in which a system becomes an autonomous agent "acting on its own behalf" (cf. Kauffman 2000), i.e., taking action to secure access to available resources necessary for continued living. It is often overlooked that the subject-object structure of this active agent is mediated not only energetically by a structured entropy difference between organism and environment, but also semiotically, by signs of this difference; signs of food, signs of the niche, signs of where to be, what to eat, and how to trigger the right internal processes of production of organismic components the right time. The active responsitivity of the agent organism (based upon observable molecular signs) has, as an 'inner' dimension, a quality of feeling, implied by what is in Table 1 called *irritability* at the level of a single cell. Irritability is a real phenomenon, well-known in biology, logically in accordance with a basic evolutionary matter-mind continuity, rationally conceivable, though impossible for humans to sense or perceive 'from within' or empathetically know 'what it feels like', say, for an amoeba or an *E.coli*.

It is highly conceivable that synthetic systems analogous to this level of embodiment may be produced some day.

Life as biobodies – coordinate your cells!

Characteristics like multiple code-plurality (involving the genetic code, signal transduction codes, and other organic codes, see Barbieri 2003) and forms of semiotic coordination between cell lines cooperating and competing for resources within a multicellular plant or fungus are characteristics of 'the evolution of individuality' (Buss 1987). The 'social' life of cells within a lineage of organisms with alternating life cycles constitutes a special level of embodied biosemiosis, and special a coupling of evolution and development. It is the emergence of the first *biobodies* in which the whole body constrain the growth and differentiation of its individual cells (a form of 'downward causation', cf. El-Hani & Emmeche 2000). This multicellular level of embodiment corresponds to what was called a vegetative principle of life in Aristotelian biology, like that of a plant.

Life as animate - moving your self!

Here the body gets animated, we see a form of 'nervous code' (still in the process of being decoded by neuroscience), and we see the emergence of animal needs and drives. When we consider animal mind and cognition, the intentionality of an animal presupposes the simpler forms of feelings and irritability we stipulate in single cells (including the 'primitive' free-living animals, such as protozoa, lacking a nervous system), yet transcends these forms by the phenomenal qualities of the perceptual spaces that emerge in functional perception-action cycles as the animal's Umwelt. Proprioceptive semiosis is crucial for phenomenal as well as functional properties of animation (Sheets-Johnstone 1999). More generally, the animal body is a highly complex and specific kind of a multicellular organism (a biobody) that builds upon the simpler systems of embodiment such as physiological and embryogenetic regulation of the growth of specific organ systems, including the nervous system. These regulatory systems are semiotic in nature, and rely on several levels of coded communications within the body and their dynamic interpretations (Hoffmeyer 1996, Barbieri 2003). The expression "the body of zoology" in Table 1 is used to emphasize both its distinctness as a level of embodiment, and that *zoology* instead of being simply part of an old-fashioned division of the sciences should be the study of animated movement, including its phenomenal qualities.

Life as anthropic - talk about life!

With the emergence of humans comes language, culture, division work, desires (not simply needs, but culturally informed needs), power relations etc. The political animal not only lives and makes tools, but talks about it. Within this anthroposemiosis (von Uexküll 1986), the body is marked by differences of gender (not simply sex), age, social groups, and cultures.

Life as societal – get a life!

After humans invented agriculture and states, more elaborated institutions could emerge and social groups became informed and enslaved by organizational principles of all the sub-systems of a civilized real society (work, privacy, politics, consumption, economy, law, politics, art, science, technology, etc.). Humans discover the culture-specificity of human life, 'them' and 'us'. Reflexivity creeps in as civilization makes more and more ways to get a life. The body becomes societal (marked by civil life) and cyborgian (crucially dependent upon technology, machines). The political animal becomes cosmopolitical. The body is marked not only in the anthropic sense (see above), but also by institutions. *The cyborg body* is a civilized one, dependent upon technoscience (to keep 'us' healthy and young) and, because of the dominant forms of civilization, ultimately co-determined by the globally inequal distribution of wealth. One can foresee Artificial Life research to play an increasing role in the contest over bodies and biopower as we approach the 'posthuman' condition (cf. Kember 2003).

Hybridization and downward causation

This tour-de-force through some levels of embodiment makes a note on entanglement and hybridization relevant. The neat linearity implied by the concepts of inclusion and increasing specificity and by the (admittedly idea-of-progress seeming) chain of levels does not hold true unrestricted. For instance, the very possibility of 'human' creation bottom-up of new forms of life seems to suggest some complication (as human purposes may radically inform the natural teleology of what looks like biobodies). Already the culture-determined breeding of new races of cattle, crops, etc. suggests that even though biology should be enough to account for the body of a non-human animal, the human forms of signification interferes with pure biosemiosis, and create partly artificial forms of life like the industrialized pig or weird looking pet dog races. In some deep sense, cows and pigs within industrialized agriculture are already cyborgs, partly machines, partly animals (cf. Haraway 1991). Culture mixes with nature in a 'downward causation' manner, and thus, the hierarchy of levels is 'tangled' (Hofstadter 1979) and 'natural' and 'cultural' bodies hybridize (Latour 1991). We might expect something similarly to apply if we access the status of 'wet' artificial life, as reported by Rasmussen et al 2004 and Szostak et al. 2001. Here, however, we need also to consider not only the biosemiotics of life, but also the special anthroposemiosis of experimental science, and especially the use of models and organisms to study life processes.

Models of life

Pattee (1989) was emphatic about the distinction between a model of life and a realization of some life process. In the early phase of Artificial Life research, focus was put on the possibility of 'life in computers', and thus the question of computational simulations vs. realizations was crucial. Considering the possibility of a 'wet' bottom-up synthesis of other forms of life, we need to expand the kind of analysis given by Pattee to include not only the role of computational models in science in general and Artificial Life in particular, but also the very notion of a model in all its variety, and especially the notion of model organisms in biology. It is beyond the scope of this note to make any detailed analysis here, so in this final section only some hints will be given.

Let us make a preliminary, almost Borgesian classification of models in biology like the following.

Formal models and simulations. Highly relevant for 'software' Artificial Life. Such models are, for their theoretically relevant features, computational and medium-independent, and thus disembodied, and would hardly qualify as candidates for 'true' or 'genuine' life, from the point of view of organicism or biosemiotics. Semiotically, the map is not the territory; a model is not the real beast.

Mechanical and ICT-models. The paradigmatic example here are robots. Robots may provide good clues to study different aspects of animate embodiment, but again, if taken not as models (which they obviously may serve as) but as proclaimed real 'machine bodies' or 'animats', their ontology is a delicate one. They are build by (often ready-made) pieces of information and communication technology; they may realize a certain kind of 'machine semiosis' (Nöth 2003), but their form of embodiment is radically different from real animals (see also Ziemke 2003, Ziemke & Sharkey 2001).

Evolutionary models. This label collects a large class of dynamic models not only across the previous two categories (because they may be either computational or mechanical, cf. also the field of 'evolutionary robotics') but also combining evolutionary methods with real chemistries. Many sessions of previous Artificial Life conferences have been devoted to these models.

"Model organisms." The standard notion of a model here is to study a phenomenon, say regulation of cancer growth in humans, by investigating the same phenomenon in another but in some senses similar organism like the house mouse. In experimental biology, it has proved highly important to a fruitful research programme to choose 'the right organism for the right job'. Drosophila genetics is a well-known case in point. The lineage or population of model organisms is often deeply changed during the process of adapting it to do its job properly, and it is apt to talk about a peculiar co-evolution of this population and the laboratories using it in research. E.g., Kohler (1994) describes how Drosophila was introduced and physically redesigned for the use in genetic mapping and sees the lab as a special kind of ecological niche for a new artificial animal with a distinctive natural history.

"Stripping-down" models. A method of investigating the minimal degree of complexity of a living cell by removing more and more genetic material to see how few genes is really needed to keep autopoiesis going (cf. Rasmussen et al. 2004). The problem is, of course, as is well-known from parasitology, that the more simple the organism becomes, the more complex an environment is needed, so by adding more compounds to the environment, you can get along with fewer genes. The organism is always part of an organism-environment relation which makes any single measure for complexity such as genome size problematic.

Bottom-up models The term 'bottom-up' may be used for all three major areas of Artificial Life, in relation to 'software', 'hardware' and 'wet' models. Considering only the later here (e.g., Szostac et al. 2001), the crucial question is to distinguish between, on the one hand, a process aimed at by the researches which is truly bottom-up emergent, creating a new autonomous level of processes such as growth and self-reproduction pertaining to biofunctionality and biobodies, and on the other hand, something more similar to engineering a robot from pre-fabricated parts, that is, designing a functioning protocell but under such special conditions that one might question its exemplifying a genuine agent or organism. Just as exciting as they are as examples of advances in wet Artificial Life research, just as perplexing are they as possible candidates for synthetic true organisms, because their process of construction is highly designed by the research team. In this way, they are similar to the 'model organisms' in classical experimental biology, but with the crucial difference that no one doubts the later to be organisms, while it is question begging to proclaim the former to be.

The Life-Model entanglement problem

A special kind of hybridization is of interest here; the co-evolution of human researchers and a population of model organisms. As hinted at above, also in the case of wet Artificial Life systems, the 'real' life and the model of life gets entangled. This raises questions not only about sorting out, or 'purifying' as Latour (1991) would say, biosemiosis from anthroposemiosis to the extent that this is possible at all, but also considering more in detail the nature of the very entanglement. The hybridicity of human design 'top-down' and nature's open-ended, evolutionary 'design' bottom-up creates a set of complex phenomena that needs further critical study.

Conclusion

From an organicist perspective, real biological life involves complex part-whole relationships, not only regarding the structured network of organism-organs-cells relationships, but also regarding the environment-(Umwelt)-organism relations. The biosemiotic trend in organicism is needed to understand natural life (the plants and animals we already know) from a scientific perspective, but is not enough to evaluate the complex question of “what is life?” as recently raised by synthetic chemistry approaches to wet artificial life. Here, also more ontological, metaphysical, and philosophy of science (and scientific models) inspired considerations are needed. Some of these have been presented, other just hinted at.

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