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Thomas A. Sebeok Fellowship lecture[1]

Semiotics is a theory of life

Kalevi Kull

"It is important to realize that only living things and their inanimate extensions undergo semiosis, which thereby becomes uplifted as a necessary, if not sufficient, criterial attribute of life" (Sebeok 1994: 6). A statement as firm as this — the difference Sebeok makes — asks for attention. Moreover, both in biology and in semiotics, relating life to semiosis makes a big difference. Its role can be seen in the context of major paradigms in scientific approaches to living nature over the ages.

This lecture is about the semiotic approach in biology. In other words — about the role of semiotics for biology, or about a semiotic theory of life, a semiotic biology — *biosemiotics*.

Despite the fact that under any circumstances semiotics and biology would have found each other some day, sooner or later — because this is just a "necessity" of the development of human knowledge — despite this the whole story and the entire situation today would not be as it is without the work and role of Thomas A. Sebeok.

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One of Thomas Sebeok's aims was establishing biosemiotics as a branch of science, as an independent field of inquiry.[2]

In this respect it is interesting to note that, after his initial work in linguistics, Sebeok's interest turned towards semiotics and towards zoology approximately at the same time. In Sebeok's own words, "By 1962, I edged my way into animal communication studies. Two years after that, I first whiffled through what Gawin Ewart evocatively called 'the tulgey wood of semiotics'" (Sebeok 1986: ix; see also Kull 2003a: 50).

The intersection between semiotics and biology can be interpreted in two quite different ways.

Firstly, biosemiotics can be seen as a field that emerges in the periphery of general linguistics or communication science on the one hand, and of ethology on the other — thus covering a set of interdisciplinary problems arising in few cases when biology and semiotics intersect, for instance, when analyzing the signaling behavior of non-human animals. This is a view that can be applied when interpreting the early zoosemiotic works of Sebeok (1962; 1969).

Alternatively, biosemiotics is an approach to the whole living world, a semiotic biology, a field that has a scope and importance no less considerable than biology itself. This is a view espoused by Sebeok in most of his later works, at least since the late 1970s when he started to appraise Jakob von Uexküll's approach as one of a general semiotics.

The first type of biosemiotics, providing a complementary terminology for describing some biological phenomena, would leave the fundamentals of biology itself intact, as one more interpretation — particularly in a relatively small branch of research — need not refute an already established biological explanation.

The second type of biosemiotics, however, would aspire to replace the former biological theory.

At the same time, these different versions of understanding imply different roles for semiotics.

According to the first interpretation, biology is just one more area where a semiotic description can be applied, as to chemistry, or geology, or geography, or, for that matter, hydrology — we could have a semiotics

[2] See also Sebeok 2000: 83.

of water, for instance. If this is so, semiotics will be seen as quite independent of all these areas of its application.

According to the second type of biosemiotics, however, the theory of semiotics itself can be influenced by studies in the field of biology. This is the view of Thomas Sebeok when he states that “sign science and life science are coextensive”:

> By the thirteenth century, Thomas Aquinas had concluded that animals make use of signs, both natural and those founded on second nature, or custom. Virtually every major thinker about semiotic issues since, from Peirce to Morris to Thom, and, above all, Jakob von Uexküll, have reaffirmed and generalized this fact to encompass the totality of life. Only a stubborn but declining minority still believes that the province of semiotics is coextensive with the semantic universe known as human culture; but this is not, of course, to deny Eco’s dictum (1976: 22) that "the whole of culture *should* be studied as a communicative phenomenon based on signification systems." (Sebeok 1999: 392)

For me, the meaning of biosemiotics has always been the latter. That is, biosemiotics is, or should become, a theory of life, a theory of living systems. Which means that theoretical biology should be constructed as biosemiotics.

In what follows, I attempt to give a brief overview of some crucial concepts that constitute the core of semiotic biology as we know it today.

Biology before and after Modernism

A feasible way to characterize semiotic biology is by placing it in the context of the main periods in the history of biology.

According to a widespread approach, the most important date in the history of biology is 1859, the year of publication of Darwin’s *Origin of Species*. However, in a closer analysis, this date, though still important for the history of Modernism, would not be more than a secondary mark.[3] The main eras of biological thinking can be distinguished according to the

[3] E.g., see Foucault 1989; Kull 2003b.

basic or deep models used, i.e., the models that have organized and influenced most of the theories and interpretations of the periods in question.

The first two periods have been well described by Arthur Lovejoy in his book *The Great Chain of Being* (Lovejoy 1964 [1936]).

The Medieval concept of (living) nature can be characterized as a chain, or a *ladder*. The Medieval view was a holistic view according to which the creatures formed levels in a harmonious and perfect nature. The ladder started from minerals, and moved upwards to plants and worms and insects, to vertebrates and to humans and, possibly, angels. But this was in no case an evolutionary sequence — it was a division of a whole. Nature was seen as perfect and monsters belonged to another world.

The situation changed — i.e., the principal view of nature changed — in the 18th century with the Enlightenment. This can be illustrated by Voltaire's statement that nature can be imperfect, which means that *nature can be improved* — an idea that before the Enlightenment would have been absurd indeed.

The idea of improvement, simultaneously, introduced the possibility of a multiplicity of developmental paths. This is also a linear idea of time, and of progress. Structurally, this means that the model of the ladder was replaced by a model that could represent alternative branches and growth, that is — of the *tree*. As regards biological taxonomy, this meant Carl Linné's *Systema Naturae*. At the same time, evolutionary interpretations appeared, e.g., the one of Jean Baptiste Lamarck. The study of monsters — teratology — brought monsters into the surrounding world, and soon re-interpreted them as material for biological evolution. Thus, Darwin's theory appears as a peak of the dissemination of the tree-model of nature, adding the idea that, due to the lack of space, not all branches of a tree can survive, and thus harsh competition takes place between them, allowing a progress to occur as a result of competitive exclusion.

Monophyletism, and thus an interest in the problem of origin, has been another important feature of the tree model. Modernist biology has been studying the race of replicators.

A replacement of this model would mean claiming that (a) there is no such thing as progress in nature; instead, there are cycles and fluctuations; (b) there is no reason to presume a single root; instead there are possibly many beginnings; (c) branching and competition are not the basic processes; instead there are recognitions and symbiosis; (d) genealogies are neither chain-like, nor tree-like, but *web*-like.

This replacement of the tree model by a web model has been an issue mainly for the 20th century. Jakob von Uexküll was an early pioneer of the web model, but a peak occurred in the 1960s, when networks of communication were taken as a fundamental model in biology. This includes the development of network models in ecology (trophic web), biochemistry (metabolic network), and histology (neural networks).

Thus arises the concept of ecosystem, an ecological web on the one hand, and a communications network, a semiotic web on the other hand. Indeed, 1962 marks also the date when the word ‘biosemiotics’ was coined, and it was in the same decade that the ecological era started. And, I dare say, it is also a semiotic era. Postmodernism, in a deeper sense (Deely 2001), means that semiotics and ecology join hands.

The previous model — the tree — is still in use as the major one in mainstream biology up to this day, yet semiotic biology certainly belongs to a third period, the period of biological webs.

Remarks on the history of biosemiotics

A summary of the “story” of development of biosemiotics, as seen from the vantage point of today, would include several significant dates.

Since the year 2001, international annual conferences in biosemiotics have been held, called *Gatherings in Biosemiotics*, initiated by the Copenhagen and Tartu biosemiotic groups.[4] This is an independent series of regular meetings in the field. Before 2001 most of the symposiums in biosemiotics were organized as sessions under the auspices of some larger semiotic meetings. It is also noticeable that since 1990s, many (if not most) larger semiotic meetings have included a session (or several) on biosemiotics, which indicates that semiotics has recognized biosemiotics as a regular sub-field. In biology proper, this process is only starting. Among the few gatherings in biology that have included sessions on

[4] These have taken place in Copenhagen (2001, 2003), Tartu (2002), and Prague (2004). Materials of the first ‘Gatherings in Biosemiotics’ have been published in *Sign Systems Studies* 30(1), 2002.

biosemiotics, are notably the biannual meetings of the International Society for History, Philosophy and Social Studies in Biology.[5]

The decade around 2000 has also been significant as concerns biosemiotic publications. Several special issues of journals have been devoted to biosemiotics — *Semiotica* 120(3/4), 127(1/4), 134(1/4), *Sign Systems Studies* 30(1), *Cybernetics and Human Knowing* 10(1), *European Journal for Semiotic Studies* 9(2), etc. Several books have been published, notably Hoffmeyer (1996), Merrell (1996), Deacon (1997), Barbieri (2001), Sebeok (2001a), Emmeche *et al*. (2002), Markoš (2002), Martinelli (2002), Neuman (2003), Weber (2003), Schult (2004).

Before that, 1992 was an important date as the year of the Glottertal symposium in which the biosemiotic group was established.[6]

In 1978, the conference "Biology and linguistics" took place in Tartu.

In the epilogue to the final volume of *Towards a Theoretical Biology*, published in 1972, Conrad Hal Waddington reached a fascinating conclusion: "it is language […] that I suggest may become a paradigm for the theory of General Biology" (Waddington 1972: 289; Kull 2000b).

1963 — T. Sebeok wrote about zoosemiotics, and Roman Jakobson about the linguistic aspects of genetic code.
1962 — F. S. Rothschild used the term 'biosemiotic' (Rothschild 1962; Kull 1999b).
1940 — Jakob von Uexküll's *Bedeutungslehre* was published.
1920 — The first edition of J. v. Uexküll's *Theoretische Biologie* appeared.

In 1864, the founder of embryology, a major biologist of the 19th century Europe, Karl Ernst von Baer, published his presidential address to the Entomological Society of Russia — "Welche Auffassung der lebende Natur is die Richtige? Und wie ist diese Auffassung auf die Entomologie anzuwenden?" ("What is the correct understanding of living nature? And how should it be applied in entomology"). Two important issues emerging in that paper were the introduction of the concept of the ecological web, and an analysis of biological, subjective time in non-

[5] For example, the one in Vienna, 2003, included four sessions on biosemiotics, under slightly different titles.
[6] For reminiscences of this meeting, see Emmeche et al. (2002: 53); Hoffmeyer 2002.

human animals. This served very much as a predecessor of Uexküll's concept of *Umwelt*.

In the 1830s the physiologist Johannes Müller, of the University of Berlin, introduced the concept of specific sensory energies, stating that "the modality of sensation depends in an immediate manner only upon what region of the central organ is put into a corresponding excited state, independent of the external causes bringing about the excitation" (Schlick 1977: 165), or, according to a formulation of Uexküll (1931: 209), "a living cell has its own self-tone".[7]

What is this new biology going to look like? What are the phenomena or processes that we will explain in a different way when taking a biosemiotic point of view into account?

I will try to illustrate this by describing some simple, yet crucial, concepts: recognition, categorization, codes, evolution, sign systems. Using these terms in their semiotic interpretation, we may both provide a general language of description for the living sphere, and introduce the field of biosemiotics.

Recognition

What is 'recognition' in organisms? In case of lifeless interactions, if a certain kind of thing reacts in some way with things of one type and does not react with things of another type, we can describe this using the terms 'fitting', 'affinity', 'reactive'. When using the term 'recognition' we usually assume a little more — a comparison with, and resemblance of an already existing model. The main feature of recognition (as different from lifeless interaction) consists in the development of the system to fit a certain form, and to remember this. This is precisely the meaning of the biological term 'adapted'. Living systems develop habits and if the organic form is capable of developing, then it is obvious that among living (biological) interactions we may find very complex forms indeed. Thus, the main difference between the living and non-living (semiotic and physical) interactions is that those which are alive can use their

[7] A more detailed timeline of biosemiotics can be found in Kull 1999a, and the early history in Sebeok 2001b.

history to fit in better, whereas the lifeless ones have no such mechanism to improve themselves.

Taking chemical reactions as an example, we see that in the case of inorganic compounds a molecule fits to its reactant, but in case of enzymes it recognizes its substrate. The enzyme has its history or evolution and inheritance, which is not the case with inorganic compounds.[8]

Thus, 'recognition' is not just a match of molecules — it is, at the same time, something else; recognition means that the individual form of an agent signifies.

This is so because the individual form of a recognizing agent cannot be deduced, i.e. calculated, on the basis of universal laws of physics and chemistry, as this form is purely individual due to a local history, due to a process similar to learning.

An interesting issue to note here concerns the nomenclature of chemical molecules. In inorganic as well as organic chemistry, the naming of substances corresponds to the differences in the structure of the molecules — in order to identify the name, one has to establish the structure. A remarkable fact is that the situation is radically different in case of enzymes. Establishing an enzyme's structure does not allow us, generally, to identify its name. Why so, and how can the name of an enzyme molecule be identified?

The whole classification of enzymes is based not on the structure of these molecules, but on the functions these molecules fulfill in a living organism.

Enzymes with quite different structures may catalyze the same reaction, and enzymes with very similar structures may catalyze different reactions. Thus, the fact is that even when we know the structure of a particular enzyme, there is still no way of calculating what it does. In case of inorganic molecules, or simple organic molecules, this is usually quite possible to do so, whereas in case of enzymes this is almost never the case.

The only way to establish an enzyme's function is to look at what it does in a living organism, in its real context.

This situation with enzymes resembles the situation with gestures or words. There is no way to calculate the meaning of an unknown word

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[8] More details in Kull (1992: 223).

from the sequence of phonemes, for these things are unrelated. We can just observe what a word does in a language situation, or, also, pose hypotheses about its meaning on the basis of etymological studies. This is exactly what we can do with enzymes as well, no more.

Therefore, the relationship between the structure and function of enzymes is somewhat conventional, and M. Barbieri (2001) has even called this the 'natural convention'.

Categorization

Categorization is a general semiotic process that occurs together with recognition.

Namely, if there is a system of interactions between many recognizing agents, then reciprocal recognition takes place. Reciprocal recognition in turn inevitably leads to the formation of discrete systems, discrete groups.

Proceeding from the phenomenon of perceptual categorization (Stjernfelt 1992), we may apply to such formation of discrete systems — the discretization as a result of reciprocal recognizing interaction — the term 'categorization'.

This is also how order is created in the biosphere (as well as the semiosphere) — via categorization which categorizes individually different things in one and the same category of objects (Emmeche *et al*. 2002: 23).

Each recognizing agent (either an enzyme, or a cell, or any organism) has its individual recognition window(s) that distinguish between the suitable and the non-suitable.

In a community of such agents, each of which has its individual *recognition window*, the recognition processes — which make up a type of communication — automatically lead to a more stable situation, which is characterized by the formation of distinct types of agents. The only general precondition for this to take place is the inevitable use of the process of recognition for the further existence (and re-building) of the agents.

This is a mechanism that can explain why there are species in the living world.

The nature of biological species has been a complicated subject in biology for a long time.

The biosemiotic explanation states that biological species are an inevitable result of biparental reproduction, which, commonly, implies sexual communication.

This means — species are not natural kinds, in the same way as linguistic objects are not natural kinds.

To analyze this semiosic approach to species in detail is a separate and most fascinating topic. The concept was developed initially by entomologist Hugh Paterson (1993), who has called it the 'recognition concept of species'.

Thus, it can be claimed here that the existence of biological species is an emergent phenomenon that accompanies reproductive communication. And it should be added that this does not concern only species. Almost all the specific objects of biology — also colonies, swarms, tissues, and even organisms themselves, are communicative structures. That is, they are not built on the basis of universal internal determination as are non-living physical objects, but on the basis of local indeterminate communication.

For instance, tissues: epithelial, muscular, neural, etc. — dozens of types of cell communities — are formed only through intercellular communication. If — experimentally — communication between the cells is prevented, the differences between tissues start to disappear, a "de-differentiation" will take place. This is what occurs, for instance, in the case of cancer.

In a similar vein, if there were no sexual processes, the species would start to fuse. This is well-documented, for instance, in the case of apomictic groups in plants (for instance, genera like *Hieracium*, *Alchemilla*).

We come close here to the general problem of identity, including that arising in human cultures.

Another fascinating issue in categorization is space, for categorization is always a spatial process that requires some substrate in order for it to take place. Organic diversity — either in the brain or in a landscape — requires space.

Codes

A code is a conventional, or habit-based correspondence between the elements in one domain and the elements in another domain; a code is an arbitrary correspondence.

In other words — a code is a correspondence that cannot be deduced from the general physico-chemical laws.

Codes appear between categories, between categorized communities.

What was discovered by J. Watson and F. Crick — the structure of DNA, the correspondence between its two strands — is not a code, whereas the correspondence between the nucleotide triplets and aminoacids, as discovered in the 1960s, is a code — the genetic code.

There exist, of course, many more codes in all organisms, in addition to the genetic one.

M. Barbieri (2001) shows that there are several codified assemblies in the multi-step sequence of epigenetic processes. According to his characterization, each code connects two independent worlds, and "adds meaning to information". As examples, he gives some details of the RNA splicing codes and the cellular signal transduction codes. Other codes noted include the signal integration codes, apoptosis codes, cell migration codes, cytoskeleton codes, etc. He also specifies several organic memories, e.g., the epigenetic cell memory of determination. Thus, it appears possible to describe the body plan as a supracellular memory, the body's memory (Barbieri 2001: 202).

The evolution of coding rules means the evolution of natural conventions, as can be concluded from the general concept of code. Accordingly, "to the classical concept of evolution by genetic drift and by natural selection, we must add therefore the concept of evolution by natural conventions" (Barbieri 2001: 153).

It is also important to notice that *Umwelt*, as well as the functional cycle as described by Uexküll, is based on code relationships. Uexküll distinguishes between *Merkzeichen* and *Wirkzeichen* — signs of perception and signs of action. These are the categories in two domains of an organism. And these are connected by a certain code which creates a correspondence between perception and action.

Evolution

The biosemiotic approach to biological evolution differs quite radically from the classical neo-Darwinian one. This is apparent both in the importance or role of an evolutionary explanation in science, and in the understanding of the principal mechanisms of evolution.

Here, the basic assumption is that the genome, as well as the environment, are subjects for interpretation by the organism. An organism and its cells, are like readers that can interpret one and the same structure in several or even many different ways – a genome cannot fully determine how it will be interpreted. With this in mind, it will be possible to see some interesting ways for evolutionary change, rarely analyzed in non-semiotic biology.

In particular, this concerns the interpretation of the Baldwin effect, i.e. the enhancing role of individual learning abilities regarding evolution. This also applies to the possibility of collective transformations in evolution becoming more understandable in the light of semiotic theory of evolution.

Since the discussion of the biosemiotic mechanisms of evolution would require that more technical details be introduced here, let me here just refer to relevant literature (Hoffmeyer, Kull 2003; Jablonka et al. 1998; Kull 1992; 2000a; Markoš, 2002; Paterson 1993; Sebeok 1962). However, our brevity in this respect has a further reason — the evolutionary aspect is actually not so important for understanding either the principal functional features or the diversity of life. Evolution can be seen as a side effect of living processes — evolution occurs because of the type of stability that the categories and codes have. The stability of living systems is local, thus the various hereditary changes cannot be entirely avoided. But these changes, as well as evolution itself, are not necessary for life to last and continue.

Sign systems

If we define biosemiotics through its aim "to extend the notions of general semiotics to encompass the study of semiosis and modeling in all species" (Sebeok, Danesi 2000: 15), then this presumes a view of a certain fundamental similarity of semiosis throughout all life forms. However, the inclusion of all life in the semiosphere also emphasizes the principal differences between the life forms that should be described and re-interpreted on a semiotic basis. This means that biosemiotics provides a way to study and describe the semiotic threshold between human language and other sign systems, as well as the possible additional semiotic thresholds between animal and non-animal semiosis.

Thus, we can distinguish between four levels of sign systems.

> (I) Cellular sign systems. These are the sign systems of any bacterial cell. Their characteristic processes are enzymatic recognition and membrane reactions. Their inheritance system combines the epigenetic and genetic memory. As described, e.g., by T. v. Uexküll (1985: 104–106), the cell has no *Umwelt*, but dwelling integument (*Wohnhülle*). It is characterized by microsemiosis. According to Yates (1997: 458), microsemiosis 'does not address communication between cells or among cell complexes' — i.e., microsemiosis forms the intracellular semiotic sphere.
> (II) Vegetative sign systems. These include the communication between the tissues in multicellular organism. It is the system that is responsible for the genesis of multicellular biological form, the whole morphology of the body, and also the production of tissues (Ingensiep 1999; 2001; Kull 2000c). The basic inheritance system here is epigenetic. Its typical representatives are morphogenesis and cell differentiation. In this sense, vegetative sign systems are not confined to plants — they occur in all multicellular organisms.
> (III) Animal sign systems. These are the senso-neuro-muscular systems, the ones that are responsible for the behavior of a motile animal organism. The basic inheritance system, here, is neuro-humoral (or behavioral, according to Jablonka *et al*. 1998). A characteristic feature of animal sign systems is the existence of complex *Umwelt*.
> (IV) Linguistic sign systems. Unlike the animal sign system, these include syntactic signs (Bickerton 1990), and are principally symbolic (Deacon 1997). Their characteristic feature is the existence of propositions, which provide exceptional combinatorial abilities. Other characteristic features include the production of artistic, ideological, ethical, etc. structures.

A history of this typology goes back, for instance, to the classical distinction between *anima vegetativa*, *anima sensitiva*, and *anima rationale*. Already the doctrine of Thomas Aquinas included the view that in the first stage of embryonic development, the vital principle has merely vegetative powers; then a sensitive soul comes into being, and still later this is replaced by the perfect rational soul. Thus, the whole story of the semiotic phenomena of all organisms is very much reminiscent of an old discussion, in which some scholars assigned some sort of soul, an *anima vegetativa*, to plants, whereas others thought that soul is related to consciousness.

Semiotics is a study of diversity. The application of the concept of semiosis across all living species requires a clear understanding of differences between types of semiosis, which in its turn involves a more profound understanding of what a sign is, and what life is.[9]

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