From Umwelt to Mitwelt: Natural laws versus rule-governed sign-mediated Interactions (rsi’s)

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Abstract

Within the last decade, thousands of studies have described communication processes in and between organisms. Pragmatic philosophy of biology views communication processes as rule-governed sign-mediated interactions (rsi’s). As sign-using individuals exhibit a relationship to following or not-following these rules, the rsi’s of living individuals differ fundamentally from cause-and-effect reactions with and between non-living matter, which exclusively underlie natural laws. Umwelt thus becomes a term in investigating physiological influences on organisms that are not components of rsi’s. Mitwelt is a term for the investigation of all rsi’s of organisms. Living organisms are never solus ipse subjects of semioses, but share common sets of rules and signs. Life depends decisively on symbiotic communities. Serial Endosymbiotic Theory proved that evolution of higher eukaryotic superkingdom was a merger of ancestral bacteria. The integration of bacterial genomes into eukaryotic genomes was also a step from analog to symbolic genetic codes. Now we know, that so-called “junk”-DNA” has higher order regulatory functions on genome architecture and protein coding DNA plays only the role of a structural vocabulary.

Keywords: Mitwelt; epigenetic apriori; symbiotic interdependence; geMetaCode.

1. The supplement of the Umwelt-concept with a Mitwelt-concept

Within the last decade, the tendency to describe interactions in and between organisms as communication processes has continued to grow. Intra- und interorganismic communication is supplemented by metaorganismic communication that is between members of different species, genera and organismic kingdoms. Exploding research in the field of symbioses proved, that in fact life on our planet is entirely dependent upon functioning symbiotic interaction communities (Zook 1998, Kowallik 1999, Wagner et al. 1999). A pragmatic philosophy of biology and a three-leveled biosemiotics found and justify communication processes as rule-governed sign-mediated interactions (Witzany 1993 a, b, 1995, 2002 a, b, 2005 in press). Sign use by interaction partners simultaneously obeys syntactic, semantic and pragmatic rules in principle (Witzany 2005 a, in press).
The conditions on the planet's surface without living organisms are determined entirely by the sun's energy and the laws of physics and chemistry (Margulis 1999). A planet with living organisms, i.e. with biosemiotic processes deviates considerably from this scheme. The gas composition and temperature will vary in a manner that cannot be predicted exclusively by the laws of physics and chemistry alone. Such a planet contains incompatible gas mixtures and temperatures whose relatively stable balance is actively controlled by organisms.

The interaction between organisms and matter is one in which organisms interpret and structure their abiotic environment according to biological principles. The relationship to other organisms is a communicative one: their mutual behavior underlies changeable rules, within the frame of natural laws, more precisely (semiotic) rules of sign use with which the biological individuals interact, i.e. coordinate and organize. The difference is that organisms cannot develop such a "to follow or not follow"- relationship with natural laws, but underlie them in the strict sense.

The Umwelt concept cannot do justice to the fundamental differences between natural laws and rsi’s because this concept reduces rsi’s to the information transmission effect and therefore to a level of coding and decoding via an individual organism’s physiological sensory organ. The intersubjective-communicative character of the rsi’s, and therefore the relationship to following or not-following commonly shared rules of sign-use, does not manifest itself here.

In investigating communication processes in and between organisms, it is therefore sensible to supplement the Umwelt concept with a Mitwelt concept (Witzany 2005 in press). The Mitwelt concept underlines the difference between the cause-and-effect reactions in natural laws and rsi’s: Umwelt thus becomes a helpful term in investigating those physiological influences on organisms that are not components of rsi’s. Mitwelt is a term for the integrative investigation of all rsi’s of organisms, i.e. all intra-, inter- and metaorganismic communication processes themselves and their developmental history.

For example, plants maintain two types of membrane domains that resemble the neuronal and immunological synapses of animal cells (Baluska et al. 2005). The first one transports Auxin and allows the highly plastic development of plants. The activity of this developmental plant synapse is modulated by two physical factors, light and gravity. The developmental plant synapse assembles those molecules of non-living matter which are necessary to structure the plants non-biological environment according to biological principles, i.e. molecules become features of signs for an interpreting organism. There, the Umwelt term is useful in describing how organisms develop themselves by metabolising within natural laws.

Figure 1. "Immunological plant synapses for cell-to-cell communication between plant host cells and their pathogens, parasites and symbionts. (a) Closely apposed plasma membranes of intruder and host cell during a penetration attempt. If the host cell succeeds in effectively forming a papilla then this synaptic cell-to-cell communication is terminated. (b) Alternatively, the intruder might penetrate deeply into the host plant cells and then immunological plant synapses support haustorial complexes and mycorrhizal arbuscules. (c) During the initiation of a Rhizobia–plant symbiosis, bacteria organize infection threads, the tips of which represent immunological plant synapses specialized for transporting bacteria deeply into root tissues." (figure 1 and text in Baluska et al. 2005: 108).

A limited number of chemical messenger substances is available to maintain and simultaneously conduct the communication between (a) root cells of three different types, (b) root cells and microorganisms, (c) root cells and fungi and (d) root cells and insects (Bais et al. 2004, Callaway 2002, Dessaux 2004, Dunn and Handelsman 2002, Teplitski et al. 2000, Walker 2003, Fleming 2005). The communication process in the root zone is generally intra-, inter- and metaorganismic and requires a high communicative competence in order to be successfully interactive on all three levels and to distinguish messenger molecules from "noise" (Federle and Bassler 2003, Hirsch et al. 2003, Sharma et al. 2003). Here, the *Mitwelt* term is useful: its objects are primarily rule-governed sign-mediated interactions, which depend on coherence of signs and three-leveled rules and not on natural laws alone.
2. The epigenetic a priori of semioses

As in the case of semiotics, also biosemiotics depends on the a priori of bodies, i.e. living organisms: without living organisms there are no intra- inter and metagenomic semioses, transcription, translation, copying, coding, splicing, i.e. the whole complexity of semiotic processes. Rule-governed sign-mediated interactions depend on living bodies in principle. Living bodies are the epigenetic a priori of semioses. Only in rare exceptions living bodies are monads, but they are in any case involved in a commonly shared rule-constituted genetic set up with their descendants.

If signs are used by humans, there is according to Peirce, a non-reducible three leveled relationship between (1) the sign-user/sign-interpreter and (2) the signs which designate (3) (some)thing. According to Morris the relationship: (a) between sign-user/sign-interpreter and signs is subject to pragmatic rules, (b) between signs and the designated (some)thing is subject to semantic rules (c) between signs and signs is subject to syntactic rules. According to Wittgenstein (Philosophical Investigations) rule obeying sign-users/interpreters are never solus ipse subjects (as with Descartes, Kant, Hegel, Husserl, Carnap, Frege, Russel, Tarski, Popper) but always performative participants of communicating communities. Using/interpreting signs is social interacting. Monological acting is an exceptional case.

Therefore, semiotics as well as biosemiotics are really social sciences (Witzany 2005 b). Their research is directed towards signs, their use, their meaning, their syntactic combinations (Noeth 2000, Kull 2005). Because one sign alone is not a sign and without a sign-using community there is neither meaning, nor interpretation or linguistic action, i.e. active sign use, the social component is the decisive one. In (language-game-) Wittgenstein it is the analysis of obeying rules, in Peirce it is the "ultimate opinion of an indefinite community of investigators" which refutes the solus ipse subject of knowledge of Descartes and Kant in principle. It is never the role of an interpreter, because "the interpreter" as solus ipse subject doesn’t exist (Witzany 2005 b). Interpreting is a social action, and the “interpretant” is the commonly shared background knowledge of a historically evolved linguistic community.

From this point of reflection we can describe sign use in non-human nature also. But not from a monological solus ipse perspective as a cognitive simulation of an (quasi-) extraterrestrial observer, but with the knowledge that living bodies are involved in social lifeworlds which depend on social lifeworlds of (a) the same and parallel (b) other organismic kingdoms. All living organisms of the eukaryotic superkingdom depend decisively on functioning symbioses with microbial social lifeworlds. In examining the cells of the human body, 10% stem from the human individual and up to 90% are symbiotic microorganisms (Blech 2000).

3. Evolution of the eukaryotic superkingdom by genomic integration

Another example applying the Mitwelt-concept is the Serial Endosymbiotic Theory. The SET is so revolutionary because it reversed the evolution vector from ramification to unification. Eukaryotic cells, according to Margulis, are the result of merging several different ancestor genomes, that of (1) thermoplasmic archaeabacteria with (2) motile spirochaeta-like eubacteria. This was followed by a merging with (3) aerobic organisms. The final step was the merging with (4) photosynthetic bacteria. One integrated genome
was sufficient in the merger of archae- and eubacterium. In the proteotista two integrated genomes were necessary, in the fungi three, in animals at least four, and in the plant kingdom (350 million years ago) at least five. (Margulis 1996, 1999, 2004, Margulis and Schwartz 1988, Margulis et al. 2000, Margulis and Sagan 2002, Cavalier-Smith 2002, Stechmann and Cavalier-Smith 2003).

From the biosemiotic point of view this symbiogenetic process was a change from metaorganismic communication, i.e. rsi’s between two individuals who lived in symbiosis, to an intraorganismic communication process. In the latter, two different genomes integrated into one at the correct sequences, at the correct genome ratio, (i.e. the genome architecture). It had to involve a correct integration of entire gene-blocks.

The SET demonstrates that complex genomic make-ups can be passed on directly and not through step-by-step development via chance mutations (Witzany 2005 in press). One scenario of how this integration process of two different genomes could take place can be imagined by the phenomenon of horizontal gene transfer (Wagner et al. 1999, Wolf 1999, 2000, Jain et al. 1999, 2003, Xie et al. 2004, Timmis et al. 2004). As suggested (Witzany 2005 a, b, in press) these horizontal gene transfer processes are not changes in aggregate status solely but undoubtable biosemiotic ones: They are highly competent DNA textprocessing procedures. Thomas and Nielsen identified 17 steps of integration performance (see Fig. 2).

The DNA transfer between prokaryote cells include transformation, transduction and conjugation which depend on certain mobile genetic elements such as plasmids, bacteriophages and transposons. In this processes that agents are the ‘natural genetic engineers’ (Frost et al. 2005).

4. Analog — symbolic (prokaryotic genome - eukaryotic genome)

The step from prokaryotic to eukaryotic cells and the recombination of up to 5 different genomes into one, as occurred in the evolution of plant cells was also the step from a nearly complete analog protein-coding DNA to a genome architecture of analog and increasingly symbolic sequences (Witzany 2005 b). As higher-developed eukaryotic multicellular organisms show, this analog/symbolic-ratio changed into a proportion in humans, for example, of 3 percent protein-coding DNA (which is nearly identical to that of mice, namely 99 percent) and 97 percent non-protein-coding DNA.

Ten years ago this non-protein-coding DNA was not the center of research interests and therefore named "junk"-DNA. While there is no relation between the complexity of organisms and the quantity of protein-coding DNA, but an obvious relation between complexity of organisms and non-protein-coding DNA, this "junk"-DNA became interesting. It does not code for proteins but for RNAs especially for a type of micro-RNAs (Cavalier-Smith and Beaton 1999, Mattick 2001, Mattick and Gagen 2001, Mattick 2003, Mattick 2005, Shapiro and Sternberg 2005). These micro-RNAs are as competent as proteins in DNA/RNA-editing. Some may term this discrete structure of eukaryotic DNA (that doesn't indicate analogous for what it codes) digital (Emmeche and Hoffmeyer 2005). But this information theoretical description is a more or less technical term, whereas "symbolic" is a better description for the phenomena as such (Cvrcková and Markos 2005, Witzany 2005 in press).
Some of the discovered tasks of these micro-RNAs are co-suppression, suppression of transposition, position effect variegation, start-stop signals, RNA interference, imprinting, chromosomal methylation, transvection, transscriptional and posttranscriptional gene silencing along with numerous other RNA-DNA, RNA-RNA (trans-acting RNAs),
RNA-protein interactions (Mattick and Gagen 2001). Today we may say, that cellular differentiation and phenotypic variation results primarily from variations in this high-order regulation, not in the proteins themselves, thus non-protein-coding DNA bears the architecture of eukaryotic complexity (Mattick 2001).

5. Structural (protein-code-) vocabulary and its higher-order regulation

The phenotypic variation in complex organisms is then the result of a different use of a set of protein-coding core components. We can say that in higher eukaryotic organisms we find 3 percent protein-coding DNA as the structural vocabulary and 97 percent non-protein-coding DNA which has higher-order regulatory and constitutional functions that are decisive for expression, differentiation, development, (i.e. coordinated expression in time). I postulated these higher order regulatory and constituting functions as a consequence of the pragmatic philosophy of biology approach already in 1993 and in a further developed version in 2000 in terms like "innovation-code, text-generating-code, evolution-code" (Witzany 1993 b, 1997, 2000).

In an article in S.E.E.D. Journal (Witzany 2005 b), I put it in concrete as the genome-editing MetaCode. This non-protein coding geMetaCode has regulatory and constituting functions in chromosomal methylation. These functions decide about different signalling pathways of the same genetic setups through different rules of gene silencing and special start and stops via alternative splicing. With this chromosomal methylation, organisms are able to handle "multiple protein meanings" (Ast 2005) of the same genetic dataset. As shown by some epigeneticists, these (geMetaCode-) functions are influenced and altered by environmental and other influences which are heritable but do not involve or depend on mutations of the DNA itself (Jenuwein and Allis 2001, Spot-wood and Turner 2002, Sternberg 2002, Turner 2000, 2002, Jaenisch and Bird 2003, True et al. 2004, Wang et al. 2004, Waterland and Jirtle 2004).

The proposed geMetaCode integrates the features of (1) non-protein-coding DNA, (2) DNA which codes alternatively for (micro)RNAs and proteins, which depends on situational contexts and (3) the protein-coding DNA. This enables the (epigenetic) body and genome to interact in time over the whole lifetime, in the expression pathways of early development, the body axis, extremities, up until the adult individual. Or, as in plants, the never-ending growth and development (Trewavas 2001, 2003, 2005) based on one and the same protein coding vocabulary. The latter is used depending on the developmental context as epigenetic orientation of the plants, and therefore by the non-protein-coding regulatory, constitutional and generating functions of geMetaCode.

6. Genetic backup insurance against mutational faults

Plants can overwrite their genetic code they inherited from their parents and revert to that of their grand or great-grandparents (Lolle et al. 2005, Weigel and Juergens 2005, Pearson 2005). This contradicts traditional DNA-textbook conviction that children simply receive combinations of the genes carried by their parents. Now a backup code was found that can bypass unhealthy sequences inherited from the parents and revert to
the healthier sequences possessed by their grandparents or great-grandparents. As shown by a research team plants are able to replace abnormal code sequences of their parents with the regular code possessed by earlier generations.

Is it therefore necessary that not only the genetic set up of the parents is inherited but also that of the grand-parents and former ancestors? What is proposed is that higher order regulating micro RNAs - which function as expressions of geMetaCode - inscribe ancestor genome structures, which overrule protein-coding DNA under certain circumstances like stress. Such stress situations that could be dangerous for survival, could trigger plants to revert to the genetic setup of their ancestors which perhaps is more competent to deal with this circumstances than that of their parents.

It means that (pragmatic) situational context of a living plant body (neuronal, hormonal, inflammatory, immune) stress, for example, may induce epigenetic intervention on geMetaCode, i.e. active micro-RNA's activate a certain signalling pathway network which is able to restructure semantics of a genetic setup. By initiating methylation- and histone- modifications, certain silencings, start and stops, alternative splicing processes constitute alternative sequences, so that in existing genome architecture not the inherited parental sequences are translated and transcribed but the backup copy of grand or great-grandparents.

Under normal conditions genetic set up is in use which stem from the parents. These research results are indications that not only a combination of parental genes is inherited but also ancestral genome-regulating features in "non-coding" DNA, which enables alternative splicing pathways, i.e. a different use and multiple protein meanings of one and the same genetic data set (Lolle et al. 2005, Weigel and Juergens 2005, Pearson 2005).

7. Conclusions

This contribution could be an approach to resolve the contradiction of Neodarwinism and Neolamarckism: The protein-coding DNA is not subject to evolutionary remodifications that lead to new abilities or new organisms, but is subject to chance mutations which can alter existing genotypes. The non-protein coding DNA, with its higher-order regulatory functions is subject to evolutionary remodifications that are heritable but also reversible and that regulate the structural vocabulary of protein-coding DNA. The geMetaCode is subject of encoding acquired abilities i.e. to higher-order regulatory and constitutional functions, which may reorganize and generate new and altered genotypes with phenotypic consequences by alternative use of one and the same protein-coding DNA.
Note

1. The „indefinite community of investigators“ of Peirce doesn’t resolve the discrepancy between scientific languages and everyday language as the ultimate Meta-language. Only the pragmatic action theory was able to found and justify rule-governed sign-mediated interactions as the a priori of the intersubjectiv-communicative character of thought, research, progress of knowledge and everyday language. In difference to Peirce the pragmatic action theory doesn’t focus on the interpreter of signs in a process of interpretation, but on the preconditions for his ability to interpret, i.e. his a priori reliance on a social lifeworld which was the basis for his learning to speak and to act communicatively. In my opinion James Royce with his „community of interpretation“ followed by George Herbert Mead and his „community of universal discourse“ where more radical in reaching a post-Kantian (communicative) subject of knowledge.

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