

G. Van de Vijver, S. N. Salthe, M. Delpo (eds.), *Evolutionary Systems, Biological and Epistemological Perspectives on Selection and Self-Organization*. Dordrecht : Kluwer Academic Publishers, 1998, 438 pp.

This volume is the result of the International Seminar on Evolutionary Systems in Vienna, held in 1995 and contains a collection of twenty-nine contributions. Some authors should be well-known even to those not really acquainted with the subject. From the beginning, this book draws our attention because it does not only provide the reader with different accounts of self-organisation in evolutionary systems theory, but also considers at length the debate on the relation between self-organisation and selection in evolutionary thinking. Self-organisation and selection are examined as possible explanatory principles, and insights of both theories are combined and confronted. The viewpoint that the evolution of living systems can be accounted for merely in terms of variation and natural selection is severely questioned. Evolutionary systems theory wants to show how the internal and material structure and development of an organism and its developmental dynamics must necessarily be taken into account in order to obtain an adequate description of the evolution of biological systems. One of the major questions is whether the classical evolutionary viewpoint has to be complemented or rather substituted by evolutionary systems theory. The role played by selection and self-organisation is to be examined.

Some general issues, which the classical evolutionary picture fails to account for, are the following. Firstly, while fine-tuning or the local adaptation of an organism to its environment is sufficiently explained by the modern synthesis, the large-scale biological order seems to require another approach in which the issue of similarity in evolutionary change is a core problem. Secondly, development has to be thought of in terms of its concrete material principles. Thirdly, the origin of the living and the general processes of organisation related to it should not be put aside. «A theory of evolution that starts from the existence of living beings and black-boxes their origin, their internal structures and material development, can never be an adequate theory of evolution.» (p. ix)

The reader who wants to get through the numerous contributions, will certainly be rewarded, but will have to do an effort. The preface is a short and useful introductory guide to start the reading, as well as the two introductory papers respectively by Csányi and Salthe, in which the

insufficient to explain convergent evolution and the restricted variety of living forms, Csányi asks how the metaphor of evolution as the history of the whole biosphere can become a scientific model. According to Csányi, the classic metaphor of Darwinism, i.e. evolution as a transformation of lineages, has to be turned upside down if we realise that the most important elements in the environment of a given species are other living species. Therefore, one of the major questions is why and how the *environment* has changed, and not only how a changed environment formed some species. Csányi claims that what we need is a system model, in which the selective forces are not external agents, but themselves part of the internal, larger structure. In short, the organisation and self-evolution of the whole biosphere is the issue at stake. But how then can evolution be modelled if the whole itself is changing, or what drives the whole to change? According to Csányi, the creativity of the whole is the consequence of 'hidden properties' of the parts of the system. This interpretation does not need any external agents. The evolution of the whole moves toward individuality and stability. Csányi concludes that "Therefore in the final model the metaphor of evolution turns into stability and unchangeability of existence. With this the evolution metaphor turns into its own negation." (p. 11)

The remaining papers are divided into four parts. The first two parts deal with biological topics, respectively the debate between self-organisation and selection, and thermodynamical, information theoretical and mathematical perspectives on development and evolution. The two last parts enter into epistemological issues, respectively the notions of causality and explanation, and the semiotic approach to natural systems. Four contributions, one out of each part, are presented here.

In the debate between self-organisation and selection, Michael Conrad deals with the 'evolution friendliness' of biological systems, as opposed to computer programs. He claims that self-organising, non-programmable dynamics are a prerequisite for evolution friendliness and that the latter precisely is the result of the evolutionary process, or briefly evolution facilitates itself. Therefore, self-organisation and evolutionary adaptability go together. "In order for a system to have a high degree of evolutionary adaptability (through variation and selection) it must have a high capacity for self-organization based on the interactions among its components. In order for a system to develop such a high capacity for physical self-organization it must have a high degree of evolutionary

adaptability.” (p. 33) In contrast to biological systems, computer programs are fragile. This means that single alterations in the program structure do not produce acceptable computational functions. Therefore, without self-organising properties, the program fails the basic requirement for evolution to occur (on an acceptable time scale). Biological systems have self-organising dynamics, which makes them a lot less sensitive to structural variations than computer programs. For biological systems to evolve, particular genetic variations must not be required to occur simultaneously if evolution is to take place on an acceptable time scale. Biological systems have the property of having mutation-buffering redundancies. This means that redundant components and several weak interactions can buffer the effect of genetic variations on critical aspects (of form and functions), in such a way that the number of feasible pathways for evolutionary development increases.

What now is Conrad’s message? In his view, reproduction, variation and selection on the one hand and the material organisation on the other hand are inseparable. “The idea that variation and selection can mold passive systems to produce arbitrary biological forms and functions is incompatible with the manifest fact that biological organizations are not passive, with the fact that passive systems are too fragile to exhibit evolutionary transformations at all comparable to those that occur in biology, and incompatible with classification (which reflects homomorphisms).” (p. 42) However, Conrad does not support the view that adaptation can only do the fine-tuning, while self-organisation is the more important determinant in evolution. In his view, self-organising dynamics becomes increasingly evolution amenable in the course of evolution and therefore more and more malleable. As he said, evolution facilitates itself.

Concerning the modelling of evolution and development, thermodynamical, information theoretical and mathematical perspectives are presented in the second part. Let us take the more philosophical contribution by Rod Swenson. In evolutionary thinking, it is often thought that organic evolution is the negation of physical evolution, which does not spontaneously tend to order. Starting from the philosophical dualism between physics and psychology (meaning and intentionality) and physics and biology (end-directedness), Swenson tries to provide a physical basis to bridge this gap. Relying on the laws of thermodynamics, he argues that the world selects order whenever it gets the chance. “The active striving of living things is no longer seen as a struggle against the laws of

physics, but a manifestation of them.” (p. 174) In his interpretation, spontaneous ordering can be seen as an expected consequence of natural law. A nomological but non-Laplacean basis can be provided for the world as active and end-directed. The intentional dynamics of autocatalytic systems (i.e. open systems which conserve their identity through the flux or motion of their components) can be grasped on a basis which establishes a commensurability between physics, psychology and biology. This results in the rejection of the Cartesian view which influenced both ‘closed-circle theories’ (which makes meaning and intentionality relative) and the opposite views of evolutionary and natural selection epistemologists. Commenting the problems of both views, Swenson offers an alternative that no longer is influenced by some philosophical conceptions starting from Descartes.

The third part enters rather philosophical matters, such as causality and explanation. Juarrero considers causality as constraint. Constraints not only reduce alternatives, but also create alternatives. In information theory, to convey a message the random distribution of signals must be constrained such that it diverges from chance, randomness and equiprobability. Context-free constraints increase the improbability by creating order and patterns, which have the capacity to carry information. But the reliability of transmission is inversely related to message variety. Transmitted to thermodynamics, matter would clump if nature relied only on context-free constraints, and complexity would not arise. Therefore, Juarrero considers a second type of constraint: context-sensitive constraints, which are such that the components of a system are no longer independent of each other. Here, conditional probabilities are imposed on the relations between the components, on top of the context-free constraints. They permit unlimited possibilities in message variety and enable to convey relational information. An analogue is found in dissipative and autocatalytic structures (e.g. Bénard cells). “Constraints [...] do not function just by closing off possibilities; contextual constraints are also the mechanism whereby the creation of a new level of organization with greater degrees of freedom, takes place.” (p. 237) According to Juarrero, the increasing complexity of evolution is a function of the operation of contextual constraints. Context-sensitive constraints increase the things that a system can do, while the number of ways the parts can be arranged is reduced. They alter the behaviour of the components and create levels of organisation with new capacities. The higher systemic level then acts

as a top-down selective constraint on the lower level components. Juarero argues that this has consequences for explaining intentional behaviour: "If causality is reconceptualized in terms of the operation of constraints, intentional behavior can be rethought as an example of constraints operating top-down." (p. 242) Moreover, the relation of part and whole becomes more understandable.

The last part offers semiotic viewpoints on evolution. Rocha is pleading for a kind of equilibrium between selection and self-organisation, by means of a semiotic model with two symbol types. Rocha does not want a purely symbolic approach to cognition, nor does he want to defend a conception in which natural selection is sovereign in evolution. The way in which evolutionary and learning systems should be approached includes self-organising mechanisms *and* genetic algorithms (in the domain of artificial life) and connectionist classification *and* higher level accounts of cognitive categorisation (in the domain of artificial intelligence). The reason is that the emphasis on embodiment and materiality does not exclude the necessity to explain the representational relation between categories and the context of the cognitive system. Evolution relies on self-organisation as well as on selection. Moreover, only those systems that are self-organising and able to use their dynamics in order to obtain a symbolic dimension can have an open-ended evolutionary potential. Therefore, Rocha stresses the symbolic component of open-ended evolutionary systems as well as the material, dynamic and self-organising properties of matter.

In general, the confrontation between evolutionary systems theory and a selectionist account shows how biological systems acquire stability through the interaction with the environment. Because the evolving system can change its conditions for further adaptation, evolution is no longer merely a matter of the selective power of the environment. Biological systems are seen as active and co-organise their evolution. Because of this interactionist point of view, the causal power of the *system* must be taken into account, together with an account of how such a system becomes an individual system through its interactive history. Concerning the interaction between systems, the semiotic viewpoint tries to show how something can be meaningful to a system that is temporally and materially situated and how that can be described.

The overview of the different positions on and approaches to self-organisation and selection makes this contribution particularly many-

sided. For the reader interested in the subject, it surely is a valuable contribution that opens up a set of viewpoints and new questions.

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