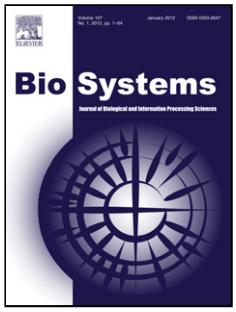

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PII: S0303-2647(17)30171-5
DOI: http://dx.doi.org/doi:10.1016/j.biosystems.2017.06.004
Reference: BIO 3750

To appear in: *BioSystems*

Received date: 10-5-2017
Revised date: 16-6-2017
Accepted date: 26-6-2017

Please cite this article as: dos Santos, Wanderley Dantas, Carrying pieces of information in organocatalytic bytes: Semiopoiesis—A new theory of life and its origins.BioSystems http://dx.doi.org/10.1016/j.biosystems.2017.06.004

BioSystems Words 9,219

Carrying Pieces of Information in Organocatalytic Bytes: Semiopoiesis — a New Theory of Life and its Origins

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Abstract
Living beings have been classically described as autopoietic machines: chemical systems, which maintain a reproducible steady state by producing their components and boundaries. On the other hand, very simple autopoietic micelles have been produced in laboratory. They consist in micelles able to catalyse the production of their own surfactants. However is very clear that these autopoietic systems are unable to evolve. In this way, these autopoietic micelles cannot be associated to living organisms, which are always linked by evolutionary relationships. Here I claim that living beings are a class of autopoietic systems able to conserve molecular information, a feature denoted by the term semiopoiesis. By defining the molecular information of their products, semiopoietic systems control their interaction with the medium and, by being able to convey molecular information beneficial to the maintenance of the organization to their offspring, semiopoietic systems can evolve by natural selection. Information can be described as a specific state or order assumed among a set of other possible states or orders. Thus, molecular information is the specific order by which the molecular components are ordered, such as the sequence of nucleotides in nucleic acids or of amino acids in proteins. However, molecular information is not limited to copolymers. The atoms in small organic compounds may also present diverse orders, giving rise to isomers. Different isomers can present very distinct chemical and physical properties such that the biophysical-chemical properties of an organic compound are determined by its composition and molecular information i.e. the specific positions in which their atoms are posited. This molecular information can be conserved during reactions catalysed by selective organocatalysts. In this way, organocatalysts appear as plausible candidates to primitive hosts for the genetic information, before the emergence of systems based in biopolymers. The bases of a putative organocatalysts-based evolution are discussed. Finally, I argue that organocatalytic micelles can be designed to produce programmable materials, artificial photosynthesis, self-building materials and artificial life with relevant industrial impact.

Keywords: autopoiesis, evolution, code, semiopoiesis, molecular information, wet artificial life.

Introduction

Autopoiesis refers to self-production as the essential operation of metabolism. The specific mechanisms by which actual living beings perform their autopoiesis (polymeric catalysts made with information stored in genes) was explicitly excluded from the autopoiesis theory because autopoiesis is a theory about the essence of life and therefore it should apply to all living systems, in any stages of evolution, terrestrial or not. The actual way by which living beings perform their autopoiesis is contingent and, therefore is not part of the model. The authors recognize that the changes throughout reproduction results in biodiversity that, in the final instance, is the raw material for natural selection and evolution. However, they argue that autopoiesis is the sole characteristic necessary and sufficient to describe life (Maturana and Varela, 1980).

On the other hand, in the early 1990s, Pier Luigi Luisi and co-workers succeeded in building artificial autopoietic systems, as described in Figure 1 (Bachmann et al. 1992, Bitol and Luisi 2004, Luisi 2006). According to autopoiesis theory, these systems should be considered alive. Luisi disagrees concluding that