

Beyond neo-Darwinism. Building a Symbiogenic Theory of Evolution

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Abstract This short paper provides information on symbiosis and symbiogenesis, and reinforces the importance of these concepts in our understanding of the biological world and the role they play in the evolutionary complexity of living systems and in the establishing of the web of life in our planet. This will help to build a Symbiogenic Theory of Evolution and to introduce the new concept of symbiogenic superorganism.

Resumo Este breve artigo fornece informações sobre simbiose e simbiogénese e reforça a importância desses conceitos para a compreensão do mundo natural e do papel que desempenham na complexidade evolutiva dos sistemas biológicos e no estabelecimento da "teia da vida" no nosso planeta. Todos estes dados contribuem para construir uma Teoria Simbiogénica da Evolução e introduzir o novo conceito de superorganismo simbiogénico.

In order to understand a scientific theory, we should not only look at the facts that support it, but also at its origin and evolution. As Ernst Mayr argued in his book *The growth of biological thought. Diversity, evolution and inheritance*:

Much of modern biology, particularly the various controversies between different schools of thought, cannot be fully understood without a knowledge of the historical background of the problems.¹

¹ Mayr, 1982.

To understand and discuss biological evolution and its mechanisms is also essential to consider the knowledge of the related historical background. The traditional scientific explanation for evolution is based on two classical theories: Darwinism and neo-Darwinism. The latter is still currently considered as the *holy grail* of evolution studies. Evolution, however, is not only the result of mutations and genetic recombinations combined with natural selection. It involves other processes, namely symbiotic associations between different organisms to form consortia. The concept of consortia represents a new structural dimension in the biological world, and it has led to the renovation of the organism concept, leading to the idea of *symbiogenic superorganism*. This idea is based on the superorganism concept that was introduced by the American entomologist William Morton Wheeler² and subsequently developed by others.³ The notion of ant-colony as an organism differs from our idea of symbiogenic superorganism in different aspects, which includes four main characteristics:

1. different species of organisms work towards a common goal;
2. the new entity is a polygenomic one, in which the different genomes operate together in a complementary and synergistic way for the whole;
3. the parts and units of this entity are different from the same parts and units when isolated;
4. the final outcome of the synergy is not the mere addition of the attributes of each unit, which together constitute the consortium, but the acquisition of new collective synergies and characteristics.

² Wheeler, 1911, 1928.

³ Wilson, 1975; Wilson & Sober, 1989; Holldobler & Wilson, 2009.

This situation is widespread in the natural world and some examples of associations can be considered as symbiogenic superorganisms, such as the lichens, the termites and their symbionts, the symbiotic system *Azolla-Anabaena*-bacteria⁴, and the animal bodies, including human's, with their microbiota.⁵ In his work, Jan Sapp refers that:

every eukaryote is a superorganism, a symbiome composed of chromosomal genes, organellar genes, and often other bacterial symbionts as well as viruses. The symbiome, the limit of the multicellular organism, extends beyond the activities of its own cells. All plants and animals involve complex ecological communities of microbes, some of which function as commensals, some as mutualists, and others as parasites, depending on their nature and context.⁶

This concept can also be applied to the eukaryote cell itself, which should be regarded as a consortium, an idea previously developed by Lynn Margulis in 1967, and included in her serial endosymbiotic theory.⁷

In this sense, eukaryotes are not entities genetically unique, and the concept of individual must be seen as a complex biological ecosystem, composed of multiple interdependent parts living symbiotically. It is at the symbiome level, composed by an integrate multigenomic genetic pool, that natural selection could act.⁸

Without denying many of the Darwinist principles, it would, nevertheless, be detrimental to the study of evolution to limit it to the Darwinist or neo-Darwinist perspectives. It is necessary for other existing evolutionist approaches to be deepened and discussed within biology and philosophy of life sciences. In this sense, we would like to share in this short paper a set of principles, which could be integrated

⁴ Carrapiço, 2010a.

⁵ Sapp, 2003.

⁶ Sapp, 2009.

⁷ Sagan, 1967.

⁸ Carrapiço, 2006.

in a new approach to the evolutionary process, helping to build a *Symbiogenic Theory of Evolution*.⁹ This theory includes Darwinist principles, but does not limit itself to the latter in its attempt to promote and explain the development, organization and evolution of the biological world in a symbiogenic and synergistic sense. To integrate these ideas in the scientific literature, we need to go deeper into their roots and to develop a new approach to analyze evolution based on six pillars:

1. Darwinian principles;
2. The symbiosis concept;
3. Symbiogenesis as an evolutive mechanism;
4. The serial endosymbiotic theory;
5. The horizontal gene transfer and other genetic recombinations;
6. Epigenetic changes.

These lines of research should also be considered as a contribution towards a new insight into the natural world and towards understanding the true organismal interactions and relationships present in the different ecosystems on Earth. All the data coming from these domains of research should be incorporated into a new biological field called Symbiogenic Developmental Biology, or informally, *symbio-devo*, merging symbiogenic evolution with developmental biology.

In the article «The parasitic host. Symbiosis *contra* neo-Darwinism», Michelle Speidel, referring to the traditional criticism associated to this new paradigm wrote: “nature is competitive, and cooperation is a strange case that needs to be explained...”¹⁰ In our point of view, and reinforcing Speidel’s statement, we do not need to explain and understand cooperation as an alien idea. We should

⁹ Carrapiço, 2006, 2010b, 2012.

¹⁰ Speidel, 2000.

consider the importance of cooperative synergistic interactions as a recurrent and central force in the evolutionary process.¹¹ In this context, we need to investigate it, and consequently incorporate the concept of synergistic cooperation as one of the main scientific principles to explain the origin, organization and evolution of life in our planet.

¹¹ Carrapiço, 2010b, 2012; Corning, 2005; Margulis & Fester, 1991; Reid, 2007; Sapp, 2009; Sciama, 2013.

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