



Phylogeny and ecogenesis - similarities and differences

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Abstract. An interesting scientific approach would be the link that exists in the history of life on Earth between the phylogeny of species and the genesis of ecosystems. This is the purpose of our work, which is a conceptual work. Although the concept of species has evolved over time, the evolutionary principles and concepts of evolution have remained about the same. The ideas presented by Botnariuc & Soran (1993) are still relevant. The following scheme of the evolutionary process can be admitted, which should highlight possible relationships or relationships between phylogeny and ecogenesis: i) at the base of the evolutionary process we must place the random mutation; ii) genotypes carrying mutant genes compete with non-mutant ones for occupying the same ecological niche, a niche understood mainly functionally, but in some situations also spatio-temporal; iii) we must look for the beginnings of speciation in the decisive role of the differentiations initiated by the diversification of ecological niches.

Key words: climax, evolution, evolutionary ecology, homeostasis, speciation, synthetic theory.

Introduction. An interesting scientific approach would be the link that exists in the history of life on Earth between the phylogeny of species and the genesis of ecosystems. This is the purpose of our work, which is a conceptual work.

Botnariuc & Soran (1983) quoted from a paper by Whittaker and showed that there are certain similarities between phylogeny and ecogenesis, but also certain fundamental differences. The quoted author's assertions were the result of his reflections on the foundations of the so-called evolutionary ecology.

Evolutionary ecology. Evolutionary ecology is at the intersection of ecology and evolutionary biology (Fox et al 2001; Hendry 2016). It approaches the study of ecology in a way that explicitly takes into account the evolutionary histories of species and the interactions between them. Instead, it can be seen as an evolutionary study approach that incorporates an understanding of the interactions between the species under consideration (Fox et al 2001; Pianka 2011). The main subdomains of evolutionary ecology are the evolution of life history, sociobiology (the evolution of social behavior), the evolution of interspecific interactions (eg. cooperation, predator-prey interactions, parasitism, mutualism), and the evolution of biodiversity and ecological communities (Hendry 2016).

Evolutionary ecology considers two main things: how interactions (both between species and between species and their physical environment) shape species through selection and adaptation, and the consequences of evolutionary change that results (Fox et al 2001; Pianka 2011).

Much of evolutionary ecology refers to the use of models and the finding of empirical data as evidence (Fox et al 2001; Peck 2001). Examples include the size model of the Lack clutch designed by David Lack and his study of Darwin's belts in the Galapagos Islands (Peck 2001). Lack's study of Darwin's syntheses was important in analyzing the role of various ecological factors in speciation. The lack suggested that

differences between species were adaptive and produced by natural selection, based on GF Gause's assertion that two species cannot occupy the same niche (wblog.wiki/en).

Richard Levins introduced his species specialization model in 1968 (Brown & Pavlovic 1992), which investigated how habitat specialization evolved in heterogeneous environments using the fitness sets that an organism or species possesses. This model developed the concept of spatial scales in specific environments, defining fine-grained spatial scales and coarse-grained spatial scales. Implications of this model include a rapid increase in environmentalists' understanding of how spatial scales influence species diversity in a given environment (wblog.wiki/en).

Another model is Law and Diekmann's 1996 models of mutualism (Diekmann 1996), which is defined as a relationship between two organisms that benefit both individuals. Law and Diekmann developed a framework called adaptive dynamics, which assumes that changes in plant or animal populations in response to or lack of disturbance occur at a faster rate than mutations (Diekmann 1996). It aims to simplify other models that address community relations (wblog.wiki/en).

The tangled nature model offers different methods for demonstrating and predicting trends in evolutionary ecology (Christensen et al 2002). The model analyzes an individual prone to mutations in a population, as well as other factors, such as the rate of extinction (Laird & Jensen 2006). The model was developed by Simon Laird, Daniel Lawson and Henrik Jeldtoft Jensen of Imperial College London in 2002 (Laird et al 2008). The aim of the model is to create a simple and logical ecological model based on observation. The model is designed so that environmental effects can be taken into account when determining the shape and condition of a population (Laird et al 2008; Roach et al 2017).

The synthetic theory of evolution. The synthetic theory of evolution resulted from the intersection of mathematics, genetics, paleontology, biogeography, and systematics with Darwinism (wblog.wiki/en). It has adopted common principles on evolutionary processes (Reif et al 2000). According to the synthetic theory of evolution, whose pioneers were S. S. Cetverikov, T. Dobzhansky, E. Mayer, G. G. Simpson, J. Huxley, R. Fisher, J. Haldane, C. Darlington, I. Şmalgauzen, N. Vavilov, N. Timofeev-Resovschi, N. Dubinin, etc., the substrate or object of the evolutionary process is not the individual, but the population (Botnariuc & Soran 1983).

This substrate, object or system ultimately does not exist in isolation in space and time, but belongs to a living community or biocenosis and probably evolves with biocenosis. Individuals that make up a population of a given species are related to each other through a common offspring, and are related to the populations of other species through a finite number of relationships. In this context, it is worth mentioning Kamshilov's (1976) idea of dividing the links between organisms into two large groups: genealogical links, also called phyletic links, and ecological links (Botnariuc & Soran 1983).

The phyletic link is based on the transfer of genetic information from parents to offspring, including a transfer of a substance (deoxyribonucleic or ribonucleic acid). The information flow is specific and unidirectional in time, it takes place in time and through the passage of time (Botnariuc & Soran 1983).

Ecological links include a limited number of relationships (varied in essence) that are established between different species through individuals and their populations. These links are based on the transfer of substance and potential chemical energy, as well as the transmission of paragenetic information, mostly environmental information (Botnariuc & Soran 1983). There are two broad categories of ecological links: group (synecological) and individual links. Ecological group links reflect statistical legitimacy. The individual ecological links are in relation to the random manifestation, usually reflecting the particular case of the statistical law (Botnariuc & Soran 1983).

Two types of evolution. The two types of links between organisms (the older and more conservative genealogical link, the younger and more dynamic ecological ones)

determine two different types of evolutions: phylogenetic evolution and ecogenetic evolution (evolution of cenoses according to Liapunov (1972)).

Phylogenetic evolution in turn is manifested on two interconnected planes, but different in repercussions: microevolution and macroevolution (Kuratani et al 2022). The result of microevolution is the genesis of species based on the random appearance of mutations and the action of natural selection on new mutant individuals. In terms of microevolution, the process can sometimes be very slow (Botnariuc & Soran 1983). Macroevolution leads to the genesis of large groups of kingdoms. It is fast spreading to new groups. Macroevolution is based on extensive genome restructuring due to the emergence of "ingenious genes" and mutations that affect groups of genes (Botnariuc & Soran 1983).

Ecogenetic evolution is based on other processes (Dunlop et al 2009). In the case of phylogenetic evolution, the essential element is the faithful or modified transmission of genetic information from parents to offspring and within the individual (Botnariuc & Soran 1983). In the case of ecogenetic evolution, the main processes on which they are based are energy flow and biogeochemical cycles generated by energy leakage. Consequently, ecogenetic evolution is manifested by successions (relatively rapid changes in biocenoses) of ecosystem types, usually ending with the installation of the climax (steady state that triggers a slow evolution closely correlated with millennial climate change) (Botnariuc & Soran 1983).

Whittaker (1975), taking into account several characteristics of the two types of evolution, tried to analyze the similarities and differences between them.

The approach between ontogenesis and ecogenesis was discussed in a first approach. It has thus been argued that the differentiation, growth and maturation of an organism can be likened to the different stages or phases of a succession that take place in an ecosystem until the onset of the climax. But there is a fundamental difference. The ontogenesis of the individual is genetically programmed. Ecogenesis is not programmed, but is the result of the game of environmental factors (Botnariuc & Soran 1983). It was also stated that the steady state characteristic of the climax would be similar to the homeostasis of the body. The analogy between the two processes is acceptable within certain limits. There are also important differences. Biocenoses and ecosystems are not customized or individualized systems with a precise boundary between them and the environment (Botnariuc & Soran 1983). To these can be added the fact that biocenoses do not have a coordinating center to maintain the homeostasis of their parameters between certain rigorously established values (Stugren 1981a). In the case of the stationary state achieved in natural ecosystems, the mechanisms of ecological feedback act slowly and not fast, not deterministic, but probabilistic (Botnariuc & Soran 1983). Biocenotic homeostasis, if we can call it that, does not lead to the establishment of a state identical to the one before the disturbance, but to one similar to the previous state through a kind of adaptive optimization of ecosystem parameters to new and old conditions (Botnariuc & Soran 1981).

Biocenosis, the context of evolution. Since the interwar period, Borza (1924) was convinced that the secret of speciation is hidden in the complex structure and functionality of ecosystems. Relatively late, Whittaker (1975) argued the exact same idea when he unequivocally stated that the biocenosis or living community is the context in which species survive and evolve.

Given the fact that species spontaneously live only within ecosystems, phylogenetic evolution must intersect in some way with ecogenetic evolution. Therefore, one of the objectives of the discussion of this paper is to theoretically analyze some of the multiple relationships that could exist between phylogenetic evolution and the evolution of ecosystems (Botnariuc & Soran 1983).

This problem, complex as a whole, was the subject of theoretical investigations by Smalgaugen (1946, 1968), but see also the investigations carried out by Boşcaiu (1982). These authors hypothesized that ecological factors, one by one, several together or even all together, form selection filters (Pierce & Cerabolini 2018), which guide the evolution of

populations in certain directions or keep it within certain limits, according to the so-called homeostasis of the evolutionary process (Stugren 1981b).

In the conditions of natural ecosystems, together with Mayr (1970) and Botnariuc & Soran (1983), we consider that evolution is not driven by a single factor, but often by a complex of factors. The selection filter, in this case, is the complex of factors. It interacts with the individual genotypes in a population and the result is the evolutionary trend (Botnariuc & Soran 1983).

Among the factors that play the role of selection filter, directing evolution and determining speciation, we must include the ecological niche (Botnariuc & Soran 1983). Elton (1958) and later Mayr (1970) showed that the entry of a species into a new ecological niche is often difficult and based on fierce competition. Of course, there are some exceptions to the rule, this being the case for invasive species (Bud et al 2006; Petrescu & Mag 2006; Oroian et al 2014). Consequently, mature natural ecosystems, in the climax stage and well biologically balanced, with saturated niches, allow only a stabilizing selection, so very slow evolution in terms of genealogy (Botnariuc & Soran 1983).

In contrast, young ecosystems from successive stages or those that exceed the limits of the area through newly created niches, allow either a targeted selection or a disruptive one, with an increased speed of evolution through the process of occupying free ecological niches (Botnariuc & Soran 1983).

However, in the successive young stages of the ecosystems, the number of ecological niches is small compared to the ecosystems in the climax stage (Müller-Schwarze & Schulte 1999). As a result, the young stages of ecosystems allow a limited number of species to evolve at random (Botnariuc & Soran 1983). With the increase in the number of niches and the evolution of ecosystems towards maximum stability, more and more species are being given the chance to evolve, but at a slower and slower rate. This finding can be correlated with the amount of energy flowing through food chains and the number of food chains in young and mature ecosystems (Odum 1975). The abundance and diversity of vegetation and fauna of some regions, especially tropical ones, is due to the large number of ecological niches existing in ecosystems (Mayr 1970). The ecological niche factor has therefore been one of the main determinants of genealogical or phyletic evolution in the history of the biosphere (Botnariuc & Soran 1983). It may push one species or group of species into a stabilizing selection mechanism or into another, directed selection mechanism, depending on the circumstances dictated by the evolution of ecosystems. In such theoretical considerations we must not lose sight of the fact that the ecological niche, as Lewontin (1974) has argued relatively recently, is also a factor in the isolation of populations (Botnariuc & Soran 1983).

A view on the evolutionary process. Based on what has been discussed, the following scheme of the evolutionary process can be admitted, which should highlight possible relationships or relationships between phylogeny and ecogenesis (Botnariuc & Soran 1983):

- i) at the base of the evolutionary process we must place the random mutation;
- ii) genotypes carrying mutant genes compete with non-mutant ones for occupying the same ecological niche, a niche understood mainly functionally, but in some situations also spatio-temporal;
- iii) we must look for the beginnings of speciation in the decisive role of the differentiations initiated by the diversification of ecological niches.

The stages that speciation goes through could be three, according to Lewontin (1974). In the first stage of the genesis of a species there is a geographical isolation and with it an ecological one, based in most cases on a diversification of the ecological niche. At this stage no morphological differences can be distinguished, although there may be some biochemical and physiological differences between the various populations (Botnariuc & Soran 1983).

In the second stage of geographical and ecological isolation, those genetic differentiations occur that nullify the viability of the cross between geographically separated individuals (Gray et al 2019). This results in the reproductive isolation of

geographically isolated populations. These differentiations must affect about 10% of the genome (Botnariuc & Soran 1983).

Finally, in the third stage, genome differentiations increase to 10-50%. In this case, the differences on the thread line are so great that the evolution of the various groups takes place independently (Botnariuc & Soran 1983).

The species concept. Understanding the concept of evolution and speciation requires a careful definition of the term species. The concept of species has evolved over the decades, as can be seen in the differences between the terms defined by different generations of researchers.

There are four main species concepts accepted by scientific community over times: 1) typological or essentialist species concept, 2) nominalistic species concept, 3) biological species concept, 4) evolutionary species concept.

In 1954-1956, Cain regarded the Typological species concept as the morphospecies concept (Zachos 2016). As the members of the species or a taxon can be identified by their essential characteristics, a group of scientists refer to this as essentialist species concept (byjus.com/biology/concept-of-species).

Nominalistic species concept considers that "Nature produces individuals and nothing more". This concept was put forward by Buffon and Lamarck in mid 18th century in France (www.rncollegehajipur.in). According to this concept, only individuals exist and species are man-made constructs (Mayr & Ereshefsky 1992).

The biological species concept defines a species taxon as a group of organisms that can successfully interbreed and produce fertile offspring. According to that concept, a species' integrity is maintained by interbreeding within a species as well as by reproductive barriers between organisms in different species (Ereshefsky 2007).

According to the current zoology and taxonomy ("the evolutionary species concept" - Simpson (1961); Wiley & Mayden (2000); Kottelat & Freyhof (2007); Nowak et al (2009)), subspecies have disappeared from the nomenclature, being raised at species level, either lowered at variety or breed level (Stoian et al 2018). "The evolutionary species concept" was suggested by Simpson (1961) (and reconsidered by Wiley 1978) to adapt the concept of biological species to the paleontological context: a species is an evolutionary line (a sequence of ancestor and descendant populations) which evolves separately from other lines, having its own evolutionary roles and unitary trends (Stoian et al 2018).

Conclusions. Although the concept of species has evolved over time, the evolutionary principles and concepts of evolution have remained about the same. The ideas presented by Botnariuc & Soran (1993) are still relevant. The following scheme of the evolutionary process can be admitted, which should highlight possible relationships or relationships between phylogeny and ecogenesis: i) at the base of the evolutionary process we must place the random mutation; ii) genotypes carrying mutant genes compete with non-mutant ones for occupying the same ecological niche, a niche understood mainly functionally, but in some situations also spatio-temporal; iii) we must look for the beginnings of speciation in the decisive role of the differentiations initiated by the diversification of ecological niches.

Conflict of interests. Authors declare that there is no conflict of interest.

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