



## Evolutionary ethnobiology

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### ABSTRACT

Ethnobiology is a discipline that deals with understanding the relationship between human beings and biota. The strong interdisciplinary component of ethnobiology allows it to interact with different fields of knowledge. The evolutionary approach in ethnobiology is not completely absent, however it lacks systematization, which has been recently proposed. From this proposal, the evolutionary ethnobiology emerged. This approach studies the relations between human groups and biota from theoretical scenarios of ecology and evolution. Here we present the evolutionary ethnobiology, its key concepts, the theoretical scenarios with which it dialogues.

**Keywords:** Human ecology; Ethnoecology; Biological evolution; Cultural evolution; Evolutionary psychology.

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### INTRODUCTION

After the emergence of our species in the hominid lineage, human groups have dealt with a variety of environmental conditions, whether in Africa (Trauth et al. 2010) or in other continents through migratory events (Steward and Stringer 2012). Studies show that people's responses to environmental challenges vary depending on culture and cognitive factors linked to perception (Kuruppu and Liverman 2011). This suggests that people's relationships with their environments are complex and can be influenced by different factors.

When considering the factors that may affect the human-environment relationships, there is a set of evidence, obtained from different theoretical scenarios, that stress the role of biological, cultural and environmental factors (see Albuquerque et al. 2015a). This means that a discipline dedicated to the study of such

relationships must have an interdisciplinary nature. In this case, contributions from anthropology, ecology and biology have been developed to understand various aspects of these relationships, and this is also one of the central objectives of ethnobiological research. Ethnobiology represents an interdisciplinary science that studies the interactions of people with their environments, particularly with biota (Albuquerque and Alves 2016).

The definition of ethnobiology, with the focus on interactions between people and biota, also suggests an approach from an ecological perspective (see, for example, Ladio et al. 2007; Hurrell and Albuquerque 2012; Santoro et al. 2015; Hart et al. 2017; Barnes et al. 2019). Ecological scenarios allow the understanding of the current factors that modulate people's relations with their environments in space and time (Albuquerque and Ferreira Júnior 2017). For example, one can understand how people use strategies

linked to the knowledge and use of biota to respond to environmental changes (Ferreira Júnior *et al.* 2015). In addition, it is possible to understand how human groups affect the populations of plants and animals in the environments, due to their actions of collection and modification of the landscapes (Casas *et al.* 2015; Levis *et al.* 2017). Recent studies have shown, for example, the ability of human populations to tame entire landscapes, as in the case of the Amazonian forest, whose present configuration is largely the product of indigenous peoples' management over time (Levis *et al.* 2017).

The evolutionary approach, although not absent in different ethnobiological researches, only very recently had a systematization proposal for the adoption of an evolutionary look for these relations (see Albuquerque and Ferreira Júnior *et al.* 2017).

## What is Evolutionary Ethnobiology?

In addition to ecological scenarios, evolutionary scenarios have been used to investigate people's relationships with biota (Henrich and Broesch 2011; Salsis-Lagoudakis *et al.* 2012; Moura *et al.* 2020; Silva *et al.* 2020; Alves *et al.* 2021). These scenarios allow us to understand how human behavioral diversity - in terms of its interaction with the environment - has developed throughout history and the forces that govern these behaviors (Albuquerque and Ferreira Júnior 2017).

One can imagine, then, that ecological and evolutionary scenarios are very important to understand our evolutionary trajectory. Thus, Albuquerque and Medeiros (2013) proposed a new branch of ethnobiology, called evolutionary ethnobiology (from now on EE), which "*...studies the evolutionary histories of human behavioral patterns and human understanding about biological resources and behavior, considering the historical and contemporary aspects that influence these behaviors at both the individual and societal levels*" (Albuquerque and Medeiros 2013, p.3). This branch of ethnobiology seeks to understand human-biota interactions from ecological and evolutionary scenarios, integrating many of the researches already executed and proposing guidelines for future research.

The EE encompasses both approaches related to biological evolution and cultural evolution, usually integrating both. As far as biological evolution is concerned, EE's interest lies not only on how it can shape human behavior, but also on how it can be shaped by such behaviors. Throughout evolution, human interactions with the environment have generated both selective pressures in our species (see the case of amylase and sickle-cell anemia [Albuquerque *et al.* 2015b]) and in other living beings (in the process of plant domestication [Casas *et al.* 2015]), af-

fecting even the evolutionary history of several other species on the planet (Sullivan *et al.* 2017).

In the case of cultural evolution, an important focus of EE is 'change', that is, how human populations react (and provoke) environmental, socio-economic and cultural changes. Thus, studies in contexts of human migrations and environmental changes may, for example, evidence cultural adaptations in the way people interact with certain biological resources (see, for example, Medeiros *et al.* 2012; Cuni-Sanchez *et al.* 2018). Studies on migrations, for example, have shown that factors such as environmental differences between the place of origin and the new environment, as well as phytosanitary barriers to the entry of plants, give force to strategies of cultural adaptation to the flora of the new environment, causing the migrants to acquire a new repertoire of medicinal plants or enrich their repertoire with new plants (Medeiros *et al.* 2012).

Albuquerque and Ferreira Júnior (2017) developed theoretically and epistemologically the concept of EE punctuating a set of definitions, important theoretical scenarios and hypotheses. In this brief paper, we present the EE, its key concepts, the theoretical scenarios with which it dialogues and the main findings of the recent investigations of this approach (focused on the investigations of our research group). We also present as part of the scope of this field scientific ideas present in studies that, although they do not call themselves EE, are examples of approaches aligned with it.

## Key Concepts in EE

The EE assumes that the set of human knowledge and practices directed to the environment is part of complex social-ecological systems. These emerge from people's relationships with their environments and involve the strong relationship between two systems: the sociocultural (norms, beliefs and practices present in a human group) and the ecological (the biota present in the environment and its interactions, including abiotic factors) (see Berkes *et al.* 2000).

Social-ecological systems are open and dynamic, and because of this, one of the major objectives of EE is to investigate the structure (how these systems are constituted), the functionality (how they currently respond to changes in the environment), and evolution (scenarios that explain the origins of these systems and how these systems have changed throughout human evolution).

An important feature of these systems is **reciprocal influence**, that is, humans co-evolve with their environments, so that they affect the environment with their decisions and are also affected at different levels (e.g., psychological, behavioral, social and

cultural). As in any system, there is information flow between the different components of this system. For example, when a person teaches someone about the use of a particular natural resource (such as a plant to treat a particular disease), they are transmitting information. This particular type of information we call a **biocultural trait** (a combination of cultural information associated with an information of biological content). These traits can be adaptive, in the case of selecting a plant that may favor the treatment of a disease, or maladaptive, when the trait does not favor survival (the plant is not effective for the treatment of the disease, for example). (see Santoro *et al.* 2018). The factors affecting the transmission of these traces in time and space are also the study object of EE (Santoro *et al.* 2018), which in this case derives from the theory of cultural evolution (see Castro *et al.* 2010).

The concept of a **naturalistic mind** is important in evolutionary ethnobiology. EE focuses not only on understanding human culture and behavior in time and space, but above all, how our interaction with the environment has evolved even in cognitive terms. We believe that our mind has been subjected to the process of natural selection. Additionally, cultural forces may have acted as selective pressures, influencing the human mind through evolution, and shaping the way we perceive the environment and its challenges, and how we store and retrieve contents from memory. The development of this concept is based especially on the dialogue with evolutionary psychology (see Moura *et al.* 2020, 2021; Silva *et al.* 2020). In synthesis:

- Evolutionary ethnobiology seeks the understanding of people-biota interactions from ecological and evolutionary scenarios. - Evolutionary ethnobiology deals with theoretical scenarios related to biological evolution and cultural evolution, usually seeking the association of both. - This scientific field studies not only the structure and dynamics of social-ecological systems, but the forms and biases of cultural learning related to these systems, which can favor the sharing of adaptive biocultural traits, as well as maladaptive ones in these systems. -The adaptive strategies present in human populations, whether they are genetically fixed or products of cultural evolution, are usually based on obtaining security in the use of natural resources.

### Some examples of research in evolutionary ethnobiology

Recent research has used ecological and evolutionary scenarios to understand various aspects of people-biota relationships and, in this sense, may be in line with the approach of evolutionary ethnobiology. In

the last 10 years, some of these studies have evaluated (1) the resilience of social-ecological systems (Díaz-Reviriego *et al.* 2016); (2) factors influencing plant selection in different human groups, such as environmental factors (Linstädter *et al.* 2013), cultural factors (Menendez-Baceta *et al.* 2015), factors linked to chemosensory perception (Molares and Ladio 2009) and to chemical properties involving certain groups of plants (Saslis-Lagoudakis *et al.* 2012); (3) the processes of transmitting plant information from the cultural evolution scenario (Henrich and Broesch 2011, Leonti *et al.* 2015); (4) the effect of past environmental management on the current diversity of plant species (Levis *et al.* 2017) and (5) the role of local knowledge to favor the survival of human groups (Reyes-García *et al.* 2016) - see some more examples in Albuquerque *et al.* (2015a) and in Table 1 (with the focus of studies carried out by our research group).

### Future

Research in evolutionary ethnobiology is still taking its first steps. Some of the challenges for the future of this field are:

(1) The establishment of research groups around the world that formulate new hypotheses and test the hypotheses already proposed within the scope of this scientific field. It is necessary to investigate if the findings of the current studies are product only of the regional context or tend to be repeated in different socioenvironmental contexts. In this case, we have observed in our investigations that human groups respond strongly to regular challenges in the environment, such as having a greater knowledge of treatments for diseases perceived as more frequent (Santoro *et al.* 2015; Nascimento *et al.* 2016). We have even observed that the knowledge of treatments for diseases perceived as frequent increases significantly in a very short time, less than 10 years, suggesting rapid evolutionary changes in local medical systems (Santoro and Albuquerque 2020). Based on this and other evidence, we have proposed the *Principle of Regularity*, which can be stated as follows: in social-ecological systems, human cognitive and behavioral mechanisms respond primarily to conditions or contexts that present greater regularity in the environment, to which humans are more spatially and/or temporarily exposed. This allows social-ecological systems to be structured to meet the constant needs of human beings (see Ferreira Júnior *et al.* 2019). It would be interesting in the future to assess how our species respond to regular events in nature, in different contexts.

(2) The calibration of effective methods in order to give robustness to the hypothesis test in evolutionary

ethnobiology. Many of the methods used come from classical ethnobiology, cultural evolution studies, evolutionary psychology, and others. It is necessary to triangulate methods and repeat research designs in order to verify if the findings correspond to reality or if they present strong biases derived from the selected methods.

(3) The application of theoretical scenarios of evolutionary ethnobiology beyond the domain of medicinal plants. This domain presents high complexity and variation, which makes it especially inviting to studies in this sense. However, it is necessary to extrapolate the premises of this field to other components of social-ecological systems. Food plants and food systems, for example, may provide important insights for evolutionary ethnobiology. A key issue in this sense would be how natural selection influenced the choices of food plants and the acceptance of new components in food systems. In addition, an increase in studies on wild and/or unconventional food plants has revealed the role of several factors in explaining why plants with high caloric value, and with potential in the treatment of diseases, are restricted to a few social-ecological systems (Ferreira Júnior *et al.* 2021; Medeiros *et al.* 2021b). This may be the focus of future investigations in evolutionary ethnobiology, to address the biocultural factors involved in the consumption and popularization of these resources. Another interesting point would involve the study of the relationship between food and medicinal uses, investigating the evolution of knowledge in these domains and the main local criteria for selecting species that serve both purposes (Medeiros *et al.* 2021a).

(4) In the future, studies in Evolutionary Ethnobiology may contribute to strategies related to biocultural conservation. By investigating people-biota relationships from an ecological and evolutionary perspective, we can highlight the mechanisms that are modulating these complex interactions. These studies can favor, for example, the understanding of the processes that affect the importance of – and the attention given to – species and landscapes for people and the actions that our species performs in different environments, which has implications for the conservation of species and landscapes, in addition to the processes that regulate these social-ecological systems. In this sense, by understanding these foundations, we can build interdisciplinary dialogues to favor biocultural conservation (see Saslis-Lagoudakis and Clarke 2013).

## Note

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## CONFLICT OF INTEREST

The authors declare to be free of any commercial or financial relationships that could be construed as a potential conflict of interest.

## CONTRIBUTION STATEMENT

All authors have made important contributions in the text conception and by reading and approving the final version of the manuscript.

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**Table 1.** Some examples of scenarios used by our research group involving Evolutionary Ethnobiology.

Scenario	Description	Examples
Resilience of social-ecological systems	The ability of the social-ecological system to maintain its functions and processes in the face of disturbances, although modifying its structure (Ferreira Júnior <i>et al.</i> 2015).	Ferreira Júnior <i>et al.</i> (2011); Santoro <i>et al.</i> (2015); Nascimento <i>et al.</i> (2016);
Resource selection process	EE seeks to understand the ecological and/or evolutionary factors that modulate the incorporation of new resources into social-ecological systems, as well as the differential use for different utilitarian domains.	Medeiros <i>et al.</i> (2017); Gama <i>et al.</i> (2018); Albuquerque <i>et al.</i> (2019a); Silva <i>et al.</i> (2020); Alves <i>et al.</i> (2021); Medeiros <i>et al.</i> (2021a)
Cultural evolution	From this scenario, EE assesses how biocultural traits can be learned, transmitted, and modified over time in social-ecological systems.	Soldati <i>et al.</i> (2015); Santoro <i>et al.</i> (2018); Dantas <i>et al.</i> (2020); Santoro <i>et al.</i> (2020); Silva <i>et al.</i> (2020)
Niche construction	This scenario explains how the behavior of organisms of a given species can modify the conditions of their environment in order to change the selective pressures that act on the species itself and on other species present in the environment (Odling-Smee <i>et al.</i> 2013).	Albuquerque <i>et al.</i> (2015); Santoro <i>et al.</i> (2017); Lins Neto and Albuquerque (2018); Albuquerque <i>et al.</i> (2019b)