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Evolutionary Ethnobiology

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Chapter 1
Evolutionary Ethnobiology

Ulysses Paulino Albuquerque, Patrícia Muniz de Medeiros, and Alejandro Casas

A number of concepts and views about ethnobiology can be found in a vast literature produced during the last decades. A newcomer scholar in the field often feels trapped in a maze of concepts and assumptions that generate more questions than explanations. This is commonplace for a discipline that is growing, defining its nature, and assessing its interests, research methods, and connections with other scientific areas overlapping questions and fields of interest. No science constructs and matures without continually questioning its own bases and premises looking for its own identity. In addition, some research fields have more than one identity, and this is the case of Ethnobiology. This field convenes and joins researchers with various theoretical and epistemological backgrounds. The complexity of ethnobiological problems require the working together of a high diversity of perspectives, methods and viewpoints for approaching theoretical questions and applied perspectives in common.

This text is a modified version of Albuquerque and Medeiros (2013).

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Anderson (2011:1) defines ethnobiology as "the study of the biological knowledge about certain groups of plants and animals and their interrelationships." In order to approaching the interrelationships, it is necessary an ecological perspective. Hurrell and Albuquerque (2012) stated that ethnobotany can also be understood as a part of ecology.[1] The same can be said to ethnobiology; and also it is possible to say that ecology may be part of ethnobiology. At the end of the day both definitions visualize that ecosystems and ecological problems cannot be understood without influence of humans, and similarly, human cultural and social problems cannot be understood without considering ecosystems and ecological interactions. In fact, nowadays making reference to social-ecological problems is an explicit recognition of this intimate interaction (Berkes and Folke 1998; Folke 2004; Walker et al. 2004). Ethnobiology is eminently a social-ecological science, concerned with interrelationships between people and their biological resources (plants, animals, and other organisms). It deals with interaction between the different biotic components and frequently also with abiotic components of ecosystems and their dynamic relationships occurring in time and space.

It is not unusual for us to consider the relationships between people and biological resources from an ecological perspective. The conventional ecological science (the modern ecological research) insufficiently considers human aspects as topics of theoretical interest. The classic notion of ecology, dissociated from human beings, may constitute a source of bias, given that humans interfere directly in ecological and evolutionary processes. Similarly, sociological or anthropological approaches decontextualized of ecological systems and interactions do not allow a holistic comprehension of the real problems. According to Fritjof Capra (2004), the contemporary environmental crisis is the crisis of a conception of environment dissociating nature from society. Therefore, the synthetic approach of social and ecological issues is not only a theoretical challenge, but also an applied necessity. As social-ecological science, ethnobiology may make important contributions in this direction.

Ethnobiology has been predominantly focused on the utilitarian role of plants and animals (Toledo and Alarcón-Cháires 2012). The most common approach in ethnobiology today is to focus on lists of useful plants and animals, which leaves out attempts to understand the complex relationships between people and biological resources but fails to identify patterns in the use of such resources. This approach belongs to the history of ethnobiology (strongly influenced by an economic and perhaps taxonomic perspective because of the preoccupation with the listing of organisms). It is an important step of Ethnobiological research because it records knowledge that may otherwise soon be lost by communities and because it aids in the search for "new products". This approach on the other hand is insufficient to for the theoretical foundations of ethnobiology, that are indispensable for any scientific field. Although concerns and descriptions of utilitarian aspects are undoubtedly part of ethnobiology, these topics and approaches do not define the body of a science. Constructing a social-ecological science like ethnobiology requires much more theory and methods.

[1] More specifically, the authors discuss a biocultural ecology to account for the human dimension in the traditional ecological approach.

The broad concept of ethnobiology presented above does not fully meet the current need for including concepts of ecology and evolution in ethnobiology. Although some researchers advocate that it is redundant to address ecology and evolution in ethnobiology, we doubt whether these researchers are using these perspectives in their work at all. On the one hand, these concepts are used extensively as theoretical scenarios for interpreting and guiding research (as in the case of plant management and domestication studies; see, for instance, Casas et al. (2007). On the other hand, they appear to be completely forgotten in many studies. Johns (1990) presents interesting ideas and approaches, from an ecological and evolutionary perspective, for understanding the use of medicinal plants and food by humans. Unfortunately, very few researchers consider this perspective in their investigations. Even so, Johns (1990) strongly influenced the construction of a theoretical scenario accounting for an evolutionary view on health and disease (see Fabrega Jr 1997).

What may then justify this lack of ecology and evolution in ethnobiology studies, especially in countries where the science is practically performed by professionals from the natural sciences? We are not arguing for the exclusion of the humanities and social sciences, given that humans are a cultural species. Belonging to a cultural species does not eliminate our biological-evolutionary trajectory. Our social behavior is also a product of biological evolution, and our cognitive, social and cultural components were primarily responsible for our dominance over most other species. What we are and how we act are influenced by a biological-cultural complex. Ecological and human cultural processes influence to each other and delineate crucial aspects of nature of humans and humanized nature. It is not our intention to rekindle here the debate about human behavior, i.e., whether our choices and tendencies are biologically determined or whether they are the result of the culture in which we find ourselves. We have already outgrown this debate by accepting that, in the case of our species, ecological and human cultural processes are strongly linked in an evolutionary trajectory. We will not advance in our understanding of the relationships between people and nature by ignoring either the animal (biological-ecological) nature of humans or the natural context of human culture. We consider it is possible to substantially advance in constructing ethnobiological science by drinking at the fountains of different areas that have been busy understanding human beings from an ecological and evolutionary perspective.

The ecological approach seeks to account for the current aspects that explain the relationship between people and nature, considering the interrelationships that people establish with different natural resources and ecosystems in space and time. This approach asks how people behave in different environments and how they deal with diversity, in addition to asking what determines the properties of social-ecological systems. The evolutionary approach also studies current behaviors, but with the intent of trying to unravel which pressures have shaped us, i.e., how and why certain traits or characteristics emerged.

Thus, we have a challenge ahead of us: to define the field of ethnobiology that seeks to combine ecology and evolution in understanding how people from different cultures cope with (influencing and being influenced by) the natural resources in different environments given the ecological, evolutionary, and cultural pressures to

which our species is subject. It is important to point out that the evolutionary branch of ethnobiology may consider two aspects of evolution: the biological evolution and the cultural evolution. Although they may follow similar trajectories, the first one requires genetic and/or epigenetic changes while the second can be performed in a single generation, by means of environment-influenced behavioral changes. Thus, we call evolutionary ethnobiology the branch of ethnobiology that studies the evolutionary histories of human behavioral patterns and human understanding about biological resources (about both cognition and behavior), considering the historical and contemporary aspects that influence these behaviors at both the individual and societal levels.[2] An ethnobiology that adopts this perspective will routinely address concepts such as adaptation, adaptability, evolutionary trends of traits, and phylogeny.

The first two basic premises are clear[3]: (a) that human behavior, variable between pairs of the same group and related to the use of natural resources, evolves by means of the selection of traits that confer adaptive advantages; and (b) that large behavioral variability should be inherited, not necessarily on a genetic basis, but primarily by cultural transmission. In a single human population, distinct individuals may have different strategies for dealing with natural resources and different ways of interacting with other members of the same population that influence their decisions and their behavior. Our understanding of the relationship between people and natural resources can very much benefit from the incorporation of all concepts built over the years in other areas and from methodological approaches that assess the role of an individual and the influence of different social-environmental contexts in structuring our ecological understanding.

Ecological and evolutionary perspectives are undoubtedly important theoretical issues for making ethnobiology a holistic science. Evolutionary ethnobiology accounts for social, cultural, ecological, and evolutionary issues derived from the interactions between humans and biotic components of ecosystems. An evolutionary ethnoecological perspective allows including the modelling of ground, water, and other abiotic elements. With this perspective, throughout this book we review the ecological and evolutionary consequences of interactions between humans and nature. As discussed in Chap. 4 by Casas et al. (2015), evolutionary ethnobotany is a research approach that combines different perspectives from a broad spectrum of disciplines. Its general purpose is analyzing the evolutionary processes derived from interactions between humans and plants, animals, fungi and a broad spectrum of microorganisms, which may have consequences on: (1) organisms

[2] This perspective makes sense in light of Niche Construction Theory, which is still neglected and not well known. All living beings (including humans), through their activities and decisions, modify their own niches and those of other organisms. In altering niches, organisms would also be altering natural selective pressures (see Odling-Smee et al. 2003).

[3] These premises are inspired by the fundamental ideas of behavioral ecology (see Jeanne 1998). However, in behavioral ecology, a behavior is considered adaptive when it generates a positive impact on the fitness of its descendants. It is difficult, but not impossible, to measure such an impact when we work through the issues of interest in ethnobiology.

interacting with humans, (2) humans themselves, their culture and societies, and (3) ecosystems and landscapes. This perspective indicates that evolutionary ethnobiological questions are eminently social-ecological complex problems and their understanding therefore requires interdisciplinary research approaches.

Examining the interrelationships between people and nature and considering the forces that helped shape this complex relationship will help us undoubtedly to moving forward in building theories in ethnobiology.

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Chapter 2
Ecological-Evolutionary Approaches to the Human–Environment Relationship: History and Concepts

Patrícia Muniz de Medeiros, Marcelo Alves Ramos, Gustavo Taboada Soldati, and Ulysses Paulino Albuquerque

2.1 Introduction

Ethnobiology is characterized by a substantial diversity of theoretical frameworks and fields of knowledge. Insofar as this diversity makes ethnobiology a complex research area, it also expresses an important concern how can other fields of knowledge contribute to the strengthening of ethnobiology? In this chapter, we discuss how different theories concerning ecological and evolutionary understanding of social-ecological systems can be useful in studying or interpreting ethnobiological questions. The history and the concepts that we present are understood as part of the historical construction of disciplines such as ecological anthropology and human ecology. We do not present this history and these concepts as if they were part of a trajectory followed by ethnobiology but as a set of factors that influenced different researchers at various points in time.

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In the chapter's first part, we rehabilitate several historical concepts related to the contribution of ecological and evolutionary approaches to the understanding of the human–environment relationship, particularly those concepts that originate in ecological anthropology and human ecology. To better understand this relationship, we present examples of ethnobiological investigations and the respective philosophical currents adopted (even implicitly) by their authors. In the second part, we address the interactions of ethnobiology with other disciplines, particularly environmental psychology and evolutionary ecology.

We understand that an evaluation of the human–environment relationship in this manner implies the adoption of a materialistic outlook. However, in adopting this perspective, we remain unwilling to reduce the complexity of that relationship to explanations of a biological nature while neglecting the influence of cultural factors. In truth, this discussion has a long history and has been controversial. However, we believe that this materialistic outlook can improve our understanding of part of the phenomenon and contribute to the evolution of a theory of the human–environment relationship.

2.2 The Human–Environment Relationship and the Evolution of Ecological Anthropology

2.2.1 Determinism and Environmental Possibilism

Among the main discourses that attempt to explain the person–environment relationship, one finds environmental determinism (see Kormondy and Brown 1998; Hawley 1986). According to the determinist discourse, the environment is the primary force that defines human behavior[1] and possesses substantial power to modulate our cultural traits. This view discomfits the scientific community because, for example, it diminishes the importance of human choices. Therefore, over time, the determinist discourse has lost credibility and adherence in scientific circles.

Historically, within the humanities, social sciences, and ethnosciences, the term "determinism" has been distorted. It is not uncommon that studies that consider the environmental influence in any aspect of human life are labeled deterministic. When not provided with a scientific basis, this label can be dangerous because it typically marginalizes investigations that seek to understand the extent to which the environment can influence certain aspects of human behavior. Such marginalization can result in a lack of interest in the question of environmental influence, and consequently, reduce the çevel of knowledge generated regarding this topic.

[1] As Mesoudi (2011) emphasized, human behavior is the performance of information that is genetic or acquired through individual or social learning. Thus, strictly speaking, behavior is not necessarily related to cultural information, that is, learned socially. However, to facilitate the presentation of positions, in this paper, the term "behavior" is only linked to information of cultural origin.

For instance, in ethnobiology, it is customary to investigate the factors that influence the selection of useful plants. For example, a determinist discourse would consider environmental questions to be key modulators of such selection. However, although current research seeks explanatory environmental factors (e.g., the availability of species, as discussed in other chapters of this book), it also considers that other factors influence the selection of natural resources, such as historical, symbolic, and religious factors. Thus, to investigate the role of the environment as another variable of importance cannot be labeled a deterministic approach. On the contrary, the failure to consider this variable can make the understanding of reality, at some point, reductionist.

Accordingly, we agree with Carvalho-Júnior (2011) when he considers it "incorrect, imprecise and semantically invalid to label a theory as deterministic when in fact it only emphasizes the influence of environmental factors without negating the role of other factors or human activity."

In fact, several non-deterministic ethnobotanical studies have demonstrated that an environment can exert a powerful affect on human behavior (see Ladio et al. 2007; Albuquerque et al. 2008), which prevents us from disregarding such influence. Thus, what lesson for an ethnobiological investigation can we learn from this theoretical approach, without accepting the theory in all of its ramifications? The environment can be one of the factors that influence human behavior with respect to the foraging of natural resources. Although the environment plays a highly important role in human behavior, we cannot deny that human choices as well as cultural and genetic factors also influence behavior.

Environmental possibilism emerged as an attempt to overthrow deterministic thinking as the only explanation for human behavior. In this view, the environment appears as a factor that limits the options of human populations but without determining behavior (Kormondy and Brown 1998). For instance, with respect to the employment of useful plants, the environment acts such that only the plants to which a given population has access could be used. However, from this accessible set, cultural choices could be made during the selection process.

Therefore, environmental possibilism helps us better understand the relationship between human beings and natural resources by revealing that environmental factors cannot be viewed as the only explanation of human behavior. That is, the environment offers human population opportunities to choose. However, other factors should also be considered, such as the history of natural resource exploration, human migration events, and the mechanisms of cultural transmission.

2.2.2 The Insertion of Evolutionary Thought in the Understanding of Cultures

Despite the conflicts between determinism and environmental possibilism, both discourses share an understanding of a one-way relationship between humans and the environment based on their common view of the environment as a primordial

element in the construction of human behavior. Nevertheless, a number of schools of thought criticize this position and seek to understand culture as an active (not merely passive) element in the construction of social-ecological systems. Two exponents of this new approach were the Americans Leslie White (1900–1975) and Julian Steward (1902–1972), who were forerunners in the area of ecological anthropology. It is important to clarify that anthropologists had previously developed evolutionary explanations of culture. However, these explanations are based on an understanding of evolution as a continuous, unique, and linear progress (see Mesoudi 2011).

White was a student of Franz Boas (American, 1858–1942), one of the most important thinkers, who initially structured anthropology by developing historical particularism. According to Boas, cultures evolve in specific manners that are related to their history and environmental context. The same evolution does not occur in each society. Therefore, Boas proposed to understand each cultural system individually without the pretension of explaining general patterns. White rejected this proposal and sought to understand evolution as universal. White's ideas were essentially materialistic as a result of his exposure to the social theory of Karl Marx. Thus, he proposed a structured concept of culture according to which culture consists of three spheres: ideological, social, and technological. These spheres are not equally important: the third sphere is the driving force behind the creation of cultural patterns. As noted by Neves (2002), "life can be boiled down to the struggle for the capture of free energy. For him [White], culture is nothing more than a tool used by Homo sapiens to capture and to control energy available in systems and place it at the service of human societies." The universal law of cultural evolution can be reduced to the ability of cultural systems to transform energy into labor.

2.2.3 Cultural Ecology

Like White, Julian Steward was trained in historical particularism and was a materialist par excellence. However, he was influenced by physical geography. Steward's ideas contributed to the field of cultural ecology in which (as in White's view) certain cultural elements are considered to be the most important and most worthy of scientific attention. However, according to Steward, the cultural characteristics that require investigation are associated with production and thus reflect adjustments of a culture to the environment more than the culture's ability to transform energy. According to Neves (2002), "he [Steward] establishes a research focus, a "*cultural core*," cultural aspects more related to subsistence activities and to economic arrangements. The core is formed by all the religious, social, and political aspects that are more directly related to the support material bases of these societies." This component directly affects the environment, and the environment would be affected by it, whereas the other elements that constitute the culture of a social group, such as social elements, organization, beliefs, and ideologies, would be only indirectly influenced by the environment and vice versa. In this perspective, the

idea of mutual influence (i.e., a "two-way street") between the environment and the culture is introduced into scientific circles. Additionally, Steward selected other, relatively more important environmental characteristics for investigation, for example, the quantity, quality, and spatial distribution of food supplies.

In addition to this "cultural core," and perhaps more clearly, cultural ecology is differentiated by its use of a method in which (a) above all the forms of local production and the environment should be analyzed and (b) it is necessary to understand how the strategies of environmental production and exploitation influence other cultural aspects. Accordingly, Stewart introduces an important cultural reading from the evolutionary perspective: an adaptive understanding of cultures with respect to the environment.

To illustrate the contribution to ethnobiological approaches of the mutual influence between environment and culture that emerges from cultural ecology, we can think about a hypothetical situation in which a given community has a set of plants or animals that are considered sacred and thus excluded from use. What are the ecological implications of this scenario? Possibly, the distribution of these species will change because their persistence is favored at the expense of other species. Primate hunting exemplifies this situation, in which, for example, chimpanzees are not hunted by certain human populations because of the physical resemblance of the animals with human beings or because of folk beliefs regarding the ancestry of human beings (Silva et al. 2005; Putra et al. 2008; Alves 2012).

The use and preference for specific biological resources can also result in the depreciation and subsequent decrease in the availability of these species over time. A number of studies conducted in the semiarid region of Brazil on the use of firewood as a household fuel source demonstrate that the collection behavior of this resource is selective to the extent that it prioritizes the species perceived as locally preferred (Ramos et al. 2008; Ramos and Albuquerque 2012). Thus, as cultural ecology advocates, the forms of exploitation of the resource, i.e., the specificities in the local practices of production and lifestyle maintenance, reflect cultural adjustments and should be targeted for investigation. This type of relationship can result in structural modifications in the populations and plant communities.

Thus, the primary lesson that cultural ecology can teach ethnobiologists (without requiring the acceptance of all of its ramifications) is that the environment must be understood as the result of its historic relationship with human populations that over the course of their evolution have used natural resources to supplement their cultural and substantive needs. This relationship is capable of shaping natural landscapes inasmuch as certain species are tolerated and others are overexploited.

In addition to introducing cultural ecology, Steward theorized regarding cultural evolution, arguing that cultures evolve along several different lines. That is, they are multilinear. Thus, cultural changes do not progress on a single evolutionary path, and cultural similarities between distant populations may be the result of convergence[2] (Netting 1986) or information diffusion.

[2] In biological evolution, it is held that convergence occurs when natural selection favors the development of similar characteristics in certain organisms as solutions to problems created by similar environments (Freeman and Herron 2009).

An example of convergence applied to ethnobiological research relates to the botanical families that are primarily used as medicines in different parts of the world. The studies that perform this type of analysis seek to decrease the importance of family size because it is to be expected that large botanical families include more species of medicinal value than small families. Therefore, based on this idea of proportionality (and regardless of method) (see Bennett and Husby 2008; Weckerle et al. 2012), the fact that certain families, such as Asteraceae, Rosaceae, and Lamiaceae, are prominent in different parts of the world, whereas others, such as Poaceae, Cyperaceae, and Orchidaceae, are strongly underutilized (i.e., with apparently little medicinal use) becomes interesting (see Moerman 1979; Weckerle et al. 2012; Medeiros et al. 2013). These patterns converge in remote populations and can be related to the greater pharmacological efficiency of certain families compared with others. That is, this factor can influence human behavior and choices.

Thus, for ethnobiologists, multilinear evolution supports the understanding that certain human behaviors (which are often similar in distinct social groups that are isolated from one another) reflect general patterns and therefore can be predicted. However, in accepting this thesis, we must remember that the relationship between human beings and the environment involves highly complex processes that differ from culture to culture.

2.2.4 Systems Ecology and Neofunctionalism

The development of systems ecology has made new contributions to ecological anthropology (Kormondy and Brown 1998) by altering its focus from the study of culture to the study of populations. Systems ecology uses *cybernetics* to understand culture (i.e., traits, knowledge, behaviors, and social institutions) as self-regulatory and *homeostatic systems*, thus revealing a clear influence of the ecology of ecosystems. Cybernetics is a branch of systems theory that seeks to understand a series of systems with differing characteristics (i.e., mechanical, biological, and social systems). Cybernetic studies can examine the design and function of any system as well as analyze its forms of receiving, storing and processing stimuli or information. Homeostatic systems are systems that can maintain their state of equilibrium through self-regulation mechanisms. In this cybernetic context, the ideas of positive *feedback* (i.e., forces that catalyze changes in a culture) and negative *feedback* (i.e., forces that resist changes to domains of stability)[3] emerge (Marten 2001).

To illustrate several of these ideas, let us examine a hypothetical situation involving the medical system of Community X. Suppose that this community recognizes

[3] Stability exists when a system is found in (or near to) a state of equilibrium (Holling 1973). A strong variation can transform a system from one state of equilibrium to another. Accordingly, negative *feedback* refers to forces that operate for the self-correction and maintenance of a system's equilibrium, whereas positive *feedback* refers to the forces that cause disequilibrium and change in the domains of stability (Keesing 1974).

a wide repertoire of animals and plants for medicinal purposes. This community maintains its curative practices and is isolated. Therefore, external information is not introduced into its reality. In our view, these circumstances characterize a closed system (see Garro 1986). Then, a migrant community (Community Y) establishes itself near Community X. The migrant community brings with it a new set of medical knowledge and practices. The two communities have sporadic contact. However, although Community X receives the novel information, it does not adopt any aspect of Community Y's medical system. In this case, Community Y's information arrives at Community X, which is now an open system by virtue of its contact with another system. However, because of the strong effect of negative *feedback*, this information cannot be incorporated by Community X and therefore does not alter its dynamic.

Later, increasing contact between Communities Y and X introduces a disease to the latter group. The disease was previously unknown and is introduced by the migrants. Community X is unprepared to cure this unknown, or at least untested, disease. However, Community Y, which has a history of living with the disease, possesses a list of medicinal plants that can cure it. Community X incorporates this knowledge. However, it does not fully incorporate Community Y's medical system. Over time, a hybrid of the medical systems of the two communities may form, which would represent an example of intermedicality (Soldati and Albuquerque 2012a). In a study on Fulni-ô Indians, Soldati and Albuquerque found that the local pharmacopoeia represented the merging of different medical traditions.

In this case, there is a partial input of information into the system, which is catalyzed by the impairment of negative *feedback*. However, if we consider that this information did not replace the previous medical system but only added to it, theoretically, the social system's stability domain would remain unchanged. We illustrated these ideas using a simple hypothetical situation. However, we should remember that the exchanges that occur between communities depend on the individuals who are part of these communities and the nature of the relationship between individuals. The exchanges do not depend only on the efficiency and usefulness of the information that is transferred, which makes this process even more complex.

We imagine now another situation. At another time, an area near the two communities is the target of a large urbanization project. Soon, the communities begin to have access to external resources, such as television, cooking gas, and health centers. The presence of this last element can cause individuals to relinquish their traditional healing practices and replace medicinal plants with allopathic medicines. In this case, positive *feedback* acts substantially more forcefully than negative *feedback*, and all of the new information is assimilated by the system. Because the incorporated content can be competitive by nature and not complementary, a social system substitution could occur, which would encourage a transition toward another stability domain, in this case, from a traditional to a Western medical system. In this hypothetical example, the domain change can be irreversible because after a certain time the knowledge of the practices related to the first domain may be lost. However, according to the anthropological and ethnomedical literature, there are actual cases in which the two systems can coexist, creating a dynamic in which the medical system is not necessarily transferred to another stability domain (Soldati and Albuquerque 2012a).