Review

ETHNOBIOLOGY AND CONSERVATION

Is Ethnobotany an Ecological Science? Steps towards a complex Ethnobotany

Julio Alberto Hurrell[1,*] and Ulysses Paulino de Albuquerque[2]

[1] Laboratorio de Etnobotánica y Botánica Aplicada (LEBA), Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. Calle 64 nº. 3, 1900-La Plata. Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina
[2] Laboratório de Etnobotânica Aplicada (LEA), Universidade Federal Rural de Pernambuco, Departamento de Biologia, Rua Dom Manoel de Medeiros s/nº, Dois Irmãos, Recife, Pernambuco, Brazil
* Corresponding author
✉E-mail adresses: JAH (juliohurrell@gmail.com), UPA (upa@db.ufrpe.br)

Ethnobiology and Conservation 2012, 1:4 (4 October 2012)
ISSN 2238-4782

doi: 10.15451/ec2012-8-1.4-1-16

ethnobioconservation.com

Abstract

There are different links between ecology and ethnobotany. In principle, because they have some common interests, like the conservation of plant resources. Nevertheless, the consolidation of the ecology as a science of synthesis that is based on the complexity of relationships between organisms and their surroundings, allows the ecology to provide a conceptual framework for more complex and comprehensive ethnobotany. This is also, for origin, a science of synthesis. In this contribution we discuss the basic aspects of ecology that can become guides for a complex framework of ethnobotany, which acts as a context in which their contributions to acquire significance. It also discusses various aspects of ethnobotany which, by its own complexity, are linked to the theoretical framework of ecology. Finally, we consider ethnobotany as an ecological science, from which certain assumptions are given, that can guide investigations based on the complex relationships between people and plants, the object of study of this science.

Keywords: *Ethnobotany – Ecology – People / Plants relationships*

Introduction

The need for integration between ecology and ethnobotany has been argued since the 1970s (Ford 1994). The basis for this argument was that both approaches can and should complement each other. The original need for a more holistic approach in the study of the relationships between people and plants culminated in two different perspectives: the ecological ethnobotany and the ethnobotanical approach from the theoretical framework of ecology (Albuquerque and Hurrell 2010). In the case of ecological ethnobotany, we have reached the following understanding: "Ecological ethnobotany may be tentatively defined as the relational study of peoples-interactions with plants as situated in an ecological and social context" (Davidson-Hunt 2000).

In this paper we focus on the relationships between people and plants, so we deliberately exclude the links between ethnoecology and ecology (including biocultural ecology), which will result in a further contribution on relationships between people and its natural and cultural surroundings.

Some definitions of ethnobotany emphasize how people affect plants, and the researchers seek methodological tools to understand this ecological process. However, when we speak here of the approach to ethnobotany from the theoretical framework of ecology, we understand ethnobotany as a relational approach in which ecology is used to help understand how human behavior can be modulated from an ecological perspective.

The links between ecology and ethnobotany are diverse and can be approached from diverse perspectives. However, beyond the legitimate differences in the development of different individual lines of research, it is possible to find basic aspects that reveal more convergences than divergences in a broader theoretical context. What issues relate ecology and ethnobotany? Does ecology provide an adequate theoretical framework for ethnobotany? Is ethnobotany an ecological science?

The ecology complexity

According to Margalef (1981), ecology is a science of synthesis that has developed in the opposite direction to other sciences that, in their progress, diversify and tend to specialize. In contrast, ecology has developed from a combination of knowledge from other disciplines and has constituted its own field of observation. Ecology is, therefore, a general science, a transdisciplinary field that integrates and combines elements from various sources and whose contents are relevant not only for ecology but also for other disciplines. The interdisciplinary nature of ecology is often emphasized. In interdisciplinarity, the disciplines involved obtain mutual benefits without losing their individuality. However, transdisciplinarity has a greater degree of integration, and the boundaries among the original disciplines are blurred as part of a larger context (Caravantes-Garcia 1980). Because of its peculiarities, the current ecology tends toward transdisciplinary integration.

In this way, due to its origin and development, ecology is a complex science. However, the complexity of ecology is often hidden for various reasons – including the didactic good intention of promoting the understanding of ecology – and therefore, this science is at risk from reductionist explanations (Morin 1990). As a complex and relatively young science, ecology is subject to a redesigning and reframing process. Perhaps due to these factors, ecological science has produced some good theories that seek to account for general patterns and explanations. Although ecological practice has radically changed in the past decades, much of the work that has been done in ecology is still at the level of new hypothesis testing for specific phenomena.

In its broadest sense, ecology is the study of the relationships between organisms and everything that surrounds them (Begon et al. 2006; Margalef 1986, 1991; Morin 1983), but this uncomplicated definition must not hide the underlying complexity of the subject. It is relevant to clarify that the terms "uncomplicated" and "complex" are not antagonistic. As given in dictionaries, "complex" (from the Latin *complexus*, 'linked', 'embraced') refers to being 'composed of various elements' or a 'set or union of two or more things'. Often, the term complex is used synonymously with "complicated" (from the Latin *complicare*, 'tangle', 'mix', 'difficult', 'confused'), i.e., 'tangled' or 'hard to understand'. However, "complexity" involves a 'link' (a certain order). The term "complication" implies 'confusion' or 'mixture' (a certain disorder). At first glance, the complexity of phenomena may seem to be a complication, but the basis of scientific activity is to minimize confusion and visualize the complexity of the phenomena, that is, to explain it. Any explanation implies a reformulation of the studied phenomenon (Maturana 2007). If the phenomenon is complex, the reformulation is expected to express this complexity.

The opposite of complicated is "uncomplicated": 'without complications, difficulties or artifices' or 'easy to understand'. The opposite of complex is "simple" (from the Latin *simplum* or *simplex*, 'single', 'unity'), that is, 'without composition'. In this sense, a complex phenomenon can be explained easily (of course, a complicated explanation is also possible but is undesirable in science).

If an explanation of a complex phenomenon relies on the conversion to a simple phenomenon, the explanation becomes reductionist (Figure 1). A common ailment in ecology —and in other areas of scientific knowledge— is the tendency to view complex phenomena as simple, rather than adopting a more healthy option of assuming the complexity of ecological phenomena and attempting to provide an explanation that is as uncomplicated as possible.

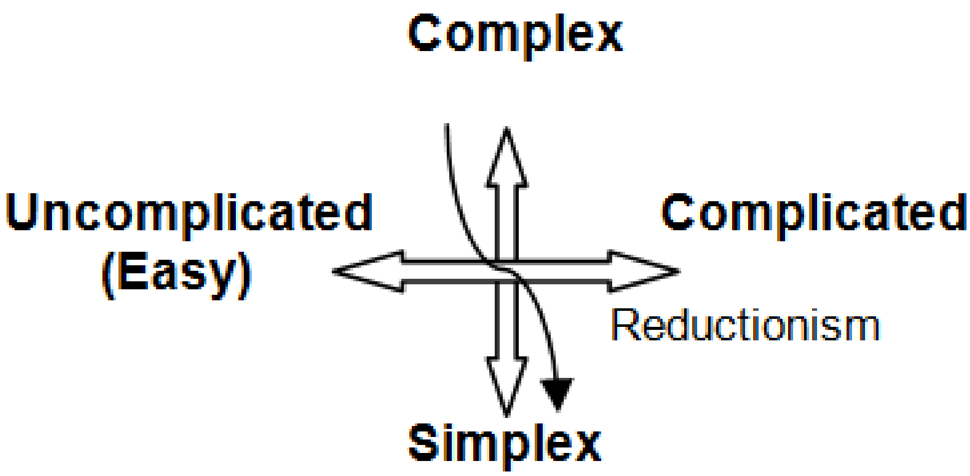

Figure 1. Antagonistic concepts: complexity vs. simplicity (vertical axis), easiness vs. complication (horizontal axis). Curved line: reductionist explanation.

The reductionist explanation, although it disregards the phenomenological complexity, especially in ecology, allows for a set of partial approximations that can be re-interpreted in a complex context. In this sense, the partial explanations are justified in the history of scientific advances. Both the reductionist and the complex approaches are directed toward the explanation of observed phenomena. Modern scientific activity is directed toward a new understanding of the world.

Some considerations about the subject of ecology: "relationships between organisms and their surroundings", give visibility to the complexity of ecology. The word “organism” refers to both individuals and biological species (from Archaea to Primates) and the ecological supraorganismic levels of organization. These levels express different links among organisms of the same species or different species, for example, populations and communities in classical ecology. A population is defined as a set of organisms of the same biological species that is reproductively isolated; and community is defined as a set of populations of different species that share the same space (Begon et al. 2006).

In current biology, the concept of organism is complex because it is assumed to be a system, which is a unit that includes diverse, related components that form a whole. The introduction of the term "system" adds another level of complexity, which brings us to the transdisciplinary nature of ecology based on the trend of the integration of various approaches to the study of ecological phenomena that has developed because we assume that the phenomena are composed of parts (physical, biological and social environments) that influence each other.

In this sense, the organism is a thermodynamically open system (open to matter, energy and information), which, unlike other systems of the same type, "builds itself". This system is the result of its own functionality and, therefore, is autonomous (self-organized) while also dependent on what surrounds it (Maturana and Varela 1972; Morin 1983). The above is valid for the individual organism to supraorganismic levels (from the organism up to the biosphere) and also for infraorganismic levels (from the cell up to the organism). This synthesis arises from the integration (in ecology and biology) of general systems theory, communication sciences, cybernetics and thermodynamics (Bertalanffy 1984; Foerster 1991; Morin 1983; Prigogine 1972).

Often the term “surrounding” is used synonymously with “environment” or “medium”, referring to the physical space where there are individual organisms, populations or communities. The environment or medium has been considered as a set of abiotic variables, as opposed to biotic variables referring to organisms (Hurrell 1990). The Spanish "medio ambiente", or the Portuguese “meio ambiente”, as broadcast by the media, is redundant. On this basis, the traditional definition of ecosystem, as the sum of the community and its environment, is sustained (Odum 1972). Nevertheless, from the viewpoint of the system, the whole is more than the sum of its parts.

Over time, due to contributions from different disciplines, particularly the non-linear thermodynamics of irreversible processes (Prigogine and Stengers 1990), the concept of ecosystem has been reformulated to consider its underlying complexity so that an ecosystem is not reducible to a simple sum. An ecosystem is, precisely, a system that integrates different elements that interact, including the organisms and everything that surrounds them (Margalef 1991). From the standpoint of the organisms, there are other organisms in their environment with which a given organism interacts in many different and complex ways, which are not always easy to clarify. These interactions (especially food-based interactions) are often used to characterize ecosystems. In ecology, for instance, the passage of a simple way of thinking to a more complex concept is displayed in the replacement of the notion of “food chain” by the concept of “food web”, which is more suited to the complexity of the feeding relationships in an ecosystem (Margalef 1986, 1991; Morin 1983).

The surrounding of an organism is everything around it, including other organisms with which the organism interacts (Hurrell 1990). This concept is close to the notion of *Umwelt* or ’surrounding world’ of the early German ecology, which refers to all of the conditions of the existence of organisms rather than only to physical factors; according to Thienemann (1956), life (*Leben*) and its surrounding world (*Umwelt*) define one another and constitute a unity (totality). Other opinions reflect the same idea. From biology, Maturana and Varela (1972) argue that a living being is coupled to its surroundings, i.e., a system coupled to other system(s) and that the coupling is a condition of existence: if the coupling is lost, the living being dies (the organism/surroundings system denatures).

From epistemology, Bateson (1972, 1981) states that the organism that destroys its surroundings destroys itself, and thus, the surroundings are not something alien to the organism, as is implied in the idea of the environment as physical space (because the surroundings are not "alien", it is preferable to speak of "the organism and *its* surroundings" instead of using the expression "the organism *and* surroundings"). Meanwhile, Morin (1983) notes that both organisms and surroundings (as systems) are integrated into other higher-level systems. This integration reinforces the idea, apparently paradoxical, that living beings are self-organizing systems and eco-dependents at the same time and at all levels of complexity. In this context, the “Gaia hypothesis” holds that life on Earth interacted with the other components of the planet throughout its history, which has affected (and affects) the creation of the conditions of their existence (Lovelock 1979; Margulis 1999). This point is an extension of the concept of organism/surroundings system on a planetary scale of the biosphere and its surroundings. The concepts of self-organizing and eco-dependence facilitate the assessment of the ecological complexity from a broader perspective in which the apparent contradiction between terms acquires a sense of necessary complementarity.

In ecology, “interaction” is often seen as being synonymous with “relationship”. Although one may argue that the term interaction is simply inappropriate by being general and vague, this assumption is incorrect. A relationship is a connection between two or more elements that allows for exchanges of matter and energy between them, i.e., they interact. The relationship is not the exchange (interaction) but is the context that makes the exchange possible; relationships guide the specific actions of organisms in their environment (Wilden 1979). Thus, the possible interactions between two organisms depend on the relationship that the organisms establish in their common surroundings because, as we saw, the organisms are always necessarily linked to their surroundings.

Based on those ideas, if the relationship is antagonistic, for example, between two different species of organisms that share the same resource, the interaction is defined as competition. This type of exchange is not binary, referring only to interactions between the two competitors, but is ternary because those interactions depend on the resource. The resource may correspond to some environmental variable, such as the light for trees in forest or other organisms from other species in the case of two predators with the same prey (Margalef 1986). The situation is most complex if the competitors belong to more than two species. However, the ternary model more satisfactorily reflects the complexity of the ecosystem. This model can explain, for instance, why the population size of each of the competitors depends on the availability of the resource (the third member of the system) through a negative feedback model (as in a thermostat), which describes how the resource regulates the growth of the populations involved (Margalef 1981, 1991).

This case shows that it is possible to provide an explanation, though relatively easy, to create a better understanding of the complexity of the system. However, if we believe that competition is a binary interaction and can be explained by the result of the process (instead of the relationships guiding the process), we affirm that competition is an interaction in which the two species are hurting (Odum 1972). Thus, we assume a simple phenomenon, and the explanation is reductionist. Competition is simplified when expressed in binary form (-,-), which is also used to simplify the complexity of other interspecific interactions, such as predation (+,-) and mutualism (+,+). This simplification means that by focusing on the results of the interaction (what happens to populations), the complexity of the relationships that guide these interactions is ignored or minimized. The ternary model of competition better express the complexity of this relationship: to assume its complexity involves a different basis for the explanation of this phenomenon. In this sense, the complexity must be understood as a starting point and not as a solution (Morin 1990). The complexity must be considered as a challenge instead of a panacea.

Human beings and their surroundings

Among the conceptions of ecology that tend to be over-simplified, it is often assumed that human beings exist outside of the ecological stage. This position is consistent with the dissociation of the organism/surroundings system: if the organism is separated from its surroundings, the surroundings are reduced to the concept of physical space. Human beings (as organisms) are also often held outside their own surroundings. This idea has encouraged a discourse that places human beings against nature (subduing it, dominating it, destroying it), which feeds the old “nature versus culture” antinomy (Morin 1973, 2010). As Morin says: “Humanist myth of supernatural man reconstituted within anthropology, and the nature/culture opposition has taken the form of a paradigm, i.e., conceptual model that heads his own thought” (Morin 1973). In this sense, as argued by Davidson-Huntm (2000), “We need (…) to re-think the nature/culture dualism and its role in our epistemology”.

From the basic concepts of ecology discussed in the previous section, based on the complexity of ecological phenomena, humans are no stranger to their surroundings and, in contrast, form a whole with their surroundings. Thus, if we destroy our surroundings, we destroy ourselves, not because we are divorced from our *Umwelt* but because we integrated it. The relationship that unites us with our surroundings is our condition of existence. In our environment, as for all organisms, including other human beings with whom we interact, it follows that the destruction of other human beings also destroys us in various ways. The main problem lies in how we think about these issues (Bateson 1981). In this sense, "Ecological processes cannot be circumvented (...) In fact, the problem of how to transmit our ecological reasoning to those who want to influence what direction we seem to be an ecologically good, is itself an ecological problem. We are not outside the ecology for which we plan, we are always and inevitably a part of it" (Bateson 1972).

Because the relationship between human beings and their surroundings is an inherent condition of existence, we human beings *are nature*, like all living beings on our planet. However, at the same time, we human beings *are culture*. In fact, the explanations of ecological phenomena that we make are a product of our own cultural parameters, and as we saw, we can point to the simplicity or to the complexity (in which relationships guide actions). It is noteworthy that both nature and culture are constitutive of our human condition. We have never abandoned nature, and we must not deny our culture to return to a “natural state”, if such a state were possible (Berman 1987). This denial marks a dissociation of human beings from their surroundings. On the one hand, an image is held of man “against nature” (humans as separate from nature, which may then be subjected), and on the other hand, an “against-culture” image of man is held (the return to a natural state based on denying culture). This double dissociation is reductionist with regard to the multidimensional nature of human beings.

We have always been part of nature, but the cultural context, our worldview, our way of seeing and interpreting the world, condition how we see that integration. According to the principles of complex ecology, “culture is our natural state”. Ultimately, "man is a cultural being by nature, because he is a natural being by culture" (Morin 1973). The passage from nature to culture, from Lévi-Strauss (1969) and the reinterpretation of his ideas from a communication context (Wilden 1979), suggests that culture has emerged from the natural human condition and that emergence allows for reflection on the human nature. However, the way of reflection is not free of obstacles. Some ideas are deeply rooted, as Morin (1973) claimed: "Since Darwin we admit that we are sons of primates, but not that we ourselves be primates".

The study of the relationships between human beings and their surroundings has been developed from different disciplinary frameworks and has received various names, such as human ecology (Campbell 1985), ecological anthropology (Hardesty 1979) and biocultural ecology (Buxo-Rey 1980). The terms "human ecology" and "ecological anthropology", are focused on human beings. The expression "biocultural ecology", in its broader sense, is more appropriate to evidence the complexity of the relationships between human beings and their surroundings (with the associated abiotic, biotic, social and cultural aspects), emerging from which is the system (ecosystem) that includes us (Albuquerque and Hurrell 2010; Hurrell 1987). In addition, there is a large area of overlap between these different disciplines and often their stories are confused in their own evolution.

The explanations about the human beings/surroundings system that we provide can be based on different underlying theoretical models but are, unfortunately, not always explicit. Such models may vary among individuals, societies or cultures but, as argued by Maruyama (1980), can be considered as general explanatory models, which he calls “epistemological types” or “mindscapes”. The most classical model corresponds to a pattern of linear or deterministic explanation (the cause/effect model), which fits well with the subjects of study that are considered simple (not the systems), in which random has no place. In contrast, random explanations favor randomness (absence of causality), although the starting point is likewise simplicity. Other epistemological types express the complexity of phenomena based on the principle of recursivity: the results of a process interact with the initial conditions that produce the process and regulate the functioning of the system. This regulation or control can be morphostatic (negative feedback), which promotes stability (e.g., a thermostat or the homeostasis), or morphogenetic (positive feedback), which promotes change (e.g., embryonal development or the arms race).

As Maruyama (1980) say: "The choice of causal model in an investigation depends on the epistemological type of the researcher, which relates to their personal characteristics and cultural background". This finding means that we can have more than one explanation for the same phenomenon based on the theoretical premises of the researcher or the traditions of the research lines (as mentioned earlier, for ecology, the concept of an ecosystem as a sum of isolated elements or as a system based on the complexity of organism/surroundings relation). If the starting point is simplicity, the resulting explanation will be of a type; if the starting point is complexity, the resulting explanation will be of another type (Hurrell 1990, 1991).

Thus, it is important to establish consensus about the theoretical principles that guide explanations, which requires reflection on how to build explanatory models that usually is absent or not very explicit in the daily work of researchers. We expect of scientists that their explanations be clear and explicit with regard to both the process and results so that the work can be repeated by others who can reach the same conclusion. It marks the differences between a scientific perspective and a magical perspective, because in the case of a magician the results are clear (e.g., the rabbit is pulled out of a hat), but the procedures are dark (the audience does not know what mechanism was used). Interestingly, some investigations seem to be more magical than scientific, if we reflect upon how and why the investigation was completed.

From the viewpoint of applications, the epistemological types that guide the explanations within a society rarely reflect on its consequences, which may be dysfunctional or even damaging (Maruyama 1992). Some researchers believe that reflection is a philosophical question, but reflection is not exclusive to philosophy. The reflection is inherent to the human condition (Morin 2010). In science, the act of reflection contributes to the clarity of procedures and results because reflection contributes to minimize the polysemy produced by the multiplicity of meanings (Albuquerque and Hurrell 2010).

In biocultural ecology, clarity about the epistemological types that guide the discourses is a matter of necessity. The researchers generate explanations from their own theoretical framework (which is not always explicit). Their explanations refer to how other human beings (from other societies or other cultures) build their own worldview (Hurrell 1987). Clarity of the epistemological basis should make it impossible for the researcher to award, transfer or impose their own categories of thought onto the people who are the subject of study. For example, the categories “medicinal” (according to the theoretical framework of the researcher) and “remedy” (which express views of the subjects that are investigated) are not necessarily equivalent and cannot be transposed in a direct way (Hurrell 1991). With regard to this issue, exponents of ethnosciences have warned of the use of the prefix “ethno-“, with regard to the perspective of the subjects investigated. As argued by Sturtevant (1964), "The prefix ethno- (...) refers to the system of knowledge and cognition typical of a given culture”. However, there is also the understanding that the prefix ethno- linked to a discipline refers to a new field of disciplinary investigation. Varied contributions have been made about so-called “native categories”, "folk taxonomies" or "ethnoclassifications" and its convergences and divergences with the categories of the so-called “Western science” (e.g., from Berlin 1973 to Keller 2011). The term Western is also debatable and may refer to diverse contexts, as claimed by McClatchey (2005).

These explanations are not trivial when embedded in the background of the ecology of human beings integrated into their surroundings, which include other human beings. The imposition of categories (intentionally or not) from one culture to another usually generates dysfunctions or damages the subjects investigated. In this context, the prefix ethno- takes on new meaning: the possibility to compare the systems of knowledge of the researcher and the research subjects and to enter a dialogue in which new patterns of action emerge (Alves 2008; Alves and Albuquerque 2005).

The ethnobotany complexity

Ethnobotany has emerged from the mixture and integration of the knowledge and interests of other disciplines, in particular anthropology and botany. Currently, interactions among other disciplines make the field of ethnobotany as complex as the field of ecology because underlying the different disciplinary integrations is the understanding that the relationship between people and plants are influenced by different factors among cultural, social and environmental spheres.

Over time, ethnobotany has become a complex observational field, whose subject of study is, in its most general sense, the diverse relationships between people and their vegetal surroundings (Albuquerque and Hurrell 2010). According to the above discussion, because ethnobotany studies the human beings/vegetal surroundings system in its various dimensions, ethnobotany is included in the field of biocultural ecology, which studies the human beings/surroundings system in general, and biocultural ecology is part of the wider field of ecology, which studies the organisms/surroundings system (Hurrell 1987). However, it should not be thought that ethnobotany constitutes a "branch of ecology" in the sense of a classical demarcation of a hierarchical system of disciplines, with well-defined limits.

Assuming complexity as a basis, the sequence of ecology to biocultural ecology to ethnobotany represents different levels of approximation, whose boundaries are not obvious. These levels contribute to various aspects of the organism/surroundings system (the most general and inclusive concept). These spaces are emerging from convergence principles rather than subordinate disciplinary fields. Therefore, ethnobotany has its own particular and complex identity, although supported by basic ecological principles, which act as an epistemological background. Thus, ethnobotany becomes a science of synthesis, a transdisciplinary field that integrates the multiplicity of perspectives within the field.

In this sense, *ethnobotany is not ecology* only because this research contributes to the knowledge of plant diversity, to cite just one kind of contribution. *Ethnobotany is ecology* because the study of the relationships between humans (in their cultural and social context) and their vegetal surroundings provide the context in which the knowledge of plant diversity acquires significance.

Ethnobotany is not ecology solely because ethnobotany is linked with plant resources and their possible preservation. It is important to note that a resource is, by definition, what human beings consider as a resource. What some human beings identify, in effect, as a resource for others is not necessarily so. In general, forests are a resource within the framework of Western thought, with a clear sense of dissociation between the organism and its surroundings, which supports the exploitation of the resource (in fact, for many people, forests are viewed only as timber). For people living in the forest, the forest is their home, regardless of the fact that the wood may also be a resource for them. *Ethnobotany is ecology* because ethnobotany elucidates what a plant resource is in different cultural contexts to re-signify what is to be preserved. If we start with a simplifying idea of ecology, which avoids complexity and separates the organism from its surroundings (human beings + surroundings), the result is an ethnobotany in which humans are dissociated from the vegetal surroundings (human beings + plants). If we place the emphasis on the organism/surroundings system, the human beings/vegetal surroundings system takes on new meaning.

Indeed, this redefinition does not operate only at the cognitive level but also materializes in actions. The translation from knowledge to actions is called the “embodiment of knowledge” or “embodied cognition” by different authors (Garavito-Gómez and Yáñez-Canal 2011; Martínez 2008; Varela 1990; Varela et al. 1992). This discussion brings us back to the question raised by considering the modes of thought and action (because knowledge directs actions) that express both the researcher and the subjects that are researched.

These differences of perspective or categorization do not only apply to the differences between scientific thought and the thought of members of another culture but also correspond to the differences between the knowledge of researchers (scientific knowledge) and the thought of the members of their own culture (popular knowledge). For example, a topic in urban ethnobotany (Hurrell et al. 2010, 2011; Pochettino et al. 2008, 2012) is the use of so-called “functional foods” and “nutraceuticals”. The concept of functional food has different interpretations in the academic sphere (polysemy), based on reference to its characteristics, active components or regulatory framework (Hardy 2000; Kwak and Jukes 2001). Functional foods, in addition to their value as sources of nutrients, provide benefits for certain body functions, are important for maintaining health or reduce the risk of disease. According to Kalra (2003), these foods are used for this purpose, although consumers may not recognize their active components and their specific properties but do recognize that the foods "are good for health".

The concept of nutraceuticals is also polysemic; however, from the standpoint of the consumer, nutraceutical is functional food that helps to prevent a disease or assist in its treatment and is recognized for these effects. In this context, what for one consumer is a functional food may be a nutraceutical for another consumer (Kalra 2003). For example, many people eat oranges because oranges are considered to be "good for health" (as well as other fruits), without recognizing their components and their specific effects on the body (the consumers see oranges as a functional food). Other people consume oranges because they recognize that oranges help prevent and fight colds (the consumers see oranges as nutraceuticals because their effect is recognized, at least in a general sense, although the consumers may not know that oranges contain vitamin C and what specific effects this substance produces in the body). Note that recognition (which guides the action of the consumption) is, obviously, a consideration of the perspective of the subjects investigated (Pochettino et al. 2012). Therefore, the consumer's perspective enriches the academic debate on how those concepts must be defined, adding complexity and making possible the dialogue between two different systems, even within the same cultural context.

In connection with the above, in the context of a complex ethnobotany, there are people who identify plants that are used simultaneously for both food and therapeutic purposes. This situation challenges the academic ranking of the usual types of plants because for many people, in different cultures, there is not always a clear and precise division between those categories, and many plants that are "good to eat" also "serve to heal" (Chen 2009; Etkin and Ross 1982; Pieroni and Price 2006). This idea is in accordance with the broad concept of health as a state of complete physical, mental and social wellness, which is not only related to the absence of disease (OMG 2011) but also with the idea of “healthy food”, which in larger cities constantly diffuses through the media and sales are focused on the *dietéticas* or ‘health-food stores’ (Hurrell et al. 2011; Pochettino et al. 2008).

One issue that has become a central development in ethnobotany is the study of traditional botanical knowledge or TBK (Albuquerque and Andrade 2002; Cotton 1996; Leyew 2011; Pochettino et al. 2008, 2012a,b; Silva et al. 2011; Soldati and Albuquerque 2012). This concept is akin to that of traditional ecological knowledge (TEK), which is a contribution to the conservation of biocultural diversity from an integrative perspective (Berkes 1993; Maffi 2001; Mazzocchi 2006; Petch 2000). TBK is defined as a set of knowledge and beliefs about the links between people and the vegetal elements of their surroundings, including plants, parts thereof and their products (Hurrell et al. 2011), that are characteristic of so-called “traditional societies”. Beyond the various connotations of the term traditional (McClatchey 2005), which corresponds to relatively homogeneous cultural contexts with a long history of human permanence in their surroundings, TBK implies a direct relation between people and plants in terms of strategies for the obtaining and consumption of plants. People who consume are who produce, therefore, people know the characteristics of plants and their products. TBK is transmitted orally and in shared action and allows the local human group to endure through various settings according to the changes in their biocultural surroundings; therefore, this knowledge is not static or conservative (as would seem to be implied by the term traditional) but is dynamic and innovative.

There are numerous studies of the TBK because it is many times on the edge of extinction, and the recovery of this knowledge is urgent. Often, traditional knowledge is at risk of disappearing because of external actions on the surroundings, which substantially modify the conditions of existence of a local human group that has no response for the speed of the changes. Sometimes, the actions are oriented from a thought that dissociates the relation between people and their surroundings (which constitute the local biocultural system). Nature is also dissociated from culture, and it is not assumed that, sooner or later, that which destroys its surroundings destroys itself and others. For example, alien aspects are often introduced to local traditions, such as new health systems, different agricultural practices or crop species from other areas, which may gradually replace the native crops that become threatened with extinction (Hilgert and Gil 2005, 2007; Hurrell 1990). In some instances, such introductions, directly or indirectly, take the form of impositions, even when the introductions stem from good intentions, such as improving the living standards of local people. In this context, it is important to remember that the ends do not justify the means.

These examples enter in conflict with at least two principles of a complex ecology: 1) the human beings are considered separate from their surroundings, and consequently, it is not visible that local knowledge emerges from the relationships between the local human group and its surroundings; 2) against cultural relativism, it is assumed that certain beneficial aspects of a given cultural context can be transferred directly to another context with the same results; however, that which may be suitable for one cultural context may be dysfunctional or harmful to another.

In addition, if we assume that the TBK is active and dynamic (adaptive), we can see how traditional knowledge can be combined in many ways with nontraditional knowledge as part of the dynamics of the local knowledge in the context in which it is produced and reproduced, for example, the coexistence of the Western medical system (biomedicine) and the traditional medical system. In this sense, in northeastern Brazil: “Analysis of the Fulni-ô medical system, from the point of view of intermedicality, allows us to recognize its multiplex nature and the fruit of the hybridization of the local medical system with other traditional systems and biomedicine. Although there are well-defined spaces of action in each one of the traditions, given their proper specificity, there is an interaction with the construction of the local medical system that results in different points of articulation depending on the correlation of existing forces and the interests that are involved. We recognize that biomedicine is floating in an ideology that does not encourage heterogeneity but seeks homogenization as a means to domination. Nevertheless, its presence in the Fulni-ô reality strengthens their search for an identity and ethnicity and, with the traditional medical system as the driving force, allows for an outlet for another event of cultural re-elaboration. Once more, we see that the Indians are active agents in constructing their reality” (Soldati and Albuquerque 2012).

Final remarks

Currently, ethnobotany has the challenge to re-define itself, assuming its underlying complexity and making the complexity visible to provide an integrative context of meaning to the plurality of possibilities that ethnobotany includes (Albuquerque and Hanazaki 2009). Also, ethnobotany must assemble the many voices that compose it into a harmonious whole.

Morin (2010) argues that the scientific disciplines tend to be fields increasingly closing on themselves and not communicating with each other; phenomena are increasingly fragmented into smaller pieces, losing the concept of their unity. Even when accepting the inherent complexity of ethnobotany (similar to ecology) and its capacity of dialogue with other disciplines, we cannot lose sight of the fact that the broader context in which the relationship between people and plants occurs is the result of an evolutionary process. Thus, if we assume that the forces operating on the evolution of life forms also operate on human beings in their surroundings, we must open dialogue with other disciplines, such as evolution, evolutionary psychology, behavioral ecology, cognitive sciences and others, well the anthropology and the botany, which have historically contributed to the development of ethnobotany. In this scenario, the following assumptions could guide the study of the relationship between people and plants:

1. The relationships between people and nature are complex, often involving adaptive responses to ecological and evolutionary forces.
2. People’s behaviors and practices may be adaptive.
3. The environment can be assumed as a limiting factor but not as a determinant of human behavior.
4. The perception of nature is a process with structural (biological/sensory) and cognitive characteristics.
5. Knowledge emerges from the relationships between human beings and their surroundings and is embodied in actions and practices. Knowledge guides the actions and these actions feedback on the knowledge, which evolves.

To use ecological theory as a background for understanding the relationships between people and plants, we need to evaluate under what circumstances people's behaviors are adaptive. Modern advances in diverse sciences (from evolutionary genetics to evolutionary psychology, at different levels) can offer interesting theoretical speculation and empirical research regarding the relationship between people and their surroundings (Albuquerque and Hanazaki 2009; Bolhuis et al. 2011).

There are several modern approaches within the current scope of ethnobotany, which often reflect their fields of origin (such as botany, anthropology and others). Nevertheless, from an epistemological point of view, we can understand ethnobotany as a science of complex identity just as we consider ecology as a complex science. If ecology is the study of relationships between living things and their surroundings, *ethnobotany is ecology* because examines the relationships between people and their plant surroundings as well as the contexts in which these relationships have meaning. Assuming this ecological identity of ethnobotany facilitates dialogue with other sciences to understand how much of human behavior can be adaptive.

Acknowledgements

The authors want to thank to María Lelia Pochettino and the integrants of LEBA, Argentina, and to the anonymous reviewers for their interesting and fruitful comments.

References

Albuquerque UP, Andrade L (2002) **Traditional botanical knowledge and conservation in an area of caatinga in Pernambuco state, Northeast Brazil**. *Acta Botanica Brasilica* 16(3): 273-285.

Albuquerque UP, Hanazaki N (2009) **Five problems in current ethnobotanical research and some suggestions for strengthening them**. *Human Ecology* 37(5):653−661.

Albuquerque UP, Hurrell JA (2010) **Ethnobotany: one concept and many interpretations**. In: Albuquerque UP, Hanazaki N (eds) Recent developments and case studies in Ethnobotany. SBEE/NUPEEA, Recife, pp. 87-99.

Alves AGC (2008) **Pesquisando pesquisadores: aspectos epistemológicos na pesquisa etnoecológica**. Proc. 60 Reunião da Sociedade Brasileira para o Progresso da Ciência. Campinas, São Paulo.

Alves AGC, Albuquerque UP (2005) **Exorcizando termos em etnobiologia e etnoecologia**. In: Alves AGC, Albuquerque UP, Lucena RFP (eds) Atualidades em Etnobiologia e Etnoecologia. SBEE/NUPEEA, Recife, pp. 11−23.

Bateson G (1972) **Steps to an ecology of mind**. 1 ed. Ballantine Books, New York.

Bateson G (1981) **Espíritu y naturaleza**. 1 ed. Amorrortu, Buenos Aires.

Begon M, Harper JL, Townsend CR (2006) **Ecology: from individuals to ecosystems**. 4th ed. Blackwell, Oxford.

Berkes F (1993) **Traditional ecological knowledge in perspective**. In: Inglis JT (ed) Traditional ecological knowledge: concepts and cases. International

Development Research Centre, Ottawa, pp. 1−9.

Berlin B (1973) **Folk systematics in relation to biological classification and nomenclature**. *Annual Review of Ecology, Evolution, and Systematics* 4(1):259-271.

Berman M (1987) **El reencantamiento del mundo**. 1ed. Cuatro Vientos, Santiago de Chile.

Bertalanffy L von (1984) **Teoría general de los sistemas**. 1 ed. Fondo de Cultura, México.

Bolhuis JJ, Brown GR, Richardson RC, Laland KN (2011) **Darwin in mind: new opportunities for Evolutionary Psychology**. *PLoS Biology* 9(7):1-8.

Buxo-Rey MJ (1980) **Antropología cognitiva y ecología biocultural: notas sobre el concepto de adaptación**. *Actas Primer Congreso Español de Antropología (Barcelona)* 1:299-318.

Campbell B (1985) **Ecología humana**. 1 ed. Salvat, Barcelona.

Caravantes-García CM (1980) **Sugerencias para una metodología de la interdisciplinariedad.** *Actas Primer Congreso Español de Antropología (Barcelona)* 1:425-442.

Chen N (2009) **Food, medicine, and the quest for good health: nutrition, medicine and culture**. 1ed. Columbia University Press, New York.

Cotton CM (1996) **Ethnobotany: Principles and applications**. Wiley, New York.

Davidson-Hunt I (2000) **Ecological Ethnobotany: Stumbling Toward New Practices and Paradigms**. *MASA Journal* 16(1):1-13.

Etkin NL, Ross PJ (1982) **Food as medicine and medicine as food: an adaptive framework for the interpretation of plant utilization among the Hausa of northern Nigeria**. *Social Science and Medicine* 16(17):1559-1573.

Foerster H von (1991) **Las semillas de la cibernética**. 1 ed. Gedisa, Barcelona.

Ford RI (1994) **Ethnobotany: Historical diversity and synthesis**. In: Ford RI (ed) The nature and status of ethnobotany. University of Michigan, Ann Arbor, pp. 33-49.

Garavito-Gómez MC, Yáñez-Canal J (2011) **Las críticas al concepto de representación y las nuevas posibilidades de la investigación cognitiva desde las perspectivas de cognición situada y corporeizada**. In: Yáñez-Canal J, Perdomo Salazar AM (eds) Cognición y embodiment. Uniminuto, Bogotá, pp. 119-192.

Hardesty D (1979) **Antropología ecológica**. 1 ed. Bellaterra, Barcelona.

Hardy G (2000) **Nutraceuticals and functional foods: introduction and meaning**. *Nutrition* 16:698-699.

Hilgert NI, Gil GE (2005) **Traditional andean agriculture and changing processes in the Zenta River basin, Salta, Northwestern Argentina**. *Darwiniana* 43(1-4):30-43.

Hilgert NI, Gil GE (2007) **Reproductive medicine in northwest Argentina: traditional and institutional systems**. *Journal of Ethnobiology and Ethnomedicine* 3:19.

Hurrell JA (1987) **Las posibilidades de la etnobotánica y un nuevo enfoque a partir de la ecología y su propuesta cibernética**. *Revista Española de Antropología Americana (Madrid)* 17:235-257.

Hurrell JA (1990) **Interpretación de relaciones en ecología a partir de la noción de sistema**. Tesis Doctoral. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Argentina.

Hurrell JA (1991) **Etnomedicina: enfermedad y adaptación en Iruya y Santa Victoria (Salta, Argentina)**. *Revista del Museo de La Plata (n. s.) Antropología* 9(69):109-124.

Hurrell JA, Ulibarri EA, Delucchi G, Pérez ML, Anglese N (2010) **Plantas condimenticias utilizadas en la Ciudad de Buenos Aires y en el noreste de la Provincia de Buenos Aires (Argentina)**. In: Pochettino ML, Ladio AH, Arenas PM (eds) Tradiciones y Transformaciones en Etnobotánica. CYTED-RISAPRET, San Salvador de Jujuy, pp. 344-349.

Hurrell JA, Ulibarri, EA, Puentes JP, Buet-Costantino F, Arenas PM, Pochettino ML (2011) **Leguminosas medicinales y alimenticias utilizadas en la conurbación Buenos Aires-La Plata, Argentina**. *Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas* 10(5):443-455.

Kalra EK (2003) **Nutraceutical. Definition and introduction**. *AAPS PharmSci* 5(3):27-28.

Keller HA (2011) **Problems of guarani ethnotaxonomy: "Animals plants"**. *Bonplandia (Corrientes)* 20(2):111-136.

Kwak N, Jukes DJ (2001) **Functional foods 1-2**. *Food Control* 12 (2): 99-107, 109-117.

Lévi-Strauss C (1969) **Estructuras elementales del parentesco**. 1 ed. Paidós, Buenos Aires.

Leyew Z (2011) **Wild Plant Nomenclature and Traditional Botanical Knowledge Among Three Ethnolinguistic Groups in Northwestern Ethiopia**. African Books Collective, Addis Ababa.

Lovelock J (1979) **Gaia. A new look at fife on Earth**. 1 ed. Oxford University Press, Oxford.

Maffi L (2001) **Introduction. On the interdependence of biological and cultural diversity**. In: Maffi L (ed) On biocultural diversity. Linking language, knowledge and the environment. Smithsonian Institute, Washington, pp. 1-50.

Margalef R (1981) **Ecología**. 1 ed. Planeta, Barcelona.

Margalef R (1986) **Ecología**. 1 ed. Omega, Barcelona.

Margalef R (1991) **Teoría de los sistemas ecológicos**. 1 ed. Universitat de Barcelona, Barcelona.

Margulis L (1999) **Symbiotic Planet. A new look at evolution**. 1 ed. Basic Books, New York.

Martínez SF (2008) **La cognición corporizada en prácticas: implicaciones para la filosofía de la ciencia**. In: Martínez SF, Huang X, Guillaumin G. (eds) Historia, prácticas y estilos en la filosofía de la ciencia: hacia una epistemología plural. UNAM, México, pp. 212-231.

Maruyama M (1980) **Mindscapes and Science theories**. *Current Anthropology* 21(5):589-608.

Maruyama M (1992) **Dysfunctional, misfunctional and toxifunctional aspects of cultures, organizations and individuals**. *Technological Forescasting and Social Change* 42(3):301-307.

Maturana H (2007) **Transformación en la convivencia**. 1 ed. Lom Ediciones, Santiago de Chile.

Maturana H, Varela F (1972) **De máquinas y seres vivos**. 1 ed. Editorial Universitaria, Santiago de Chile.

Mazzocchi F (2006) **Western science and traditional knowledge. Despite their variations, different forms of knowledge can learn from each other**. *EMBO Reports* 7(5):463-466.

McClatchey W (2005) **Exorcizing misleading terms from ethnobotany**. *Ethnobotany Research and Applications* 3:1-4.

Morin E (1973) **Le paradigme perdu: la nature humaine**. 1 ed. Editions du Seuil, Paris.

Morin E (1983) **El Método 2. La vida de la vida**. 1 ed. Cátedra, Madrid.

Morin E (1990) **Introduction à la pensée complexe**. 1 ed. ESF Editeur, Paris.

Morin E (2010) **Ciência com Consciência**. 14 ed. Bertrand Brasil, Rio de Janeiro.

Odum E (1972) **Ecología**. 1 ed. Interamericana, México.

OMG (2011) **Organización Mundial de la Salud** [http://www.who.int/es] Accessed 15 April 2012.

Petch V (2000) **Traditional ecological knowledge: an anthropological perspective**. In: Oakes J, Riewe R, Koolage W, Simpsony L, Schuster N (eds) Aboriginal health, identity and resources. Native Studies Press, Winnipeg, pp. 150-164.

Pieroni A, Price L (2006) **Eating and healing: traditional food as medicine**. 1 ed. Hawthorn, New York.

Pochettino ML, Arenas PM, Sánchez D, Correa R (2008) **Conocimiento botánico tradicional, circulación comercial y consumo de plantas medicinales en un área urbana de Argentina.** *Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas* 7(3):141-148.

Pochettino ML, Puentes JP, Buet-Costantino F, Arenas PM, Ulibarri EA, Hurrell JA (2012a) **Functional Foods and Nutraceuticals in a Market of Bolivian Inmigrants in Buenos Aires (Argentina).** *Evidence-Based Complementary and Alternative Medicine* doi:10.1155/2012/320193.

Pochettino ML, Hurrell JA, Lema VS (2012b) **Local botanical knowledge and agrobiodiversity: homegardens at rural and periurban contexts in Argentina**. In: Luna-Maldonado AI (ed.), Horticulture, pp. 105-132.

Prigogine I (1972) **La thermodynamique de la vie**. *La Recherche* 3(24):547-562

Prigogine I, Stengers I (1990) **La nueva alianza. La metamorfosis de la ciencia**. 1 ed. Alianza Editorial, Madrid.

Silva FS, Ramos MA, Hanazaki N, Albuquerque UP (2011) **Dynamics of traditional knowledge of medicinal plants in a rural community in the Brazilian semi-arid region**. *Revista Brasileira de Farmacognosia* 21(3): 382-391.

Soldati GT, Albuquerque UP (2012) **Ethnobotany in Intermedical Spaces: The Case of the Fulni-ô Indians (Northeastern Brazil)**. *Evidence-Based Complementary and Alternative Medicine* doi:10.1155/2012/648469.

Sturtevant WC (1964) **Studies in ethnoscience**. *American Anthropologist* 66(3):99-131.

Thienemann AF (1956) **Leben und Umwelt. Von Gesamthaushalt der Natur**. 1 ed. Rowohlt, Hamburg.

Varela F (1990) **Conocer**.1 ed. Gedisa, Barcelona.

Varela F, Thompson E, Rosch E (1992) **De cuerpo presente**.1 ed. Gedisa, Barcelona.

Wilden A (1979) **Sistema y estructura**.1 ed. Alianza Editorial, Madrid.