Reflections on the use of hypotheses in ethnobotany: A response to Leonti et al. (2020)

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Reviews

Abstract

In this article, we examine the review by Leonti et al. (2020) on the use of hypotheses in ethnobotany and we argue that the authors presented two main argumentative deficiencies on their analysis: superficiality and epistemological exclusivism. We discussed the main criticisms of the diversification hypothesis, the utilitarian redundancy model and the availability hypothesis and reinforced the importance of using ecological and evolutionary scenarios to understand the relationship between people and plants.

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Background

Ethnobotany is a vigorous field of knowledge that has undergone profound transformations in recent decades, especially with respect to theoretical advances and greater commitment to social and political engagement (Ludwig 2018, Wolverton 2013, Wyndham *et al*. 2011). Since the 1990s, after repeated criticism of the field, especially due to the lack of greater scientific rigor and studies guided by hypotheses, the area has undergone major changes (Gaoue *et al*. 2017). Particularly, dialogue with theoretical scenarios of ecology has been important for the development of ethnobotany as a scientific field, from a theoretical point of view (Albuquerque *et al*. 2019, Phillips & Gentry 1993).

With the proposal to review some of the hypotheses developed in ethnobotany, and which are based on ecological and evolutionary scenarios, Leonti *et al*. (2020) argue that they do not contribute to advance our knowledge on the relationship between humans and plants, besides having flaws. We argue that the authors failed in this regard, due to two important deficiencies in their argument. First, the authors criticize the hypotheses superficially, without examining the extensive literature on the subject, which include findings that provide evidence against the arguments they defend. Second, and more serious in our view, is the argumentative limitation from the point of view of epistemology and philosophy of science. In relation to this second aspect, when defending the approach of cultural history to the detriment of the research they criticize, they fall into the dangerous field of epistemological exclusivism. In doing so, they disregard that each approach in science is based on different scientific methods (from a philosophical point of view), with different applications, scope and limitations.

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In this manuscript we present counter-arguments to the criticisms punctuated by Leonti *et al*. (2020) in relation to the hypotheses of availability and diversification, in addition to the concept of utilitarian redundancy. Finally, we present some general aspects of the criticisms presented by the authors, indicating the relevance of the hypotheses developed in ethnobotany to investigate the relationships between people and medicinal plants, with an interdisciplinary bias.

Diversification hypothesis

The diversification hypothesis has been proposed to contribute to the understanding of the reasons why exotic species are incorporated into local medical systems. This hypothesis postulates that the entry of these species is a strategy to diversify medicinal systems from the pharmacological point of view (Albuquerque 2006). Thus, alien plants could help fill therapeutic gaps not filled by native plants.

The authors point as the main criticism for the hypothesis that “introduced dietary plant species often had already established uses as medicines in their place of origin. That profiles of secondary metabolites are the outcome of phylogenetic history reflecting ecological constraints is accepted knowledge. Therefore, introduced species have a high probability to contain bioactive secondary metabolites not found in local sources”.

It seems to us that the authors tried to label the hypothesis as obvious because they assumed that exotic species are naturally more likely to have different compounds than those found in one place. However, this is a superficial conclusion that does not take into account a number of aspects, such as: not all exotic species enter the local medical systems, which, according to the logic of the hypothesis, could be due to differences in contribution to pharmacological diversification; exotic species have different degrees of chemical and pharmacological overlap with native species, and according to the hypothesis this is precisely what will lead to differences in popularity between alien species.

The authors' criticism of the absence of a historical approach to this hypothesis makes no sense, since this approach would not allow testing the reasons of the behavior in relation to the introduction of plants in their current cultural systems (see Albuquerque 2006, Medeiros *et al*. 2017). The same would apply to human groups in the past (as in the case of Hart *et al*. (2017), in which data from plants introduced in human groups in the 18th century were used).

The authors seem to ignore the hypothetical deductive method process when compared to the cultural history approach. The hypotheses, when used in the approach of cultural history, would have an explanatory and interpretative function, with the aim of "giving meaning" to a set of collected data (see, for example, Beehler 2010). In the hypothetical deductive method, ideas are subjected to rigorous tests aiming at their falsifiability and, if they go through this process, they acquire the status of “provisionally verified knowledge” (Beehler 2010). By advocating, throughout the article, that only the approach of cultural history could answer the questions raised by the hypotheses/theories in ethnobotany, the authors defend an epistemological fallacy, as they ignore the epistemological differences between different approaches in science.

Utilitarian redundancy

Originally, the idea of utilitarian redundancy was developed to assess the functional overlap of resources in a social-ecological system, from the emic point of view (that is, from the perspective of the users or people who are knowledgeable on these resources) (Albuquerque & Oliveira 2007). In this sense, if in a human group different plants are indicated for the treatment of the same disease (function), this reflects a redundancy of these plants for that given function (Albuquerque & Oliveira 2007). According to Leonti *et al*. (2020), the idea of redundancy only makes sense based on a chemical evaluation and the pharmacological mechanisms of action of the species indicated as medicinal in one or more human groups.

The authors state that the model “appears to be conceived as being diagnosis independent classifications into more or less finely tuned etic categories of medical use without contemplating the pharmacology or chemistry of the specific herbal drugs”. They also mention that “for identifying the redundancy of therapeutic functions, the multiple pharmacological mechanisms of action of herbal drugs as well as precise diagnoses, including the identification of pathogenic agents, physiological and histological markers would be necessary”.

In this way, criticisms of the utilitarian redundancy model reveal a tendency to overestimate the chemical and pharmacological aspects without considering how they are translated, mediated or interpreted by the culture. Thus, we understand that the concept of utilitarian redundancy should not be limited to a chemical and pharmacological evaluation of medicinal plants, as this evaluation is linked only to the researchers' point of view, ignoring what the

studied human groups think and how they organize their medical systems (Medeiros *et al.* 2020).

This defense of “ethical” exclusivism is curious when ethnopharmacological research itself necessarily starts from the local/traditional knowledge of human beings. It would be an interesting investigation to verify the pharmacological action of locally redundant plants, assessing whether they share chemical characteristics and pharmacological actions. In this case, Leonti *et al*. (2020) suggest that there may be situations in which two or more species are indicated for the same therapeutic uses but have different chemical and pharmacological mechanisms between them. This process generates relevant questions about the factors that, in addition to pharmacological properties, explain the selection of chemically or pharmacologically distinct plants for the same diseases.

It would be acceptable if Leonti *et al*. (2020) argued that the redundancy observed in the local system is not always reflected in a “redundancy” of species from the chemical and pharmacological point of view, but it would not invalidate the approach based on local knowledge. However, when reading the authors article, it seems that we should disregard an emic assessment of redundancy and, in our view, this would be a reductionist view of local medical systems and a long-criticized perspective. For example, Reyes-García' (2010) review highlights the need for ethnopharmacological studies to incorporate holistic approaches to understand traditional knowledge systems, not only focusing on active compounds of resources used as medicinal (see also Albuquerque *et al*. 2014).

According to Leonti *et al*. (2020), "Studies using the concept of utilitarian redundancy, such as Alencar *et al*. (2014) or Santoro *et al*. (2015), do not specify which species are redundant and instead point out disease categories and body system disorders, which are considered more or less redundant...". However, specifying which species are redundant was not the focus of the works cited. Moreover, why should this constitute a criticism of a scientific model? It is possible that the authors (Leonti *et al*. 2020) are concerned only with the species, while the work of Alencar *et al*. (2014) and Santoro *et al*. (2015) are concerned not only with the species, but also with the functionality of the local medical system, evaluating the redundancy to infer about resilience. In other words, the authors criticized by Leonti *et al*. (2020) would be more concerned with understanding phenomena. Thus, much of the discussions in the work of Alencar *et al*. (2014) and Santoro *et al*. (2015) highlights the importance of redundancy in maintaining the functions and processes of the local system in the face of disturbances over time. For example, if a disturbance causes the local extinction of certain useful species, other redundant species may maintain the functions of the extinct species. Leonti *et al*. (2020) disregard this implication of redundancy. In this sense, the utilitarian redundancy model proposed by Albuquerque & Oliveira (2007) has been used in research that discuss the resilience of local medical systems in different human groups (Díaz-Reviriego *et al*. 2016, Nascimento *et al*. 2016, Torres-Avilez *et al*. 2019). Thus, the redundancy model has been useful and applicable in different contexts, without necessarily needing pharmacological evaluations of medicinal species.

Availability hypothesis

The arguments presented by the authors against the availability hypothesis reveal a problematic facet of current scientific practice: neglecting the study of relevant questions by crediting them as obvious or intuitive. In such cases, there is always the risk of perpetuating anecdotal affirmations without submitting them to proper testing.

When the authors state “it is rather intuitive that resources need to be available in order to be used”, they are employing a superficial interpretation of the hypothesis. The central idea of the studies dedicated to availability is to evaluate, among a set of species already known to be (more or less) available to people in a given region, if availability influences their differential use.

In fact, a deeper evaluation of the studies on the subject provides elements that discard the idea of obviousness. Literature has shown that, for certain use-categories, differential use is not driven by local availability. Specifically to what concerns medicinal plant use, a meta-analysis for the hypothesis performed by Gonçalves *et al*. (2016) showed that availability measured by ecological parameters does not influence the differential use. Such a pattern is more easily observed for use-categories that require the extraction of higher biomass, such as fuelwood or construction (Gonçalves *et al*. 2016).

General considerations on the importance of interdisciplinarity for the construction of hypotheses

At different points in the text, the authors suggest an evaluation of the selection of medicinal plants focused on specific factors, such as pharmacological aspects or linked to cultural history, disregarding other important scenarios for evaluating the selection

of medicinal plants by human groups at present. Although the factors defended by the authors are important for understanding the relationships between the people and resources indicated in medicinal use, the authors neglect the relevance of the hypotheses from ecological and evolutionary scenarios (see Albuquerque *et al*. 2019). We understand that the absence of an ecological (and evolutionary) reflection by Leonti *et al*. (2020) is linked to an observation made by the authors themselves indicating that ecological scenarios would be limited to assess the selection of plants by human groups, since they do not consider historical information. Different scientific approaches are not mutually exclusive and should not be neglected in investigations on the selection of medicinal plants, as the phenomenon of selection is complex and can be assessed by several factors, such as biological, sociocultural, chemical and pharmacological, historical, among others (Albuquerque *et al*. 2020, Leonti *et al*. 2015, Menendez-Baceta *et al*. 2015, Saslis-Lagoudakis *et al*. 2012).

In this sense, an excerpt from the conclusion by Leonti *et al*. (2020) draws special attention to us: "The recent call for more hypothesis-driven research in ethnobotany resulted in an uncritical and sometimes erratic application of hypotheses also used for describing well-accepted knowledge and cultural realities. Since the hypotheses and theories discussed herein ignore the cultural history that guided and shaped human-plant interactions, we highlight its importance." When considering the interdisciplinary nature of ethnopharmacology (Reyes-García 2010), the hypotheses of versatility, diversification and availability have been derived from ecological scenarios and can be evaluated, including when considering the cultural history of the use of plants in different human groups to explain resource incorporation processes. This only favors the performance of interdisciplinary research in the future, without necessarily invalidating research and scenarios that have embraced the cultural history approach.

Declarations

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