Chapter 13

Ethnobotany and Ethnoecology Applied to Historical Ecology

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Abstract

In this chapter, the reader will find guidelines and suggestions for the application of ethnobotanical and ethnoecological methods in archaeological sites and their surroundings, aiming to establish a closer dialogue between ethnobiology and archaeology for understanding the human history of past and present landscapes. The goal of such methodological proposals is to document the knowledge and practices of human populations that live on and around archaeological sites concerning the vegetation of these areas. The methods presented here can shed light on specific questions about the relationships between past human populations and their plant resources (e.g., practices of use, management, and domestication), helping to understand how people transformed the landscape and how the legacies of such relationships are visible in the present. This chapter is collectively written by ethnobiologists, botanists, ecologists, and archaeologists from several institutions working in the Amazon basin. Thus, examples presented here come mainly from research conducted in this region.

Key words Archaeological sites, Useful plants, Domesticated landscapes, Landscape transformations

1 Introduction

Long-term human activities have modified the environment during much of the Holocene, if not earlier [1]. Through management practices, people have transformed the landscapes in which they live into more productive and secure cultural niches for human dwelling, foraging, and food production [2–4]. The emergence of food production systems, starting around 10,000 years ago, caused enduring impacts on species distributions with the promotion and expansion of populations of domesticated animals and plants [5].

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Along with modifications in species compositions and distributions, humans have increased the complexity and heterogeneity of landscapes through changes in soil properties and hydrology [3, 6]. Thus, contemporary landscapes can be considered the result of complex interactions of multiple factors over time, including human actions and natural events [7]. Historical ecology is an interdisciplinary research program that seeks to elucidate the histories of interrelationships between human populations and their landscapes [8–11], attempting to understand the nature, the intensity, the spatial extent, and the persistence of human landscape transformations [12, 13]. Ethnobotany and ethnoecology offer methods that are useful for researching the historical ecology of landscapes. This chapter outlines these well-known methods and shows how they interact with other disciplines involved in historical ecology research.

Understanding the human history of a place is necessary for understanding the landscapes of the present [6, 14]. Archaeological sites are the places where we find material evidence of past human occupations, whether from decades or millennia ago. A great variety of archaeological sites and remains exist, from many geographical regions, periods, and peoples, that result in different contexts, use histories, and, ultimately, modern landscapes (Fig. 1). Examples of archaeological sites include settlements with permanent housing, temporary campsites, and agricultural, ceremonial, and tool-

Fig. 1 The Monte Castelo shell mound archaeological site near the Guaporé River is predominantly formed from freshwater snail shells and other materials intentionally deposited by humans since the early Holocene. This created an elevated area that is always above the level of the inundations in the seasonally flooded savannas in Rondonia State, Brazil, and supports a distinctive vegetation, including forest taxa. Credit: Myrtle P. Shock, UFOPA

production areas. Archaeological remains include fragments of ceramic vessels, stone artifacts, glass and metal objects, animal and human bones, plant remains, as well as features such as hearths, burials, anthropogenic soils, and postholes. Archaeology, through the analysis of different material cultural remains, reconstructs the history of human populations, and includes archaeobotany, also known as paleoethnobotany, that focuses on the relationships between people and plants through the analysis of botanical remains [15]. Archaeobotanical data can provide insights into diet, subsistence strategies, and resource management practices [16–19]. A closely associated discipline, paleoecology, seeks to understand the environmental conditions that persisted during a certain period. The identification of plant remains in paleoecological records can offer insights into how and how strongly humans modified vegetation on both local and regional scales, and when combined with archaeology contributes for a thorough understanding of the historical ecology of the landscapes [20].

Since modern landscapes are the result of cultural activities in the past [6], present-day plant communities may contain information that helps to tell stories of how humans occupied and constructed their niches [21], providing a complement to archaeological remains as a tool to understand cultural changes [22], that is, they can be considered ecofacts [23, 24]. Plants are an important part of cultural niche construction of all peoples, as numerous plant species with different uses are fundamental elements to supply the material and spiritual needs of day-to-day life of all human communities [25–27].

Through intimate, long-term interaction with the landscape, people developed detailed knowledge about how to manage and transform their environment [4]. People who live near and on archaeological sites today use and appropriate the legacies of past populations, such as the anthropogenic forests and soils, and are able to identify and differentiate forest communities and resources [26, 28] and classify them according to their uses [29]. This knowledge is critical to the histories about how niche construction transforms environments into landscapes. The different cultural dimensions of people–plant interactions and the metaphorical representations embedded in this knowledge and practices can be revealed through the methodological framework developed by ethnobiology and ethnoecology [30]. In this chapter, we propose guidelines for the application of ethnobotanical and ethnoecological methods for studies of plant communities associated with archaeological sites, in order to identify legacies of plant and landscape use and management, and to investigate the ways in which local people continue to incorporate and perpetuate these legacies. Following a presentation about archaeological sites as study locations, this chapter focuses on specific methods that can be used to

approach questions that stem from historical ecology. Most research projects combine more than one method, as they are complementary in nature.

2 Archaeological Sites as Nexuses for Investigating the History of Human–Plant Interactions

The reoccupation of archaeological sites is a common phenomenon [31], as cultural, social, and symbolic motivations can lead groups of people to recognize cultural landscapes as places to settle [32]. The continuities between the scenarios of past and present populations are not always clear, especially in places with violent colonization histories. Traditionally, such continuities are sought in social structures, in settlement and demographic patterns [31]. However, the notion of continuity can also be understood as the particular ways of relating with the environment, culturally and historically constructed by peoples of the past, and constantly re-signified by current populations, whether or not they have genetic or social relationships with the prior inhabitants [31]. An archaeological site and its surroundings encompass areas with different functionalities: habitation areas, plazas, activity areas, home-gardens, swiddens, trails, ritual areas, etc. Different functionalities are associated with different ways to use and manage the land and resources, and therefore can lead to different visible legacies on the landscape. When a place is reoccupied, these functionalities can be different and they are also likely to change with time (see Fig. 2 for a hypothetical superposition of past and present occupations). As a result, a complex vegetation palimpsest emerges, composed of a mosaic of useful plants introduced in different spaces and in different periods of time. Ethnobiological methods, designed for accessing the current relationships between people and their landscapes, can help disentangle the different dimensions involved in the construction of such a landscape.

We recommend that, whenever possible, the collection of ethnobotanical and ethnoecological data be done in combination with archaeological research. Assessing the relationship between past activity areas and modern plant species distributions is important for understanding long-term people–plant relationships. For instance, in Amazonian archaeological sites, anthropogenic soils (such as Amazonian Dark Earths, or *Terra Preta de Índio*) (Fig. 3) are often associated with areas inhabited by people in the past, and as one moves away from the habitation areas, the degree of soil modification tends to gradually decrease due to other types of past land use [34, 35]. Surrounding areas, at greater distance, with barely or unaltered soils are interpreted as having been used with lower intensity (e.g., for hunting and plant gathering).

Fig. 2 This hypothetical scheme shows a current riverside community (above) that has reoccupied a place previously occupied by a pre-Columbian indigenous population (below). The representation of the past occupation is inspired by the Xinguano villages depicted in Heckenberger [33]. Designed by Flavio Cassino

Recognizing the heterogeneity within and between archaeological sites is important for more accurate interpretation of present vegetation patterns in previously occupied areas.

3 Selection of Collaborators

The methods of ethnobiology, when applied to historical ecology studies, usually seek to understand the legacies of long-lasting histories of cultural niche construction in current landscapes. Thus, people who have lived for a long time in the study area (e.g., former residents, communities founders), are usually appropriate collaborators in surveys. The collaborators can be selected through the snowball technique [36]. According to the objectives of the researcher, other requirements besides long permanence in the region should be considered. For example, when studying the legacies of past populations on forest composition around archeological sites, extractivists, hunters, and others who frequently make use of forest resources are recommended potential collaborators. When looking for the influence of past occupations in homegardens, women who tend the gardens are the preferred collaborators [37]. For studies about vegetation diversity of fallows on anthropogenic soils, farmers who are more knowledgeable about soil types and old cultivated areas will be the most appropriate contributors (e.g., [38]). Depending on the research question, a systematic or random selection of collaborators may be required;

Fig. 3 Profile of an Amazonian Dark Earth (*Terra Preta de Índio*) at the Hatahara site, Iranduba, Amazonas, Brazil. Note the dark brown color and numerous ceramic fragments. Credit: Val Moraes, Central Amazon Project, USP

for example, to access the general knowledge on soil–plant interactions, including—but not limited to—archaeological sites (e.g., [38]). For further general recommendations on the criteria to choose survey collaborators, see Albuquerque et al. [39].

4 Free Listing of Landscape Categories and Useful Plants

Free listing is an interview strategy designed to provide an inventory of a certain cultural domain, that may also contribute to identify the cultural importance and salience of items, to identify

local specialists, and to analyze intracultural variation [40]. Free listing is a tool that has advantages and limitations, and should always be executed following the good practices recommended by Albuquerque et al. [41], Balée and Nolan [42], and Quinlan [40].

The employment of free lists on and around archaeological sites is a valuable approach for understanding local perceptions about different landscape domains, areas used in the present and past, and the different degrees of human influence across the landscape. As an example, the Ka'apor people of eastern Amazonia recognize a series of landscape domains, including high forests, fallow forests, swamp forests, riverine forests, old and new gardens, and patches with specific dominant tree species [42]. The Wajãpi people, of northeastern Amazonia, recognize different types of fallow forests according to their successional stages and their species composition (closed fallow, new fallow, old fallow, and clean fallow) [43]. The Yanomami people of northern Amazonia recognize at least 25 types of vegetation in their territory, including different successional stages of swiddens and fallows, forests with different degrees of human impact and different structures and composition [44].

Free lists can also be used to help elicit the plant composition of different landscape domains [42]. Balée and Nolan [42] asked Ka'apor collaborators to list trees that occur in fallow forests (which would be vegetation domains with cultural history) and trees that occur in high forests. The same logic can be applied to elicit plant species occurring in archaeological areas, such as species that occur on Amazonian Dark Earths [45].

Free lists of plants that occur in different areas within archaeological sites may also provide useful information that can be fed into predictive models of the occurrence of archaeological sites. Data on the distribution of archaeological sites, especially in forested areas, is still scarce and highly heterogeneous [13]. In the Brazilian state of Acre, for example, hundreds of geometric earthworks, known as geoglyphs, were discovered only after deforestation in the last few decades [46]. In recent years, with the advances of GIS technologies and the creation of extensive databases, predictive models of archaeological sites location have been developed, helping to optimize surveys to locate new sites [47–50].

In the Amazon basin, numerous useful palms and trees (e.g., *Elaeis oleifera* and *Bertholletia excelsa*) are indicators of cultural landscapes [45, 51]. Forest patches enriched with these and other useful species are considered "cultural or anthropogenic forests," because they are believed to be the result of past human management [24, 51] (Fig. 4). Clement et al. [52] suggested four categories of plant species that are indicators of anthropogenic soils in Amazonia: (a) species whose distribution is limited to anthropogenic soils; (b) out-of-range indicators; (c) out-of-typical-habitat indicators; (d) species with greater density, dominance, or frequency in anthropogenic soils rather than elsewhere.

Fig. 4 A Brazil nut (*Bertholletia excelsa*) stand along the edge of Jutica Lake, Tefé, Amazonas, Brazil. Most Brazil nut stands across Amazonia are anthropogenic in origin [53]. Credit: Eduardo K. Tamanaha, IDSM

Thus, free listings may be used to identify plant indicators of archaeological sites. Junqueira et al. [54] interviewed smallholder farmers about species that occur in fallows on ADE and in fallows on other types of soil. Using the lists produced, the authors applied an indicator species analysis [55], commonly used in ecological research, to identify which species can be considered indicator species of anthropogenic soils, without explicitly asking local residents. When applied across a wider area by integrated research groups, information about the occurrence of these species should contribute to determine regional patterns of distribution of plants that are considered indicators of archaeological sites. Further tools to analyze the cultural importance of the items cited during free lists can be found in Albuquerque et al. [41], Balée and Nolan [42], and Quinlan [40].

5 Interviews About the Uses and Management of Plants

Interviews are commonly used in ethnobiological studies. Semi-structured interviews, in which the main questions are established by the researcher to guide the collaborator to topics sought by the researchers, provide opportunities for issues that come up during conversation to be included and explored when the researcher judges them to be relevant [41]. For further discussion of the care needed for planning and executing interviews see Albuquerque et al. [41].

For historical ecology approaches, semi-structured interviews can draw upon the collaborators' knowledge of the environment, the patterns in which useful plants occur in the landscape, their associations with different elements of archaeological sites, and the areas and the ways in which they are used and managed. The persistent effects on the landscape of past management practices are often recognized by modern societies. Numerous of these cultural practices are perpetuated in the present, and modified by current societies, sometimes dynamically re-signified and adapted to local demands [3].

Similar to what was proposed for free lists, interviews can be formulated in order to elicit the different landscape units recognized by local people and the plants used by them [28]. For each plant, questions can be asked about (a) the plant's uses, (b) how it is managed, and (c) where it occurs. In addition, semi-structured interviews may provide qualitative information about the symbolic relationships between local people and the environment, and their impressions about the societies that occupied the region in the past, contributing to understanding how current societies re-signify and transform legacies from past populations.

In order to facilitate data analysis, the types of use and management can be defined and grouped into categories. Uses can be grouped into categories depending on the purposes for which a species is used. An extensive literature exists on the compilation and analysis of these categories of plant uses [44, 56–59]. Management practices can be grouped into categories depending on "what people want to achieve, whether the effects of the practice are directional or not in the way they fundamentally shape plant species assemblages, and whether the practices result in similarities in terms of forest composition, abundance and distribution of useful species" ([3], p. 4). See Levis et al. [3] for a proposal of management practice categories.

The places where a species can be found can be categorized into two main groups: past areas of use (e.g., irrigation canals, anthropogenic soils, mounds) and present areas of use (e.g., habitation areas, homegardens, swiddens, fallows, high forests). As mentioned previously, when ethnobiological methods are used in conjunction with archaeological surveys, previously used and/or managed areas can be defined much more accurately. Certain elements of archaeological sites are recognized by current local populations, who usually incorporate them into their daily activities. They can thus be sought during interviews as particular landscape units. By coupling this local recognition with available archaeological data, the distribution and overlaps between modern and past land uses categories can be compared across the archaeological site.

Semi-structured interviews were used by Machado Mello and Peroni [60], in association with other methods, to investigate local populations' perceptions about cultural landscapes in *Araucaria*

forests of southern Brazil. Their interviews contained questions regarding local ecological knowledge, management and uses of resources on *caívas*, specific landscape units of the *Araucaria* forest where animals are raised and plants are harvested by local people. With this approach, they were able to identify transformations in local resource use and management over the years and highlight the role of human management for the conservation of these systems.

When applied to historical ecology, interviews must capture the local understanding of the multiple temporalities present on the landscape. Thus, the approach should be informed by the local perceptions of the origins and the history of the cultural landscape being studied, and their relationships with the current distribution of plant species and communities. Forest patches dominated by useful plants, for instance, may be interpreted by local people as legacies of past human populations, as observed in our studies in Amazonia (e.g., [3]). Local people also consider animals to be responsible for the occurrence of forest patches, because they disperse the majority of tropical plant seeds and are frequently observed doing so. Our experiences in Amazonia have shown that, especially when dealing with forest patches close to habitation areas and cultivated fields, current residents can recall information about who was responsible for planting them. In areas that have been continuously occupied, historical knowledge of the landscape can be very detailed and go well beyond the memory and/or lifetime of local residents. Certain mythological narratives contain references to specific plant origins, such as the allusion to the guaraná (*Paullinia cupana*) domestication event in a myth by the Sateré-Mawé people of Central Amazonia [61]. In addition, anthropogenic forests are not interpreted by local people in isolation from other evidence (whether material, such as ceramic fragments, or cultural, such as oral history) considered to tell stories about forests and landscapes. From these modern observations, timelines can be projected for the histories of different plant species and places in the landscape.

By assessing present uses and management practices of plant resources and local perceptions about the landscape, historical ecology is able to design scenarios of how people constructed elements of the current landscape [62]. Recognizing the dynamic nature of cultural practices and eliciting information about past uses and management practices of natural resources enriches these scenarios. Careful interpretation of interviews is important when inferring the temporal depth of the use and management of plant resources observed in the present. Based on our experience in Amazonia, we mention two examples:

– The current social/cultural/economic importance of the species vs. the possible importance it may have had in the past. These data can often be obtained in historical accounts and

ethnographies. For example, manioc (*Manihot esculenta*) is widely cultivated and consumed by Amazonian populations in the present, but may have had less cultural importance in the diets of pre-Columbian populations [63, 64].

– The tools and management methods available in the past. In Amazonia, the absence of metal tools in pre-Columbian societies suggests that slash and burn agriculture is a postcolonial practice [65].

6 Accessing Local Oral History

Oral history techniques can be conducted through unstructured or semi-structured interviews with broad stimuli about the collaborators' life story. This method reveals stories of recent times, which are per se embedded in narratives and memories of different time depths [66]. By narrating memories to others, one can create symbolic networks, which strengthen the construction of identities within a group linked by common events. In this manner, even when facts were not experienced by the speaker, they can be significant in his memory. Oral history recognizes the agency of people in cocreating present realities [67] and "is based on awakening people's consciousness and strengthening pride in their own experience and identity" ([68], p. 3).

In the case of historical ecological research, thematic oral history, in which interviews are conducted around a central theme [69], can be used to elicit the memories of the criteria used to select a certain place for settling, its landscape dynamics, the changes that have occurred in resource use and management, the presence of prior communities/peoples and their activities, etc. Moreover, this method can provide qualitative information about the symbolic dimension of the interaction between local people and their environment.

By accessing the memories related to transformations and appropriations of the landscape, thematic oral history may be able to fill in gaps, through specific information from collaborators' reports. As an example, a former resident of Caiambé Lake (in Central Amazonia) reported to us that when he first arrived in the region some Amazonian Dark Earths in the area were filled with concentrations of hog plum (*Spondias mombin*), a tree species less common today in the local landscape. When analyzing charred plant macroremains from an archaeological site in the region, we found remains of this species, indicating its use by populations in the past. By combining oral history with archaeological data, we drew a time line of activities involving the use and management this species at Caiambé Lake.

Archaeological sites awaken a myriad of feelings and representations in local populations, triggering different forms of interpretation of the past. The life experiences of people living today on archaeological sites form networks, where archaeological remains gain meanings according to each one's trajectories. The plants of the present, with all their associated symbolic universe [43, 70], are also interpreted according to personal and shared stories. By assessing these representations, oral history complements academic interpretations of archaeological sites and cultural landscapes [43, 66].

The interview is the moment of an important encounter between the researcher and the collaborator, when a relationship of complicity is created for the production of a narrative [66]. Thus, a number of rules of ethical conduct should be observed, as described by Medeiros et al. [67] and the International Society for Ethnobiology [71]. See Medeiros et al. [67] and Meihy [69] for recommendations on the transcription, validation, and analysis of the interviews.

7 Participatory Mapping of Past and Present Use Areas and Useful Plant Distributions

Participatory mapping is a tool that can be used for locating the distribution of areas of past and present land use and the occurrence of plant resources. Maps elaborated using this technique are important representations of how people perceive their territory and the elements they find to be meaningful [72]. Thus, they are also a tool for community empowerment, as they emphasize local protagonism in elaborating a research product that represents the collective knowledge of the community, encompassing information from the present day to an unknown time in the past [73]. Participatory maps are particularly important for studies in historical ecology, as they are efficient tools to elicit recent landscape history, efficiently assessing changes in land use or in the distribution of plant resources, through the production of maps representing the landscape in different periods [74].

Methods of mapping, and cartographic representations in general, may be unfamiliar to members of many communities. Thus, researchers have the responsibility to discuss their objectives, the methods, the advantages and disadvantages, and basic elements of cartography to the participants before beginning the mapping [73, 75]. Further advice on researcher conduct for guiding participants in the elaboration of maps can be sought in Silva et al. [75].

There are several ways to carry out participative mapping [75]. We present two examples that we consider most suitable for collecting of data while working on archaeological sites: mental

maps (sketches) and mapping over cartographic bases. Both can be produced by working either with individuals or with groups. In the case of the elaboration of individual maps, the researcher may also construct a final map made by compiling those produced individually. When possible, the final product should be validated in a workshop with the community.

Mental maps are cartographic representations that do not require scale or formal references, such as geographical coordinates [72]. They are handmade drawings and their production requires simple material (e.g., A1 or A3 size paper and colored pencils). This method does not seek exact measurements or consistent and georeferenced scales, as the drawn representation is open to the author's perceptions of his/her reality [72]. Elements that are more significant tend to receive greater emphasis in this kind of mapping.

For historical ecology approaches, mental mappings can be applied to represent the local landscape in the recent past. The researcher can ask, for instance, that older residents represent how the landscape was organized when they were young (forested areas, cultivated areas, dwelling areas, location of the main plant resources, etc.). Another approach is to stimulate the representation of different elements of the archaeological site near or on which they live (e.g., where can one find anthropogenic soils, caves, earthworks, rock paintings, old cemeteries, etc.).

For mapping with cartographic bases, a printed and georeferenced base map or satellite image (preferably on large paper), containing landscape features that can be easily identified is taken to the community. Participants use the map to locate the information they wish to represent, drawing with colored pencils over tracing paper [75]. The base map must not influence the participants' perceptions of significant areas or features, to ensure that they represent objects/phenomena most related to their own experiences [72]. However, basic elements, such as rivers, community locations, and roads, should be indicated by the researcher to improve the informants' understanding of the scale and the locations of reference features. Since the drawings made by participants are overlain on a georeferenced base map, all information produced can be georeferenced.

This technique permits the investigation of landscape transformations up to the present, using the same logic as for mental maps. For example, Verbicaro and Nunes [74] asked residents of a rural community in the state of Pará, Brazil, to map the occurrence of açaí (*Euterpe oleracea*) and miriti (*Mauritia flexuosa*) palm stands in their community on several maps spanning 20 years. From this procedure, the authors were able to identify changes in the abundance and distribution of these species through time. Cartographically referenced maps are also important tools to locate cultural forests, through the delimitation of patches of useful plants and the patterns of species distributions on archaeological sites and in their surroundings [3].

8 Guided Tours

Guided tours are also known as the field informant or "walk-in-the-woods" technique [41]. They consist of walks with local informants in community areas. Guided tours help to identify in the field plant species and landscape units, besides providing the researcher with the opportunity to observe management practices that had been previously overlooked. They also allow for the identification and recognition of elements within archaeological sites and plant species that may be associated with these elements. It is recommended that the tours are guided by local experts. Usually, these experts can be identified during free listings or interviews [39]. However, in some situations, community members themselves like to identify the guides, and they may not necessarily meet the needs of the research project. In these cases, we recommend making the tour with more than one guide. As tours can take a long time, they must be scheduled in advance according to the guide's availability.

Guided tours allow integration of numerous research activities. Researchers must record the amount of time spent on the tour; record the trajectory traveled (via GPS); collect and take pictures of plant specimens for botanical identification; georeference the specimens of interest (e.g., useful species or those collected for botanical collections); and name and characterize the landscape units visited. To characterize landscape units we recommend documenting: descriptions of the activities carried out in the area; period of use or abandonment (e.g., crop age, years of fallow); soil type; popular names and properties of useful plants; vegetation descriptions, including notes about species dominance in the landscape; and traces of recent and past occupations and activities, including paths, signs of vegetation management, archaeological artifacts, evidence of burning, anthropogenic soils, patches of useful trees and palms.

Guided tours are important sources of information about the local knowledge and perceptions of landscape units and useful plant species. This method is usually a tool to complement interviews, free lists and/or participatory mappings, in order to consolidate the information obtained through other types of data collection. Machado Mello and Peroni [60], for instance, conducted guided tours with all the collaborators interviewed during their research on the maintenance of cultural landscapes in the *Araucaria* forest, in order to collect, identify and verify plant material mentioned during the interviews.

With this method, many things that have been said and represented by research collaborators can be observed. In addition, through the perception of the guide, new information can be incorporated to understand the complexity of relationships between people, plants, and landscapes.

9 Floristic Inventories

Previously, we showed how ethnobotanical methods can be applied to historical ecology approaches in studies of landscapes and plant communities that occur on archaeological sites. Here, we show how the execution of floristic inventories on archaeological sites and surrounding areas can be a complementary approach to the methods presented above, in order to identify legacies of plant use and management by past societies on modern landscapes.

Long-lived pioneer, useful, and domesticated species or species that incidentally coevolved with cultural landscapes can be used as indicators of human transformations [13, 45, 52]. These species' distributions, however, are also influenced by natural conditions (e.g., climate and soil), and our capacity to detect the effect of past human influence on modern species distributions is limited by the data available (either ecological or cultural). Reliable information on the spatial distribution of plant species depends on good botanical collections and proper floristic inventories. The execution of floristic inventories provides a characterization of the structure of plant communities that can be correlated to human perceptions, values, habits, and modes of past and present resource use [76]. Thus, the dataset generated during floristic inventories in different landscape units is an important descriptor of the behavior of plant communities in areas with different human activities.

Floristic inventories on archaeological sites and related areas can complement information about useful plants associated with past human activities [13, 77]. Indeed, some species that were used in the past may no longer be recognized as useful in the present, especially when one takes into account the common discontinuity between past and current human societies. Another application of systematic floristic inventories conducted in different archaeological contexts and regions is the creation of databases containing information about species that may be indicators of archaeological sites in different regions, which could lead to the identification of past cultural preferences.

The identification of the plant community of a given area is necessary for fundamental ecological investigations, such as modeling patterns of species diversity and determining species distributions [78]. If the interpretation of archaeological structures/remains can lead to the recognition of past land use patterns, floristic inventories performed on these areas can be directly related to long-term human history. Floristic inventories applied to historical ecology can follow different approaches. Here, we present some of the possibilities for vegetation surveys that can contribute to understanding the role of humans in shaping plant communities.

The decision about inventory plot size depends on the possibilities offered by the study area and the analysis that will be

performed with the data collected. Traditionally, one-hectare plots are established as a standard sample size for floristic inventories [78]. However, depending on the goal of the survey, smaller plots can be defined. Junqueira et al. [45], for instance, established 25 × 10 m plots, in order to avoid border effects when sampling small patches of secondary forests on anthropogenic soils. Lins et al. [79] inventoried the entire extension of homegardens, regardless of their area. For investigation across wider areas, standard 1-ha plots should be adopted (e.g., [77]) in order to facilitate comparisons with other studies [76]. Especially in tropical communities, where diversity and heterogeneity are high, when plots are small due to constraints inherent to the research questions, sampling a larger number of plots is highly recommended so that a sufficient number of individuals have been sampled for a robust quantitative analysis.

The definition of the biological group (woody or herbaceous individuals, lianas, etc.) and the size of sampled individuals (minimum diameter at breast height—DBH) will depend on the objectives of the research. Usually, in 1-ha plots, all stems with DBH $\geq$ 10 cm are sampled. Despite the recommendation of 1-ha plots as standard, Phillips et al. [78] showed that 0.1-ha plots are more efficient in obtaining floristic information if all stems with DBH $\geq$ 2.5 cm are inventoried. Following any sampling strategy, rarefaction methods can be used for standardized comparisons with other floristic studies, as discussed by Araújo and Ferraz [76]. Subplots for the inventory of herbaceous plants can be designed when necessary. Due to the economic importance of the Arecaceae family and because they are good indicators of anthropogenic forests [45, 80], we recommend the inclusion of palms in inventories of historical ecological studies. For the correct identification of the taxa sampled, it is recommended that vouchers be collected and deposited in collections, prioritizing fertile material whenever possible.

Floristic inventories per se provide a large amount of valuable data. However, when floristic information is analyzed together with environmental (e.g., soil) or ecological (e.g., functional traits, tree growth rings) data, it is possible to obtain better and more detailed insights to help reconstruct the history of the vegetation sampled. Integrated analysis of these parameters will contribute to the assessment of the human and environmental effects on plant distributions and compositions [13]. Furthermore, while performing floristic inventories, the use of scientific literature to obtain ethnobotanical data about the sampled species can provide complementary information about the species collected in the field. The information about the uses, management, and other relevant data about the history and distribution of plant species identified in floristic inventories associated with archaeological sites may constitute a basis for advances of interpreting the history of interactions between human populations and their landscapes.

Floristic inventories can also be performed during archaeological excavations [46]. Based on the assumption that modern plant communities may also be considered archaeological remains [23, 24], floristic inventories of plots delimited around excavation areas are complementary procedures to any archaeological intervention for the systematic collection and registration of these "ecofacts." In this situation, the establishment of the sampling plots can be determined according to the position of test pits and/or excavation units. The analysis of floristic composition around an excavation area, in combination with the analysis of other classes of archaeological remains, will allow interpretation of the current plant community in a more defined historical context. For further discussion of the sampling methods and analysis of floristic data in ethnobotanical studies see Araújo and Ferraz [76].

10 Final Considerations: The Integration of Archaeology and Ethnobiology

In the introduction of this chapter, we mentioned the contributions made by archaeobotany and paleoecology to understand the history of human–plant interactions by (a) identifying which plants were used and managed in the past, (b) identifying the environmental context in which they were used, and (c) shedding light on the scale and duration of landscape transformations. The accuracy of archaeobotanical and paleoecological studies can be enhanced by establishing a closer dialogue with ethnobiology. Drawing upon ethnobotanical knowledge is essential to (a) provide information about which species have current or historic uses in the region of study, and therefore guide the elaboration of reference collections for the identification of botanical remains; and (b) to record how plants are used and processed by people, and thereby illuminate possible scenarios of preservation and non-preservation of specific plant remains in archaeological contexts. While drawing upon ethnoecological knowledge holds numerous benefits for understanding local historical ecology [81], current human land-uses provide an important baseline from which the paleoecological record can be interpreted. In the absence of "natural" vegetation baselines, one must start from cultural landscapes and work backwards [82, 83]. Thus, in the same way that archaeological data are important for ethnobiological research to interpret cultural landscapes, the interpretation of archaeological contexts benefits from the understanding of present scenarios of management and use of landscapes and plant resources.

The integration of ecological, paleoecological, and archaeological studies is revealing that most of the apparently natural areas of the planet have longer and more pronounced cultural histories than assumed in the past [1]. Case studies illustrate examples of forest recovery, forest enrichment with useful species, and the creation or

maintenance of places that today are valued habitats, indicating that the human history of appropriation of ecosystems can have positive effects over biodiversity [25, 84, 85]. The integration of ethnosciences with archaeology can offer models for understanding the resilience of such current landscapes based upon their history [86]. Local populations are vital partners in this approach, as their knowledge and practices reinforce ecosystem health that resulted from thousands of years of human occupation [84, 87].

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