

Implications of Ethnobotanical Studies on Bioprospecting Strategies of New Drugs in Semi-Arid Regions

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Abstract: Many strategies are currently used by researchers and pharmaceutical companies to search for new drugs for medical and pharmaceutical purposes. The choice of a strategy depends primarily on the costs involved, team background in a given area, and/or promising results pointed at certain approaches. Ethnobotanical/ethnopharmacological studies are proving to be powerful tools in the search for new drugs. However, despite being scientifically recognized claimed approaches, it is necessary to recognize that the relationship among people, their traditions, and the use of natural resources for medical purposes can be quite complex. In this opinion article, our intention is to show the implications of some findings of our research group that may be relevant to the search for new drugs in semi-arid regions.

Keywords: Caatinga, ethnopharmacology, phytochemistry.

INTRODUCTION

The relationships between people and plants are complex, often involving adaptive responses to ecological and evolutionary forces [1] (Fig. 1); in addition to these adaptations, our culture is also a powerful force that can shape these complex relationships. Our research group has been asked to frequent: how ecological and evolutionary may have shaped the relationship between people and plants throughout the evolution of different societies and cultures? Therefore, in this opinion article, we aim to review some of the assumptions with which our group has been working in semi-arid northeastern Brazil and to highlight the potential implications for drug discovery from ethnobotanical and/or ethnopharmacological studies. In this sense, we believe that principles of evolution and ecology constitute an interesting theoretical framework for understanding the relationship between people and plants. Although the documentation collected over the past 100 years indicates that the relationships between people and plants are highly complex processes that differ from culture to culture, evidence also suggests that some processes may predictably follow general patterns.

According to Gottlieb and Borin's [2] approach: "Considering our very serious losses in biodiversity to exceed vastly the limits of natural sustainability, our plight is understandable. Appropriate financing of our efforts would be helpful, but not sufficient. We need, most of all, coordination of efforts. Our holistic work aims to provide an outline of the basic strategy: the reduction of the problem to a manageable size via understanding of the mechanisms of nature". Our approach is similar in the sense that we are trying to understand how the people select medicinal plants, to reduce the efforts of bioprospection. The connection

among phytochemistry, evolution ecology and ethnobotany is possible and desirable (see, for example, [2-4]).

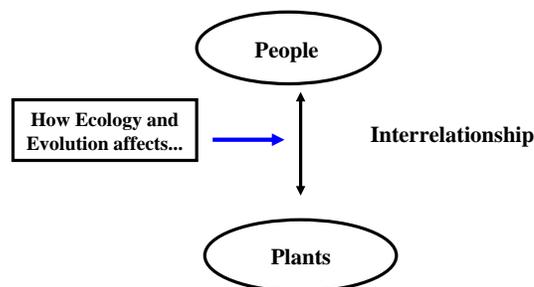


Fig. (1). An example of model to understand people and plant interactions.

CLIMATE SEASONALITY AND THE SELECTION OF MEDICINAL PLANTS

The hypothesis of climate seasonality postulates that people who live in markedly seasonal climates generally employ foraging strategies (for medical resources) focused on woody plants that are perpetually offered in nature [5]; an example of this type of climate is the caatinga, a region with semi-arid vegetation in northeastern Brazil. There are two types of evidence supporting this hypothesis: the first is based on ethnobotany, with studies indicating people's preference for plants, or even certain organs of a plant, that are continuously available, even when a number of other species with similar functions are also available [5,6]. At first, one might view this as a very obvious prediction, but considering the scenario of seasonal forests, such as the caatinga, where herbs become an abundant resource in certain periods of the year, one may wonder why during the period of abundance these herbs are not used as extensively as tree resources [7]. It is possible that this same scenario is true in other seasonal forests as well. Another issue is that

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this behavior may have been selected for as a result of ecological pressures. Albuquerque [5] collected evidence that plants with similar uses are not equally valued by people.

A second type of evidence supporting this hypothesis is that people tend to use native and perennial resources, even though herbs are more abundant, more easily accessible and locally perceived with equal efficiency at certain times of year [6]. The caatinga herbal stratum is dynamic, variable in time and space and limited to only a few months (2-4 months) per year due to rain availability [8-10]. The herbaceous flora can vary between and within years in the same area [6,8]. This local variability in availability, which does not allow local people to predict if a given resource will be available for use, may have allowed the evolution of specialized behavior in foraging for woody plants and perennial structures. Some findings from our group show, for example, that people in the caatinga region prefer to use the stem bark of an important medicinal plant, the "aroeira" (*Myracrodruon urundeuva* Allemão), even when leaves are available. We found that the concentration of tannins is markedly higher in the leaves than in the stem bark [10-12]. What seems to be a cultural decision based on and perpetuated by tradition might be justified in the local ecological context. Our findings allow us to hypothesize that not only is the use of a medicinal plant in pharmacopeia construction determined by the perception of plant effectiveness, its availability (abundance, for example) and its accessibility but also the idea of security that the resource will always be temporal available is a critical factor. If true, this assumption has important implications for seasonal environments: it is more important to have a resource that is always available than to have a resource that is biologically more efficient (therapeutic activity). If indeed these trends are confirmed with well-designed studies in several seasonal forests, it will be possible to understand the ecological and evolutionary dynamics behind people's decisions at the moment they gain ownership of natural resources. From a practical perspective, knowledge of these dynamics would be useful in the selection of prospecting strategies directed toward specific resources.

DIVERSIFICATION OF USES

From a chemical perspective, the findings of our group were also interesting in that they revealed an apparent tendency of people to include exotic plants to diversify their pharmacopeias [13,14]. Thus far, we have accumulated two types of evidence: evidence based on chemistry and evidence based on ethnobotany. In terms of chemistry, we found that the exotic plants used in a local pharmacopeia introduce different classes of compounds, thus adding chemical diversity to the pharmacopeia [14]. From an ethnobotanical point of view, our findings suggest that exotic plants are often used to treat conditions for which there is no indication of use for native plants or when these plants are less preferred [15]. In studies of the pharmacological activities of caatinga plants, there was a clear predominance of phenolic compounds (particularly tannins) in a significant percentage of the plants studied; the presence of phenolic compounds seems to be associated with some of the biological activities reported by people in ethnobotanical studies [16]. If, due to the ecogeographic conditions that characterize the caatinga,

there is a trend toward specialization of metabolic pathways for phenolic compound production, it would be reasonable to assume that the introduction of exotic plants is a possible diversification strategy, and a new question would appear: is it possible that this "metabolic specialization", focused on phenolic compounds, has led to a specialization of the possible therapeutic uses of native plants in this region, leading people to introduce new plants as a diversification strategy? One line of evidence supporting this apparent specialization is the fact that the indication for anti-inflammatory purposes is predominant among native plants of the caatinga [14-17]; this anti-inflammatory activity is also strongly related to the presence of phenolic compounds, especially tannins. An alternative path is that given the ability of phenols to bind to different types of proteins, it is possible that the spectrum of biological activity of these compounds is much wider than we believe, because the presence of a wider range of biological activities of a plant is not always due to a greater diversity of compounds present in the plant. These ideas need to be tested because they have strong implications not only for understanding the dynamics of medicinal strategies developed by people but also for directing bioprospecting investigations.

THE APPARENCY HYPOTHESIS

Other hypotheses that we tested, such as the hypothesis of apparency, have failed to explain the criteria that lead people to select certain plants for their traditional pharmacopeia [13, 18,19]. The apparency hypothesis was developed as a result of herbivory studies and was later suggested as a possible explanation for the inclusion of certain herbs in the medicinal systems of some cultures [20]. The basic prediction is that herbs and plants with short life cycles would develop defense strategies based on highly toxic compounds with low molecular weight (such as alkaloids). However, if this is correct, we would expect to find this trend among the medicinal plants used by a particular group of people. Our findings in the caatinga do not support such predictions and furthermore suggest that such compounds are more likely to occur in woody plants with long life cycles [16,18].

In conclusion, these data reinforce earlier findings that there are well-defined trends for medicinal plants selection by local people, at least for the caatinga of northeastern Brazil. Thus, it would be appropriate to test these ideas in other semi-arid regions because confirmation of these ideas would have major implications for bioprospecting: researchers would expect to find certain groups of biological activities and/or phytochemicals in the medicinal plants used by people in a given region. This type of knowledge would result in logistical, scientific and economic gains (cost reduction due to directed studies with greater probabilities of success). These ideas can only be preliminary approaches, and more studies are necessary to test if these "patterns" can be generalized to caatinga and others semi-arid regions of the world. The small number of studies with standardized methods reduces our potential for generalizations.

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