Management, Cultivation, and Domestication of Weaving Plants: *Heteropsis* and *Astrocaryum* in the Ecuadorian Rain Forest

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This article examines the management and cultivation of two plants in the Mache-Chindul Ecological Reserve, northwestern Ecuador. The plants in this study, a hemiepiphyte, *Heteropsis ecuadorensis*, (Araceae), commonly called *piqigua*, and a palm, *Astrocaryum standleyanum (Arecaceae)*, commonly called *mocora*, provide weaving fiber to make baskets, mats, and smaller woven articles. Although most people living in the area do not consciously manage this vegetation, evidence shows that locals are engaging in activities that promote the growth of the two plants, thus beginning the domestication process. Over time, cultivation can lead to mono-crops, soil depletion, and increased forest clearing. On the other hand, planting may enable farmers to produce more material for their own use, increase market possibilities, and reduce the ecological disturbance caused by overharvesting wild plants.

Introduction

PLANT MANAGEMENT plays a vital role in our understanding of people's relationship with their natural resources and has long been of interest to geographers (Sauer 1947; Doolittle 2000). This study focuses on the management of rain forest fiber plants, including cultivation, selection, and domestication. I hypothesize that, although not always obvious, people are indeed manipulating these plants and affecting the landscape. First, I look at what management activities forest people pursue in relation to two wild fiber plants, *piquigua* and *mocora*. Secondly, I review local cultivation activities, including domestication, and describe the possible consequences of such actions. Humans have long been a part of tropical forest ecosystems. Evidence suggests that tropical forests have been, to one extent or another, historically altered by people (Balée 1988, 89, 94; Denevan 1992; Colfer 1997). This paper explores the role

that plant management plays in the lives of people living in northwestern Ecuador, as an example of the continuing phenomenon of human influence on forest ecosystems.

Various forms of plant manipulation fall under the rubric of management. For many groups, the ideology behind resource management is not separated from how people subsist but is part of the natural process of forest utilization (Alcorn 1989). Examples include the Guajá and the Ka'apor Indians in the Brazilian Amazon, who weed to promote the growth of various palms (Balée 1988), and the Gorotire Kayapó of Brazil, who fertilize plants with leaf litter and termite and ant nests, thereby promoting plant growth (Anderson and Posey 1989).

The present study complements previous work on plant management. In addition to learning how people affect plant growth, my work extends beyond previous studies by seeking to understand this group's cultivation activities. These activities then lead into the beginnings of domestication. Furthermore this study looks at colonist activities, while the majority of the literature currently on the topic, including the previously mentioned examples, focuses on indigenous plant management.

Most plant manipulation studies in the South American rain forest tend to focus on the Amazon region (e.g., Balée 1988, 89, 94; Padoch 1988; Unruh and Alcorn 1988; Alcorn 1989; Anderson and Posey 1989; Chernela 1989; Dufour 1993). By contrast, this work looks at activities in the humid, tropical forests of northwestern Ecuador, an understudied area of the rain forest. The area is of particular interest because of its high biodiversity. Regional experts consider this forest to be an extension of the Chocó in Colombia, one of the hot spots of biodiversity (Dodson and Gentry 1978, 1991; Gentry 1982; Myers 1988; CI 1992; Sierra 1994). Researchers also consider the forests of northwestern Ecuador to have high degrees of endemism (Whitten 1974; Dodson and Gentry 1991; Foster 1992; Gentry 1992: Sierra 1994; INEFAN 1996), with numerous species endemic specifically to Ecuador (Valencia et al. 2000).

Furthermore, because this section of land is protected in a reserve, there is particular interest in the interactions of the local residents and the forest. The literature discussing parks and people continues

to debate whether people's activities in reserves help or hurt the goals of conservation (e.g., Allegretti 1990; Anderson 1990; Browder 1995; Kremen et al. 1999; Langholz 1996; Newmark et al. 1994; Price 1994; Schmink et al. 1992; Stocking and Perkin 1992). Much of this literature focuses on the different kinds of activities of indigenous people. In sum, this study not only adds information from an understudied region, but again, also provides an in-depth exploration of colonist activities.

Although the paper focuses on rain forest management in Latin America, the concepts explored are not limited to this geographic region. People throughout the world have manipulated plants. For example, Native Americans in New England practiced controlled burning to enhance seed production of herbaceous annuals (Russell 1980), people in the Southwest coppiced woody perennials to encourage longer sprouts for making baskets (Winter 1974), and in northern California native people arrested tree growth to produce straighter wood for arrows (Blackburn and Anderson 1993). Plant management is rarely obvious and straightforward, with most practices showing a multilayered process of botanical manipulation. Likewise, plant treatment activities include both conscious and inadvertent manipulation (Hawkes 1983; Rindos 1984; Doolittle 2000). The current study looks at both the deliberate manipulation of plants growing in the wild, and the activities that people pursue without specifically recognizing them as management, in the same way as does the researcher. The latter idea is crucial for governments and NGOs who are seeking more sustainable ways for people to use protected land on which they live (Zimmerer and Carter 2002). It is important to understand what people are actually doing, consciously and unconsciously, in order to create and implement effective programs.

Lastly, this paper looks at the beginnings of cultivation activities for plants that are considered wild. By observing the forest practices of inhabitants of the region surrounding two plants, I look at the beginnings of this vegetation's transformation from wild, collected flora to cultivated, domesticated species. This transformation has important implications throughout the world, particularly in areas where people are manipulating land that has been set aside for protection.

Geographic Setting

The study area is in the Mache-Chindul Ecological Reserve in northwestern Ecuador, South America. The protected land lies principally in the province of Esmeraldas, with its southernmost part extending slightly into the province of Manabí (Figure 1). Mache-Chindul is comprised of 111,000 hectares that were designated as an Ecological Reserve in 1996 (INEFAN 1998). Topographically, the reserve stretches from the northern slopes of the western cordilleras and then grades into an alluvial delta, with two large river basins, the Esmeraldas in the south and Santiago in the north (Zendrón 1977; Novoa 2001). Mache-Chindul lies in a humid area where annual precipitation ranges from between 2,000 and 3,000 mm (Foster 1992; Sierra 1994). Topographical relief ranges from 0 to 800 m, with undulating topography (Acosta-Solís 1977; Aguirre et al. 2000; Cañadas 1983; Dodson and Gentry 1978; Gavilanes et al. 2000; INEFAN 1996,1998; Winckell 1997; West 1957; Wolf 1975). The forest type for most of the area is considered lowland rain forest, which is characterized by tall, dense, and evergreen vegetation (Acosta-Solís 1977; Dodson and Gentry 1978; Harling 1979; Faber-Langendoen and Gentry 1991; Gentry 1992; INEFAN 1996; Aguirre et al. 2000; Gavilanes et al. 2000; Comercio 2001; Neill 2003). The *mestizos* (people of mixed European and indigenous ancestry) who make up the majority of residents now living in the reserve migrated mostly from the provinces of Loja and Manabí (INEFAN 1996, 1999). They are mostly subsistence farmers, living in homes made from forest materials and practicing limited animal husbandry.

Figure 1. Protected areas in Ecuador with the Mache-Chindul Ecological Reserve highlighted.

Investigative Methods

For this study, I conducted interviews with eleven *mestizo* families, totaling sixty-three individuals. Criteria for choosing communities included locations that were within two days' walking distance from my base, and residents who expressed an interest in working with me. Most interviews were semiformal or informal (Bernard 1995). To determine the important forest plants, I initially observed what families used in their homes. I then followed up with verbal confirmation of the inhabitants' own ranking of which plants were most central to their livelihood. Throughout the study period, I lived with various families, doing participant observation. This added invaluable casual discussion and observation about the entire process of plant use, enhancing the information I gathered from the more structured interviews.

Study Plants

The two plants that emerged as particularly important for these communities were *piquigua* and *mocora*.

Piquigua

Heteropsis ecuadorensis Sodiro (Araceae) (syn.: *Heteropsis rimbachii* K. Krause), commonly called *piquigua*, is in the Araceae, a family of herbaceous Monocotyledons. *Heteropsis* is a neotropical genus, with thirteen species, all of which occur in Latin America (Dodson and Gentry 1978; Croat 1988). *Heteropsis ecuadorensis* is endemic to Ecuador, growing in the Pacific Coastal and Amazonian rain forests

(although it is listed as growing in the Amazonian rain forest, there is some debate as to whether or not this actually occurs (Valencia et al. 2000). It grows in elevations between 1 and 2,000 m (Jørgensen and León-Yánez 1999; Valencia et al. 2000; Missouri Botanical Garden 2002).

Heteropsis ecuadorensis is a secondary hemiepiphyte, germinating on the forest floor and then growing up trees (primary hemiepiphytes begin growth as epiphytes and then produce feeder roots). It later becomes detached from the ground when the juvenile stem and roots rot. Hemiepiphytes produce a few short anchor roots, attaching them to the tree. They then send down long, slender feeder roots that grow down to the forest floor and reestablish contact with the soil (Madison 1977; Putz and Holbrook 1986; Croat 1988).

Mocora

The second study plant is a palm, *Astrocaryum standleyanum* L. H. Bailey (Arecaceae), commonly called, *mocora*. *Astrocaryum standleyanum* grows most commonly in lowland rain forests on poorly drained soils, usually below 200 m elevation (Henderson et al. 1995), but it can be found at up to 500 m (Pedersen 1994). *Astrocaryum standleyanum* has a solitary, medium sized, stout, subcanopy stem 8–15 m tall and 16–22 cm in diameter. Flattened spines that may reach 20 cm in length protect the trunk, the rachis, and the leaflets. The mature leaves are pinnately compound, about 3–4 m long. (Croat 1978; Galeano and Bernal 1987; Borgtoft Pedersen 1994; Henderson, et al. 1995; Runk 2001).

Plant Use and Management

Mache-Chindul residents use the aerial roots of *piquigua* primarily for making baskets, which they use for harvesting, collecting, and carrying articles (Figure 2). Lesser uses include brooms, hats, small baskets, and rope. With *mocora*, weavers collect the young leaflets predominately to make sleeping mats, and also for small baskets (Figure 3). In other parts of Ecuador *mocora* is also commonly used for mats. These mats are woven differently than those made by the colonists in the reserve (Borgtoft Pederson 1994). In Panama it is used for hats (Runk 2001).

Plant management, which is being viewed increasingly as an important aspect of plant and people interactions (Turner 1998), can be a subtle aspect of human-resource interaction. Although locals

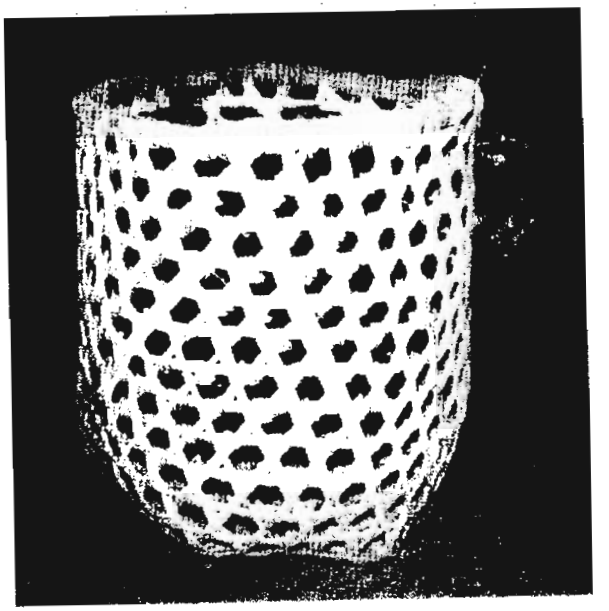

Figure 2. Piquigua *collection basket.*

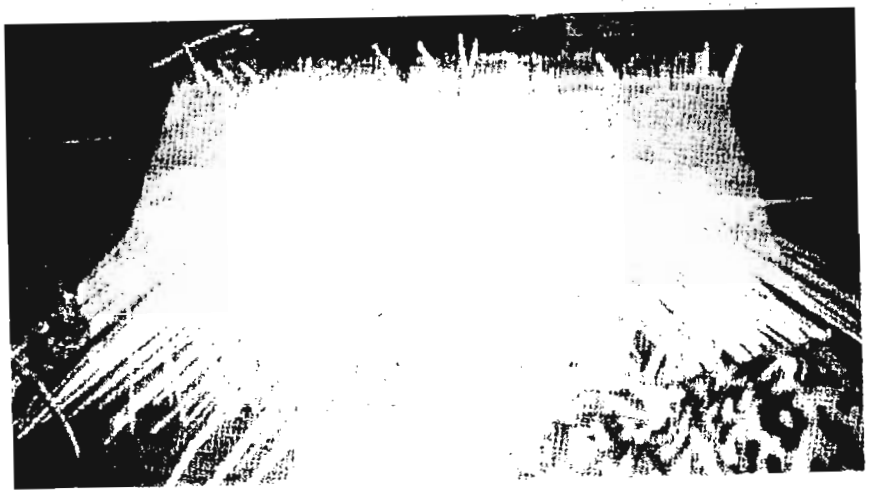

Figure 3. Mocora *mat attached still attached to a weaving board.*

would almost all uniformly respond that they themselves do not manage the two plants that are the focus of this study, it became clear through observation and casual conversation that some management activities are actually taking place (Table 1).

Table 1. Ratio of locals interviewed who were involved in plant placement, protection, and cultivation of *piquigua* and *mocora*, compared with total interviewed.

Plant type	Ratio of families interviewed who did have instances of plant placement	Ratio of families interviewed who practiced protection	Ratio of families interviewed participating in cultivation	Total ratio of those involved in plant management
Piquigua	4/11	2/11	2/11	8/11
Mocora	0/11	11/11	1/11	11/11

Piquigua

Respondents typically said "no" when asked whether they practiced plant management in relation to *piquigua*. A common reply was, "It (*piquigua*) is born in the forest, it grows in the forest, and then we collect it." For the most part, this appeared to be the reality. However, through careful observation, I witnessed specific instances in which people were actively managing the plant.

For example, one man, when he saw a *piquigua* root dropping down into a creek, pulled the root up onto the bank and buried the growing tip in the soil. One woman laughed as she told me of the time that her husband fell out of a tree trying to tuck up a vine that had fallen. He clearly put himself in danger in order to encourage plant growth. The same woman then showed me a place where two roots had landed in the river, and her husband had pulled them to the side and buried them in the soil next to the water. It is interesting to note that these examples of management were shared with me while the informants and I were pursuing activities unrelated to the topic. When asked about management, they had already replied in the negative.

Another time, while walking through a *piquigua* patch, a woman absently removed a stick that was putting weight on a climbing stem growing between two trees. On a different occasion, the same woman saw a stem dangling from a tree and tied it securely to the trunk with another plant, offhandedly saying to me, "So that it will grow better." Another form of management I witnessed involved leaving trees that have *piquigua* on them in the field when farmers clear forest. These cultivators say that the *piquigua* will grow only for a few years without the surrounding forest, but that it is worth it to save a tree that has *piquigua* on it for at least that amount of time.

Not only are some people engaging in the management of specific plants, at least one family is managing an entire population in a specific area. This particular family cleared their forest, stopping at the area where a *piquigua* patch grows. These farmers scouted the land beforehand, not wanting to clear where the hemiepiphyte is present. They organized their forest cutting, field planting, and production around the location of *piquigua*. Clearly, managing the plant can involve larger scale, conservation-oriented management of an entire section of forest.

Mocora

The most common form of *mocora* management that the *mestizos* practice is to leave palms in the fields (Table 1). However, no informant recognized this activity as a form of management. As in the previous example about *piquigua*, farmers allow these plants to continue growing when they clear parts of the forest for their farms. As one *mestizo* woman says, "You would be crazy to cut it down." The colonists say that they leave *mocora* so that they will have access to the leaves. This strategy is also practiced by those in Manabí, who maintain the palms for shade in agroforestry systems (Borgtoft Pedersen 1994). Protecting species by leaving them standing in otherwise cleared and planted fields has been part of many agricultural systems, including some in North America (Doolittle 2000). Specifically leaving palms in fields is common practice in lowland swidden agriculture (Padoch 1987).

Cultivation

In order to make collecting easier and increase scarce resources, people around the world sometimes cultivate useful wild plants. Cultivation, which among other things includes the planting of an organism, (either by seed or transplantation) (Doolittle 2000), is rarely practiced in regard to *piquigua* or *mocora* in the Mache-Chindul Reserve. Most collectors show resistance to pursuing this activity. However, as with plant management, more cultivation than initially appears is occurring in the reserve (Table 1).

Piquigua

Although the groups using *piquigua* generally do not cultivate the plant and actually say that it cannot be planted, I did encounter a

few instances of cultivation. While these efforts were on the low end of the husbandry spectrum, they are certainly of interest. One *mestizo* man, who earns his livelihood from farming, also considers himself a *piquigua* artisan. He complained of a lack of *piquigua* near his home, so he decided to plant the hemiepiphyte close to his house.

He collected twelve stems from a mature forest, approximately two hours' walk from his home. Then he partially cleared a small area for cultivation, leaving enough trees present so that the area remains mostly shaded. To enable growing stems to use the trees as trellises, he placed each root about one meter from a tree. Curving a meter of stem with an emerging aerial root into a semicircle, he then placed both cut ends of the stem and the tip of the root in the soil and weighted them down with rocks (Figure 4). He maintains a one-meter cleared area around each plant. As creative as his efforts are, it is still too early to tell whether the plants will provide sufficient roots for weaving. After four months, five plants were still growing. Detailed data about growth regimes, maturation rates, flower production, and aerial root development for *piquigua* are lacking.

Figure 4. Mestizo *planting a* piquigua *plant.*

Another *mestizo* from a neighboring community planted *piquigua* stems in both mature and secondary forest, as an experiment to see how they would progress under natural conditions. In the mature forest, next to the river, he placed a stem in the soil that he had found. In proximity to a tree near his house, in an area that is almost completely cleared, he also planted a stem. He discussed plans to plant *piquigua* on the edge of his fields and in mature forest, on the side where the trees still grow. Yet another instance of planting involved a *mestizo* woman who came across a fallen stem and decided to stick it in the ground at the base of a tree. It is still growing up that tree.

In addition to the evidence of present-day planting of *piquigua*, I also found reference to past cultivation. One informant presumes that the previous owner of his land planted the *piquigua* now found growing on his property. He maintains this idea because *piquigua* is not known to grow naturally in the area. While looking at this particular plant, my assistant decided that he too could plant *piquigua*. He cut a piece of stem and carried it home to plant in his forested land. Results of his attempt are unknown at this time.

Mocora

For the *mocora*, I found the same resistance to the concept of planting that I did with the *piquigua*. However, once again, a few individuals are planting. One *mestizo* farmer cultivates *mocora* by planting seeds and transplanting seedlings. During the waning moon, he plants ripe seeds. However, because predators find and consume the planted seeds, he experiences greater success in transplanting seedlings. The farmer gathers seedlings from secondary forest and transplants them into his field, where he is starting a mini-plantation. He plants the seedlings among his corn, periodically cutting away weeds. The seedlings are placed six feet apart, with about twenty seedlings per area. In eight months, the ten-centimeter high seedlings start growing mature leaves with spines. The farmer eventually plans to cultivate a one-hectare plot solely with *mocora*.

He wants to provide himself with a constant source of material and possibly start a *mocora* fiber business. He also wants to extract oil from the seeds. Oil is one of the few commodities that the locals do not produce on their farms and is thus an item on which all households spend scarce cash.

When looking at the future of these kinds of cultivation activities, specific incidents indicate that they could become more prevalent. One day, as I was measuring a plot in order to count the palm seedlings growing there, I noticed that one of my assistants folded a leaf and was carefully placing palm seedlings into it. Upon seeing my observation, he looked up and said, "I'm going to try and plant them on my farm at home," and shrugged his shoulders.

Discussion

The evidence clearly shows that although most locals do not recognize their own activities as plant management in the same way that the researcher uses these words, numerous individuals are to varying degrees managing *piquiga* and *mocora*. These activities include removing impediments to growth, actively assisting development, and cultivation. In fact, these plant manipulation activities are so important to the residents of the reserve that locals often go to great lengths to promote growth, as with the man who accidentally fell while placing *piquigua* roots. These activities can have consequences that are much more far-reaching than those related to the plants alone. An example is forest conservation that can result from this management, such as when the weaving family protected the area of their forest because *piquigua* grows there.

Although many people believe that neither *piquiguia* nor *mocora* can be or are being cultivated, individuals are actively involved in growing the two plants. It is important to note that these cultivation activities, small as they are, play a role in domestication. When farmers decide which individual roots or seedlings to plant, they are clearly selecting individual plants for traits beneficial to the farm. As farmers choose plants with certain characteristics, they are beginning the process of domestication (Anderson 1952). Given that the beginning stages of domestication are occurring, it is essential to consider where this phenomenon might lead.

It is especially important to pay attention to possible results of these activities in light of the issues that are being debated in the current literature regarding the role of people and their long-term effects on park areas (Kremen et al. 1994; Sundberg 1998, 99, Schwartzman et al. 2000).

When looking at the current strategies for cultivating *piquiguia* and *mocora*, one can speculate on several outcomes. When looking at the environment, one possible danger is that with increased cultivation, which is already the goal of the farmer planting *mocora*, comes the chance of mono-crop plantations. Single-species plots can result in forest destruction, soil depletion, and pest infestation (Vandermeer and Perfecto 1995). Furthermore, at this point, there is already conservation of the forest, because *piquigua* grows wild in the ecosystem. When looking at *mocora*, leaving palms in the fields helps to prevent soil erosion and maintain soil fertility (Chernela 1989). If people can obtain material from a cultivated field, they may be less likely to leave the wild-growing palms in other fields, or to preserve the parts of the forest where *piquigua* grows. Furthermore, with domestication comes the probability of increased plant uniformity. This homogenization could result in decreased genetic variability, thus weakening each of the two species (Simpson and Ogorzaly 2001).

On the other hand, increased cultivation of these plants could reduce pressure on the wild populations in the forest. Creating dependable areas of collection could decrease the number of palms collectors cut down and the number of *piqigua* plants accidentally pulled out of the trees. Furthermore, if cultivators planted as part of a sustainable agroforestry system, they could potentially increase the availability of materials without damaging the land.

When looking at cultivation in terms of social welfare, if a steady supply of material were available, the local people could possibly become more involved in the market economy by selling their woven articles. This would enable them to earn cash without participating in the destructive logging ventures currently underway in the area.

Clearly, the current activities could increase conservation by the locals, or it could decrease preservation efforts. At this point, one cannot definitively say what the outcomes will be.

Conclusions

This article provides examples of people-plant relationships in an Ecuadorian rain forest preserve. The activities of the individuals questioned and observed, although specific to *piquigua* and *mocora*, fall into a category of human-vegetation interactions that have occurred throughout history and continue to take place wherever people use plants. Communities in the Mache-Chindul are clearly

engaged in the management of wild plants. The study also demonstrates that the beginning stages of cultivation are occurring.

On the one hand, cultivation shows ingenuity and can lead to improved forest conditions. However, it can also lead to greater forest destruction. As cultivation progresses, so does the process of domestication. Manipulating a plant population's gene pool can have both negative and positive consequences.

Conservation and development groups implementing projects with those living in protected areas need to understand how people actually interact with the resources around them. In order to properly comprehend local's activities, researchers must go beyond relying on standard research definitions of "plant management" and "cultivation." In addition to appropriate interviews, careful observation is crucial in being able to properly assess what people are actually doing. This study supports the idea that humans are an integral part of protected areas, and that they need to be more seriously considered when working with reserves. These colonists are actively managing their plants, and they do have an effect on the land. Whether these alterations have positive or negative consequences for the reserve is yet to be seen. With this knowledge, groups can work in collaboration with local populations to ensure that standards of living are maintained and possibly elevated at the same time that the natural resources of an area are preserved.

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