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## **Amazonian Indians as Ecological Disturbance Agents: The Hoti of the Sierra de Maigualida, Venezuelan Guayana**

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### **Introduction**

During the past two decades, several authors have advanced the notion that the Amazonian-Orinoco lowlands consist of eminently anthropogenic rather than pristine ecosystems (Smith 1980; Posey 1983a, 1984; Stocks 1983; Eden et al. 1984; Clark & Uhl 1987; Denevan & Padoch 1987; Balee 1988, 1989, 1993; Anderson & Posey 1989; Irvine 1989; Smole 1989; Denevan 1992a; Roosevelt 1992; Gragson 1995; Heinen et al. 1995; Junk 1995; Zent 1997). According to this viewpoint, the historical hand of human intervention is evident in various key aspects of contemporary landscapes, including vegetation, fauna, soils, topography, and hydrology. In a previous article, E. L. Zent (1998) reviewed several case studies in support of this argument and concluded that indigenous human populations that maintain a traditional (i.e., subsistence-dominated, low technology, low population density) lifestyle not only have a nondetrimental impact on their surrounding environment but also are agents of creative disturbance in dynamically configured Amazonian ecosystems. The theoretical perspective adopted in the previous study and continued in the present one conceives of the human-nature relationship as art (in its literal meaning from the Latin *ars*, "ability," "expertise," "skill"), which is creative in the sense of triggering ecosystemic outcomes beyond those aimed solely at satisfying needs.

The representation of Amazonia as an anthropogenic habitat remains controversial, mainly because of the relative paucity of historical and field studies of the ecological consequences of human-natural interactions in the area. The present study offers further empirical support for the working hypothesis that traditional native human populations are agents of creative beneficial modification of Amazonian ecosystems by considering data collected among the Hoti Indians of the Sierra de Maigualida region of Venezuela. More specifically, we describe several resource-exploitation

practices of the Hoti that are not necessarily detrimental to the environment, that may even have the effect of enhancing local and regional biodiversity, and that, indeed, maybe interpreted as vital inputs into the dynamic maintenance of the Maigualida ecosystem. Before we narrate the ethnographic facts, however, it will be useful to consider how the notion of anthropogenic ecosystems is linked to the concept of biocultural diversity.

### **Integrated Concepts: Anthropogenic Ecosystems, Creative Disturbance, Historical Ecology, and Biocultural Diversity**

Acceptance of the notion of Amazonia as an anthropogenic ecosystem is closely tied to shifting theoretical perspectives on the stability and evolution of tropical forest ecosystems, the concept of ecological disturbance, and the nature of human-environment interactions in Amazonia and elsewhere. The previous view that tropical forest biomes are pristine relicts and evolve toward relatively stable climax states (Richards 1952) has been overturned in favor of a view that stresses considerable biological heterogeneity over space and time and the critical role of natural and human disturbances in proliferating and perpetuating that diversity (Sanford et al. 1985; Meggers 1987, 1994, 1995; Schubert 1988; Colinvaux 1989; Kauffmann & Uhl 1990-; Sponsel 1992; Cavelier et al. 1995; Stahl 1996). Biologists reckon that the extraordinary biodiversity observed in present-day tropical forest biomes is largely due to the disturbance and discontinuity of ecological conditions at different spatial and temporal scales (Haffer 1969; Vanzolini 1973; Connell 1978; Prance 1978, 1982; Whitmore & Prance 1987; Goldammer 1992; Phillips et al. 1994). At both macro- and > microanalytical scales, this kind of ecosystem appears to exist in a state of dynamic nonequilibrium (i.e., has no indefinite stable point), consisting of constantly shifting patches and mosaics of different habitat types. However, using a different scale of observation (e.g., middle range), it is apparent that community structure and interspecific interactions exhibit some degree of stability, in which case it is precisely the fluctuation and balance among disturbed, immature, and mature patches that define the ecosystem and allow for its continuity and prevalence. Conservation biology within this paradigm focuses on dynamic processes and the physical contexts in which they unfold (Meffe & Carroll 1994).

Disturbance is the key conceptual tool employed for understanding the dynamic or nonequilibrium character of ecosystems. Disturbance is defined as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (White & Pickett 1985:7). This concept includes environmental fluctuations and destructive events related to the spatial-temporal dimensions of a particular ecosystem as well as processes of both autogenesis (change triggered by the inherent biological properties of the ecosystem) and allogenes (change triggered by an outside agent) (White & Pickett 1985). The viewpoint that disturbance constitutes an integral component of many so-called natural ecological systems clashes with the previously held understanding, expressed

in much of the earlier ecological literature, of ecosystems as tending toward stability or equilibrium (Botkin & Slobodkin 1975). The conceptualization of disturbance as a creative event is relatively new in ecological thinking and ethic (Sprugel 1991). The more recent connotation of disturbance—as the trigger of ecological processes enhancing and providing the medium for different biotic structures and composition of natural environments—invalidated previous assumptions of disturbances as events that impeded or changed the natural regeneration of ecological systems. This creative perspective remains controversial (Hoopes & Harrison 1998), even when there is no dispute that disturbances are autogenic.

The notion of anthropogenic landscapes forms a centerpiece of recent interpretations of Amazonian cultural ecology under the research paradigm of "historical ecology" (Balee 1989, 1992, 1995; Zent 1992; Posey 1994, 1998; Rival 1998; Whitehead 1998), which emphasizes the dialectical interaction (i.e., mutual causation) of human cultural systems and natural ecosystems over time (Crumley 1994; Balee 1998b). Using this perspective, Balee (1989) advanced the argument that a minimum of 12% of Amazonia is covered by anthropogenic habitats, to which he refers as "cultural forests" in order to convey their simultaneous significance as cultural artifact and natural life form. The dual meaning follows from the theoretical postulate that there is an interpenetration of human culture and nonhuman nature, which in turn leads to the methodological principle of considering cultural practices and natural organisms as belonging to a single unit of analysis; that is, as a "total phenomenon" (Balee 1998a). In short, the ontological and epistemological separation of human culture from inhuman nature is rejected.

Viewed as an example of the interpenetration and analytical inseparability of cultural and natural spheres, the conceptual construct of cultural forests is important for understanding what is meant by the concept of biocultural diversity. Some researchers identified scenarios (e.g., managed successions) in which the human-modified habitats exhibit greater specific and structural plant diversity than do natural ecosystems (Posey 1983a, 1984; Irvine 1989; Balee 1993, 1994); other studies established a link between human management and greater abundance of useful plant species in forest communities (Unruh & Alcorn 1987; Unruh & Flores 1988; Anderson & Ioris 1992; Salick 1992; Balee 1993). Aboriginal Amazonian human populations are also thought to be responsible for developing a good deal of crop genetic diversity (Clement 1989, 1999a, 1999b) and for dispersing useful plants over great distances (Stone 1984; Posey 1988; Sanchez & Jaffe 1992). Perhaps more significant, however, empirical descriptive as well as comparative studies are now bringing out the fact that native Amazonian resource-management systems display considerable diversity and distinctiveness in terms of the specific kinds and amounts of resources harvested and the particular combination of exploitative and manipulative behaviors of the biotic and abiotic environment, both between and within ethnic domains and among different groups who occupy similar ecological ranges (Salick 1989; Salick & Lundberg 1990; Milton 1991; Kaplan & Kopischke 1992; Padoch & De Jong 1992; Beckerman 1993, 1994; Descola 1996; S- Zent & E. L. Zent 2004). We venture the hypothesis that the diversity of disturbance behaviors among culturally distinct human groups in Amazonia will result in a diverse

range of possible impacts on the environment, and in this sense we consider biological diversity to be dependent upon cultural diversity (and vice versa). But in order to prove this hypothesis, the ecological disturbance behavior of various ethnic Amazonian groups must be described in detail and then compared. We begin this enormous task by describing the disturbance behaviors of the Hoti and their possible ecological impacts.

### Ethnobotanical and Human Ecological Research in the Sierra de Maigualida Region

The Sierra de Maigualida is a large, mountainous formation that provides a natural border between Amazonas and Bolivar States in southern Venezuela, between 5° and 6° N and between 65° and 66° W. The principal rivers that drain this area include the Cuchivero, Nichare, Erebató, and Caura on the Bolivar side, which flow north into the Middle Orinoco, and the Parucito and Asita-Iguana on the Amazonas side, which flow south toward the Ventuari River basin (Figure 3.1). The indigenous human inhabitants of the Sierra de Maigualida and surrounding lands refer to themselves as "Hoti." Contact between Hoti and the West was established relatively recently (1969), due principally to the inaccessibility of the Maigualida region, so neither the people nor the land are well known from scientific or lay standpoints. Previous studies and reports of them are based on brief fieldwork experiences (Cruxent 1961; Bodin 1969; Bou 1970; Dye 1970; Jangoux 1971; Corradini 1973; Eibl-Eibesfeldt 1973; Coppens & Mitrani 1974; Guarisma 1974; Coppens 1975, 1983; Guarisma & Coppens 1978; Vilera 1985; Keogh 1995), and, naturally, this anthropological and botanical research provided a major motivation for our research project.'

From May 1996 to October 1999 we conducted an intensive field study of Hoti ethnobotany and behavioral ecology. The information presented in this chapter is based on approximately 21 months of direct observation carried out in four Hoti communities: San José de Kayama, Cano Iguana, Cano Majagua, and Cano Mosquito. The former two are larger, more permanent, mission-based settlements; the latter two, small, mobile, independent communities (for additional details, see S. Zent & E. L. Zent 2004). The methods used in this research included ethnobotanical plot studies (again, for more details, see S. Zent & E. L. Zent 2004), general plant specimen collections, formal and informal interviews, participant observation of a diverse range of activities, instantaneous scan sampling of activities, focal person observations of subsistence behaviors, resource accounting studies, geographical coordinate mapping of resource activities and sites, and daily conversational interactions.

### Biophysical Parameters

The Sierra de Maigualida displays considerable geological, geomorphological, and ecological diversity. Geologically, the region is dominated by moderately tectonized granites, with lesser extensions of pyroclastic-acidic volcanic rock, and localized regions of amphibolitic gneisses and metasedimentary green schists (MARNR-ORSTOM 1988: 25-95). Altitudes range from 150 to 2400 meters above sea level (m asl) and include

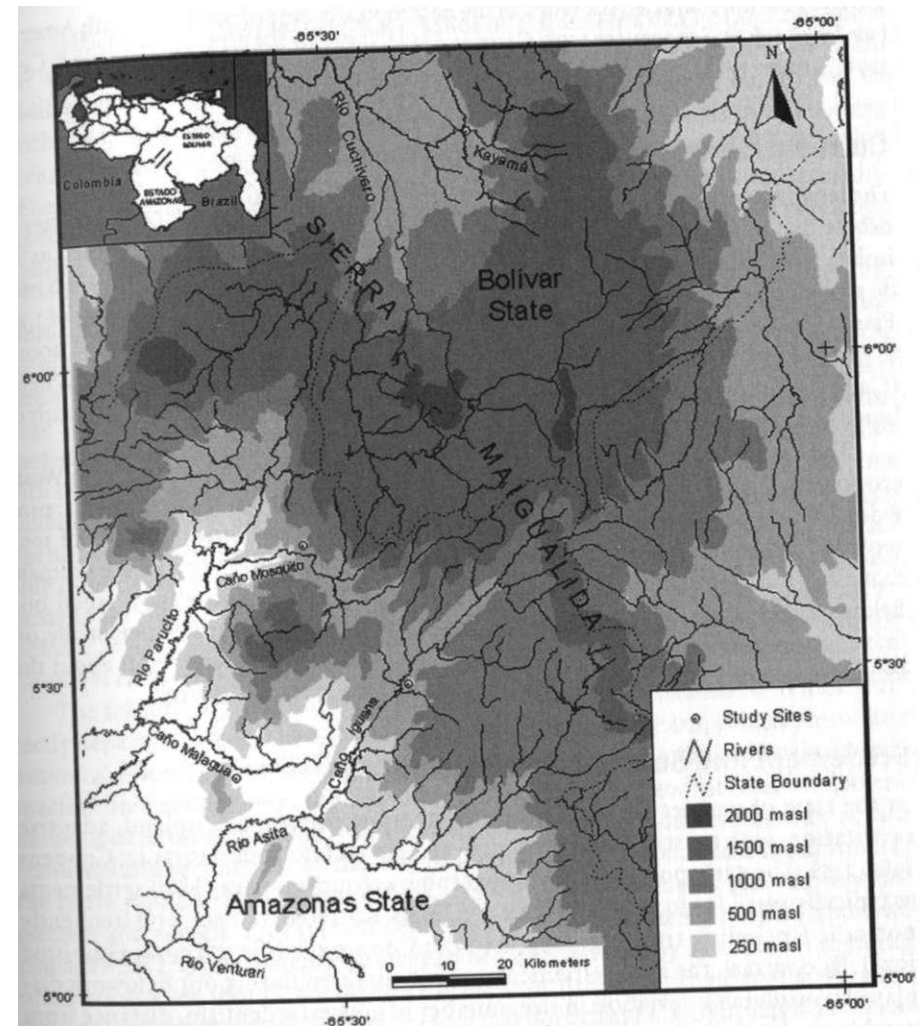


Figure 3.1. Topography of the Sierra Maigualida region of Venezuela.

various landforms: rocky and broken high plateaus (>1000 m asl), mountain slopes, cliffs, ridges and valleys (400-1000 m asl), convex and half-orange peneplains (300-600 m asl), and alteration plain surfaces (150-200 m asl) (pp. 27-29). Rainfall varies between 1900 and 2700 mm per year, and the climate for much of the region is classified under the Koppen system as Am, defined as wet tropical with a dry season of two months (pp. 17-19). The dominant vegetation is mostly semideciduous and evergreen forests, which are described as medium to high and dense, composed of two to four arboreal strata and a relatively open understory, and varied in structure and composition according to an altitudinal gradient ranging from basimontane to montane (Huber & Alarcón 1988). It is assumed that the Maigualida regional fauna corresponds in

general with the characteristic fauna of the neotropical biome of northern South America (see Phelps & de Schauensee 1978; Gremone et al. 1986; Eisenberg 1989; Gorzula & Celsa 1998; Linares 1998), but field studies in this precise area are lacking.

## Cultural History and Population

The language affiliation, as well as the cultural history, of the Hoti is largely a matter of debate due to the lack of definitive data. The Hoti language has been classified as an isolate (Durbín 1977:34), and there have been divergent hypotheses that the Hoti may be affiliated with Yanomami (Coppens 1983: 253), Makii (Henley et al. 1994-1996), or Piaroa (Jangoux 1971; Eibl-Eibesfeldt 1973; Guarisma 1974; Vilera 1985; Zent et al. 2001). In terms of material culture, the Hoti bear some striking resemblances to the E'nepa (Carib language family), their northern neighbors, which are most likely the result of borrowing and historical interaction between the two groups.

The Hoti population appears to be growing rapidly following contact with Western society. The first comprehensive Venezuelan Indian Census, realized in 1982, provides a figure of 398 Hoti (OCEI 1985: 475). The subsequent Indian Census of 1992 recorded 643 Hoti distributed in about 25 communities (OCEI 1993: 42). We estimate that the Hoti population easily exceeded 800 people by October 1999, when our fieldwork ended, based on our census of 14 communities that we visited personally, on information provided to us by missionaries, and on interviews with Hoti about the locations and sizes of other communities that we were not able to visit.

## Settlement and Subsistence Orientation

At the time of contact the Hoti exhibited a strong interfluvial, upland, adaptive orientation, with most settlements at 500-1000 m asl (Corradini 1973: 42; Coppens 1983: 255). The early postcontact ethnographic accounts portray Hoti settlements as typically small (5-30 people), single dwellings, scattered in space, and frequently nomadic (including trekking; Jangoux 1971; Coppens & Mitrani 1974; Guarisma 1974). By contrast, the Hoti settlements we encountered during our fieldwork displayed considerable variation in size, number of houses, sedentism, distance from neighbors, interethnic contacts, internal composition, architectural style, and ecogeographical zone inhabited. Consequently, it may no longer be possible to speak of a "typical" Hoti settlement pattern by way of a simple checklist of traits. For example, there is a notable gradient in regard to settlement nucleation and sedentarization, from relatively permanent, densely populated communities to very nomadic, small, dispersed settlements made up of a single nuclear family. The two mission-based communities at Kayama and Iguana are larger and more permanent, whereas the nonmission settlements, Majagua, Mosquito, and others that we visited, resemble the traditional pattern in terms of size and mobility. In spite of the more sedentary appearance of the mission settlements, camping and trekking are still very common practices in all communities, but in the case of the former two these activities usually involve very small groups and shorter stays away from the

main settlement. In any case, two basic kinds of settlements can be distinguished: base settlements, where larger and more durable housing is built and the main swidden plots are located, with a relatively stable duration of five or more years, to which the coresidential unit or segment returns on a recurrent basis from trekking or camping trips throughout the annual cycle; and camp settlements, temporary shelters, most commonly lean-tos, where individuals, family groups, or occasionally the entire settlement unit camp out during foraging outings, trekking, trade expeditions, kin reunions, ritual observances, and other forays.

The Hoti subsistence system rests on an extensive mix of hunting, gathering, fishing, and horticultural activities, the relative importance of each varying according to the size, permanence, surrounding habitat, and economic acculturation of the community (for more details, see S. Zent & E. L. Zent 2004). Medium-sized and large terrestrial mammals (e.g., tapirs, peccaries, pacas) are hunted mainly with steel-tipped lances, and arboreal mammals (mostly monkeys) and birds are shot with blowguns and curare-tipped darts. The most prominent gathered food items include palm larvae, honey, and numerous species of tree fruit (see below). Fishing was not an important activity in the traditional upland habitat and today is significant only in settlements next to the larger waterways. The main cultigens found in Hoti gardens are plantain/banana (*Musa x paradisiaca*), yams (*Dioscorea alata* and *D. trifida*), maize (*Zea mays*), sweet potato (*Ipomoea batatas*), and sweet manioc (*Manihot esculenta*) (Zent et al. 2001).

The scheduling, duration, and location of different subsistence activities is directly dependent on the Hoti's knowledge of the phenology and geography of key botanical resources and the behavioral ecology and demography of certain animal species.<sup>2</sup> In a similar vein, the fluctuation from sedentary to nomadic settlement modes is determined primarily by the perceived abundance and availability of wild resources and secondarily by the labor demands of the horticultural cycle. Among the more nomadic settlement groups, swidden plots appear to be relatively neglected, and garden labor is often deferred or simply forgotten. For this reason, we consider the Hoti subsistence strategy to be characterized by a dominant foraging orientation, even though horticulture may be the principal provider of dietary energy in some communities. As maybe expected, horticultural activity has been intensified in the more nucleated and sedentary mission communities. Nevertheless, a huge variety of wild plant and animal species are collected on an almost daily basis in all of the communities we studied, making a significant contribution to the diet and also furnishing raw materials for the manufacture of household utensils, tools, ornaments, soaps, medicines, hunting magic, fish bait, firewood, building materials, and so forth (Zent et al. 2001).

The heavy dependence of the Hoti on wild forest resources for their material and social reproduction is now well documented (E. L. Zent 1999; Zent et al. 2001). Still to be determined is whether this dependency has in turn conditioned or stimulated dependent responses in at least some of the botanical or zoological species that have been—and continue to be—subject to human exploitative manipulation for many years, decades, or even centuries. In short, to what extent have the Hoti do-

mesticated their forest environment? It is significant to note that most research to date on the cultural forest question in Amazonia has emphasized the impact of slash-and-burn or shifting cultivation on forest composition and structure (Denevan & Padoch 1987; Balee 1989, 1993; Irvine 1989). However, without intending to downplay the importance of this form of human disturbance, we have chosen to focus our present description on the creative disturbances associated with the exploitation of so-called natural resources or natural spaces. Our main reason for taking this alternative approach is because, as we expressed earlier, the organizational focus of the Hoti subsistence system is on foraging, which seems to indicate the historical dominance of this economic sector.<sup>3</sup> Therefore, we assume that the cumulative ecological impact of nonswidden activities is greater in historical perspective. Another reason for focusing on the ecological disturbances resulting from foraging behavior is to call attention to the possible historical role of human foragers in shaping Amazonian landscapes. Five kinds of human disturbance of natural resources are explored here: harvest and dispersal of edible fruit trees, exploitation and manipulation of palms, management of palm grubs, gap cultivation, and honey extraction.

### Harvest and Dispersal of Edible Fruit Trees

Environmental disturbances can be classified as events that cause the death of one or more individuals, dynamic events that change the structure and possibly the composition of a biotic community, or phenomena that liberate resources previously used and thereby increase the resource availability to other organisms (cf. Barbour et al. 1987; Petraitis et al. 1989; Pickett et al. 1992). Disturbances can take place at several levels of ecological organization: individual, population, community, ecosystem, region, and so on. The many types of environmental manipulation practiced by the Hoti correspond to the three classes of disturbance mentioned above, and their effects may be observed at different levels.

The most common disturbance activity observed among the Hoti involves the harvesting and dispersal of edible fruit trees. The collection and consumption of wild tree fruits are flexible events, in which persons of all ages (>5 years old) and both sexes participate actively. However, some fruit types are considered to be eaten only by children, which may explain why knowledge of edible plant species develops faster than do other areas of ethnobotanical knowledge (see S. Zent & E. L. Zent 2004). The frequency of such gathering bouts in a particular settlement depends on the abundance and distribution of edible tree species in the resource catchment area, season, settlement mobility patterns, and other activities being engaged in. Whereas some wild fruit foraging expeditions are consciously planned with the goal of harvesting a specific species, in which case the forager knows ahead of time exactly what plant individual(s) will be exploited and/or their general location, other harvesting events are best described as opportunistic, in that a person ingests edible fruits if he or she happens to come across them when walking through the forest, often while engaged in some other activity. The former type of harvesting strategy is usually reserved for certain species that are especially appreciated for their unique flavor or that provide a certain minimum yield (we

estimate about 3 kg) of harvestable fruit during one harvesting event. Trekking or camping trips are sometimes motivated by the principal desire to consume the fruit of a very productive, seasonally available tree species, such as *Humiria balsamifera*, *Chrysophyllum sanguinolentum*, or *Dacryodes* spp. (see below). By contrast, the opportunistically exploited species are obviously accorded lower harvesting priority, but this does not mean that their habits and habitats are less well known by the Hoti. In fact, such knowledge allows the Hoti to modulate their subsistence practices as the need arises, such that these resources are more intensively exploited during periods of environmental or social fluctuation, when the more common food items may become scarcer. We recorded a total of 222 wild botanical species that are considered edible by the Hoti, the vast majority of which are rarely eaten when normal subsistence conditions prevail. The number of plant foods actually harvested during the research period was considerably fewer, according to our resource accounting records. The most important fruit tree species exploited by the Hoti are listed in Table 3.1.

The harvesting of tree fruits usually involves one or more of the following standard collection techniques: picking up the fallen mature fruits directly from the ground; climbing trees or vines with the aid of a climbing ring, *hudibu*, which is fashioned from the inner bark of several trees (*E'kutile'yai*, *Guatteria foliosa* Benth, Annonaceae; *eloli'yat*, *Cordia sericicalix* A.D.C., Boraginaceae; *ba'tu hold'yai*, *Lecythis corrugata* Poiteau, Lecythidaceae; *totohu'yai*, *Brosimum utile* [Kunth] Pittier, Moraceae) or the outer stem of *kalawa'wa'wa* (*Phenakospermum guyanense* [L. C. Rich.] Endl. ex Miq., Strelitziaceae); building scaffolds, if the base of the trunk is too voluminous and difficult to climb; removing tree branches; and chopping down the tree. After the fruit is collected, it may be eaten immediately and the seeds discarded at the same spot. Any leftover fruit is carried back to the settlement or campsite. It is not uncommon for the collectors to continue to eat the fruit and throw away the seeds as they walk home. If the fruit is consumed at the settlement, inedible material, including the seeds, is either deposited in refuse piles along the margins of house yards or thrown into a nearby creek. Sometimes fruit that is brought down from the tree canopy is neither eaten nor hauled away by humans (for example, if not yet ripe), in which case it may be dispersed by animals. All of these practices related to the collection and dispersal of tree fruits entail rather low-level disturbance events, in the sense of affecting an individual organism, the immediate environs of the harvest site, the route from harvest to settlement sites, and/or the settlement site surroundings. However, if one considers the considerable frequency and density with which such events occur in time and space under normal subsistence practice, one can imagine the potential impact at higher levels of ecological organization." This point is illustrated through description of the exploitation of the fruit tree, *walikye'yai* (*Ecclinusa guianensis* Eyma).

During the first two months of the rainy season (April-May), the Hoti collect and eat large quantities of *walikye* fruit. This member of the Sapotaceae family is found mostly in montane and premontane forests. Its presence in lower-altitude forests is attributed by the Hoti to the dispersal behavior of human and animals. For example, it is a common trailside inhabitant around the community of Kayama, although it is not considered by the people living there to be a native species of this savanna-forest ecotone

Table 3.1

Edible fruit trees most commonly harvested by the Hoti

Family	Scientific name	Hoti name	Season of harvest
Anacardiaceae	<i>Anacardium giganteum</i> <b>Hanc.</b>	<i>uli eloli yai</i>	<b>July-September</b>
Apocynaceae	<i>Couma macrocarpa</i> <b>Barb. Rodr.</b>	<i>'kalibSle'yai</i>	<b>May-August</b>
Burseraceae	<i>Dacryodes</i> <b>sp.</b>	<i>uli Hute 'yai</i>	<b>August-November</b>
Burseraceae	<i>Dacryodes chimantensis</i> ( <b>Steerm.</b> ) <b>Cuatrec.</b>	<i>hctli' lute 'yai</i>	<b>July-November</b>
Burseraceae	<i>Protium tenuifolium</i> ( <b>Engler</b> ) <b>Engler</b>	<i>o tewaka bau'yai</i>	<b>May-July</b>
Burseraceae	<i>Protium opacum</i> <b>Swart</b>	<i>uli bau'yai</i>	<b>May-July</b>
Caesalpinaceae	<i>Hymenaea courbaril</i> L.	<i>bUye'yai</i>	<b>November-January</b>
Caryocaraceae	<i>Caryocar microcarpum</i> <b>Ducke</b>	<i>uli'kawale'yai</i>	<b>April-August</b>
Cecropiaceae	<i>Pourouma melinonii</i> <b>Benoist</b>	<i>uli we'kao'yai</i>	<b>May-July</b>
Clusiaceae	<i>Garcinia macrophylla</i> <b>Martius</b>	<i>'tawe'yai</i>	<b>July-August</b>
Fabaceae	<i>Dipteryx</i> <b>sp.</b>	<i>wai'yai</i>	<b>February-April</b>
Humiricaceae	<i>Humiria balsamifera</i> <b>Aubl.</b>	<i>'tau ate</i>	<b>December-March</b>
Mimosaceae	<i>Inga bourgoni</i> ( <b>Aublet</b> ) <b>D.C.</b>	<i>halt luwe'yai</i>	<b>February-April</b>
Mimosaceae	<i>Inga edulis</i> <b>Martius</b>	<i>uli luwe'yai</i>	<b>January-May</b>
Mimosaceae	<i>Inga cf. alba</i> ( <b>Sw</b> ) <b>Willd.</b>	<i>bayekalo luwe'yai</i>	<b>April-August</b>
Mimosaceae	<i>Inga</i> <b>sp.</b>	<i>e'ko luwe'yai</i>	<b>February-April</b>
Moraceae	<i>Brosimum lactescens</i> ( <b>S. Moore</b> ) <b>C. C. Berg</b>	<i>'i?ftweka'yai</i>	<b>April-June</b>
Moraceae	<i>Helicostylis tomentosa</i> ( <b>P. &amp; E.</b> ) <b>Rusby</b>	<i>waiyo waleba'yat</i>	<b>June-August</b>
Moraceae	<i>Pseudolmedia laevigata</i> <b>Tree</b>	<i>hali waiyo'vai</i>	<b>January-March</b>
Moraceae	<i>Pseudolmedia laevis</i> ( <b>R. &amp; P.</b> ) <b>Macbride</b>	<i>uli waiyo'yai</i>	<b>January-March</b>
Moraceae	<i>Sorocea muriculata</i> <b>Miquel</b>	<i>bu'ta hele</i>	<b>May-July</b>
Polygonaceae	<i>Coccoloba fallax</i> <b>Lindau</b>	<i>'toba'yai</i>	<b>January-May</b>
Sapindaceae	<i>Matayba</i> <b>sp.</b>	<i>ahtikwB'yai</i>	<b>July-August</b>
Sapotaceae	<i>Chrysophyllum argenteum</i> <b>Jacq.</b>	<i>oleko 'yai</i>	<b>January-March</b>
Sapotaceae	<i>Chrysophyllum sanguinolentum</i> ( <b>Pierre</b> ) <b>Baehni</b>	<i>tuwiyu'yai</i>	<b>January-March</b>
Sapotaceae	<i>Ecclinusa guianensis</i> <b>Eyma</b>	<i>walikyeyai</i>	<b>April-June</b>
Sapotaceae	<i>Micropholis egenesis</i> ( <b>A.D.C.</b> ) <b>Pierre</b>	<i>'kaile'yai</i>	<b>February-April</b>
Vochysiaceae	<i>Qualea paraensis</i> <b>Ducke</b>	<i>Hebale 'yai</i>	<b>February-April</b>

environment. The fruit is oval, about 3-5 cm long, with yellow-reddish skin when ripe and a yellow, juicy, gummy pulp. *walikye* has a sweet, tasty fruit, and, as with many Sapotaceae, the trunk and fruit exude sticky, milky latex. The fruiting period is relatively short, but the fruit is abundant enough to motivate extensive collecting expeditions among the Hoti.

<sup>1</sup> May 1998 we observed an ecologically and socially dynamic expedition to collect this fruit at Cano Iguana. A total of 37 individuals (nearly 25% of the village population) participated actively in the event, making it the largest communal economic

activity we saw or heard about during our six months of cumulative residence in the community. Cognatically as well as affinally related groups (including infants and elderly), consisting of two to seven persons, participated in the harvest, which took place at about a two-hour walk from the community. Some groups built small shelters and spent a few days there, but most people went just for the day. While some men and boys climbed up several trees and cut down the fruit-laden branches, others gathered fruits that had already fallen to the ground or after the branches had crashed down. A few large trees were felled with an ax to gain access to the fruit, even though it appeared that they could have been climbed. Most of the fruit was consumed on the spot, although several groups managed to take one or more basketloads back to the village.

What are the ecological consequences of this intensive pattern of *walikye* exploitation? Table 3.2 shows the census figures for this plant species in the 1-ha ethnobotanical plots we surveyed in the four study communities. Where *Ecclinusa guianensis* is present (at Iguana, Majagua, and Kayama), the comparative absolute densities of this species in high forest range from 1 to 7 individuals per hectare, whereas the absolute frequencies are between 1 and 6 (in a sampling universe of 25 quadrats per settlement). By contrast, the density and frequency of *E. guianensis* in the collection zone referred to above was much greater. There we counted 47 large individuals (>10 cm dbh) of *E. guianensis* in an area we estimated to cover approximately 1 ha. This species appeared to be the most dominant arboreal species in that patch of forest. Furthermore, we also saw numerous smaller individuals of the same species in the area. The diversity of heights and thicknesses of *E. guianensis* stems tells us that the local population is extremely well balanced according to age group and is a key indicator of successful colonization. Another significant feature of the *walikye* harvest zone was the conspicuous presence of indicators of past human disturbance, in the form of old tree stumps and logs from cut-down trees.

Human management through harvesting practices over long periods of time seems to be the most reasonable explanation for the high density of *Ecclinusa guianensis* in particular patches of forest. Even if the Hoti do not act consciously, their collection techniques appear to foster the dominance and maintenance of this species locally. Pertinent ecological consequences of these techniques include: enhancement of local seed banks of this species while collecting the fruit, since the Hoti eat some of it on the spot and let the seeds fall to the ground; regional dispersal of seeds, since a significant portion of the harvest is transported back to the settlement and since some of the fruit is eaten during the walk home and the seeds dropped along the trail while the rest are thrown away at the settlement site; creation of gaps by felling larger, mature individuals, which eventually allows the development of new individuals from the same or other species; liberation of nutrients as a result of cutting down branches or tree trunks, which benefits the plants around them; and stimulation of new branch growth through the selective removal of branches laden with fruit.

Analogous consequences can be observed in other arboreal fruits collected by the Hoti, such as *tuwiyu 'yai* (*Chrysophyllum sanguinolentum*) and *'tau ate 'yai* (*Humiria balsamifera*). The fructification of both species takes place in the dry season (January-March) and stimulates overnight camping trips. Both species normally grow on the

**Table 3.2**  
Synecological values for *Ecclinusa guianensis* in the four 1-hectare Hoti forest plots

Location	Absolute density <sup>a</sup>	Relative density <sup>b</sup>	Absolute frequency <sup>c</sup>	Relative frequency <sup>d</sup>	Relative dominance <sup>e</sup>	Importance value <sup>f</sup>
Caño Iguana	5	1.41	4	1.40	1.38	4.19
Caño Majagua	1	0.18	1	0.27	0.05	0.50
San José de Kayama	7	1.30	6	1.51	1.85	4.66
Caño Mosquito	0	0	0	0	0	0

<sup>a</sup> Number of individuals of the species occurring in the plot.

<sup>b</sup> Number of individuals of the species divided by the number of all individuals in the plot.

<sup>c</sup> Number of subplots (400 m<sup>2</sup>) in which one or more individuals of the species occur.

<sup>d</sup> Absolute frequency of the species divided by the total absolute frequency of all species.

<sup>e</sup> Aggregate basal area of the species divided by total basal area of all species.

<sup>f</sup> Sum of the relative density, relative frequency, and relative dominance.

stony ridge tops in premontane and montane forests (>400 m asl), and their presence in lower-lying regions is explained by the Hoti as the exceptional result of the dispersal actions of people or animals. *tau ate* is especially abundant in the vicinity of Caño Iguana and is the object of frequent collection expeditions. The fruit is oval, measuring about 1-2 cm in length, is green-to-violet black in color, and has a sweet pulp that surrounds a single seed. When ripe and ready to be eaten, it falls naturally to the ground. In this case, the main disturbance behavior of the Hoti is simply to disperse the seeds at least as far as their settlement or campsites.

## Exploitation and Manipulation of Palms

Without a doubt, palms hold a special place in the resource-management strategies of lowland South American cultures (cf. Balick 1984). Recent studies conducted in the Colombian Amazon show that palms have been used by humans continuously since the early Holocene (Morcote-Rios et al. 1998). It is rare to find a contemporary rural group that is not dependent on palms in some way. The Hoti are no exception to this pattern. As shown in Table 3.3, 10 species of palms are extensively exploited for a wide variety of reasons: food, human medicine, hunting medicine, fish bait, house building materials (thatch, wall planks), furniture (tables, benches, shelves), basketry and mats, ceremonial dress, hunting tools (lance, bow, blowgun dart, shooting pellet), household utensils (broom, food container, food grater, needle), fire drill, and cotton spindle. The contribution of palms to the Hoti diet is quite significant. The collection of four species of palm fruit (*Attalea maripa*, *A. macrolepis*, *Oenocarpus bacaba*, and *Bactris gasipaes*) has been cited as a main motivation for camping trips. The *cucurito* palm, *ulu hi* (*A. maripa*), is an especially important food source, constituting a staple food during the harvesting period (May-July). Perhaps for this reason, the Hoti regard it as the first plant created on earth, deep in the mythological past. Trekking and camping behavior during the rainy season is largely determined and regulated by opportunities to

**Table 3.3**  
The most common palms exploited and managed by the Hoti

Hoti name	Latin name	Uses
<i>halt ba</i>	<i>Astrocaryum gynacasthum</i> Mart.	Food, bows, fish bait
<i>awa'to</i>	<i>Attalea macrolepis</i> Mart.	Food, house-building material, basketry, darts, food containers
<i>ulu</i>	<i>Attalea maripa</i> (Aubl.) Mart.	Food, basketry, darts, house-building material, food containers, combustible material
<i>'kolowa</i>	<i>Attalea</i> sp.	Food, house-building material, darts, food containers
<i>leba</i>	<i>Bactris gasipaes</i> Mart.	Food, fish bait
<i>wa'wi</i>	<i>Euterpe precatorea</i> Wallace	House-building material, hunting material, combustible material, fish bait
<i>balaya</i>	<i>Geonoma deversa</i> (Pait.) Kunth	Food, house-building material
<i>tuli</i>	<i>Mauritia flexuosa</i> L.f.	Food, basketry, house-building material, ceremonial dress
<i>halt ba'te</i>	<i>Oenocarpus bacaba</i> Mart.	Food, basketry, house-building material
<i>buli</i>	<i>Socratea exorrhiza</i> (Mart.) Wendl.	Food, food graters, fish bait, basketry, house-building material, fish traps, combustible material

harvest *ulu* fruit. Thus it is common to find camp settlements next to *ulu* stands. The fruit is oval, about 3 cm long, with a leathery, ochre-brown skin that covers the soft, whitish pulp. It can be eaten raw or cooked in the form of juices (*'yu*) or soups (*'ta'ta*). The *seje* palm, *hali ba'te hi* (*O. bacaba*), is another keystone species for Hoti subsistence, providing edible fruit as well as edible weevil larvae (see below). The fruit is round, about 1 cm in diameter, with a purple-black skin and oily, edible mesocarp that is boiled and eaten or drunk as a beverage. This erect palm is found mostly on hill slopes and well-drained spots.

The conspicuous presence of palms throughout the Maigualida landscape is attested to by the data presented in Table 3.4. The dominance of palms is greatest in the riverine forests at Caño Majagua. Here the abundance of *Oenocarpus bacaba* is particularly striking, reaching an absolute density of 59 individuals per hectare (more than 10% of all individuals in the plot).<sup>3</sup> The presence of *Attalea maripa* is also substantial, showing absolute densities of 6 or 7 individuals per hectare in three of the four forest plots. Such densities appear meaningful when viewed in the context of the low densities recorded for most other species found within the plots. The vast majority of taxa on these plots are represented by five or fewer individuals: for Caño Mosquito, 89%; for Caño Majagua, 88%; and for Kayama, 86%. In short, *A. maripa* is one of the most abundant plant species found in three of the four study sites.

The existence of palm-dominant forests in other Amazonian areas has been associated directly with human management (Balee 1988; Anderson et al. 1991; Heinen & Lizarralde

**Table 3.4**

Synecological values for palm species in the four 1-hectare Hoti forest plots

Species, location	Absolute density	Relative density	Absolute frequency	Relative frequency	Relative dominance	Importance value
<i>Astrocaryum gynacasthum</i>						
Carlo Mosquito	1	0.18	1	0.25	0.03	0.46
<i>Attalea maripa</i>						
Cano Mosquito	7	1.26	5	1.31	1.63	4.20
Cano Majagua	6	1.07	5	1.40	7.37	9.84
San José de Kayama	7	1.30	3	0.76	3.88	5.94
<i>Attalea macrolepis</i>						
San José de Kayama	1	0.19	1	0.25	0.72	1.16
<i>Attalea</i> sp.						
Cano Majagua	6	1.07	1	0.28	5.69	7.04
<i>Euterpe precatoria</i>						
Cano Majagua	10	1.78	4	1.12	0.44	3.34
Cano Iguana	3	0.85	3	1.08	0.16	2.09
San José de Kayama	12	2.23	8	2.02	0.81	5.06
<i>Oenocarpus bacaba</i>						
Cano Mosquito	2	0.36	2	0.52	0.27	1.15
Cano Majagua	59	10.48	17	4.75	6.46	21.69
Cano Iguana	1	0.28	1	0.36	0.04	0.68
<i>Socratea exorrhiza</i>						
Cano Mosquito	12	2.16	10	2.62	0.43	5.21
Cano Majagua	29	5.15	11	2.98	0.99	9.12
Cano Iguana	8	2.25	7	2.53	0.58	5.36
San José de Kayama	3	0.56	2	0.51	0.14	1.21

1991; Heinen et al. 1995). This finding provokes the question, To what extent is the abundance of the palm species mentioned above the product of human intervention? The main kinds of human disturbance of possible relevance to this example include fire, felling, transport, and cooking. Both *Oenocarpus bacaba* and *Attalea maripa* are fire-resistant species. The Majagua plot was partially burned during the dry season of 1998 in a fire that escaped from a nearby swidden plot. Twenty-three *O. bacaba* individuals were severely burned and indeed appeared to be dead upon initial observation. Returning to the site five months later, we were astonished to find that every one of them had recuperated successfully. The resilience of *O. bacaba* shown in this case may have to do with the fact that it has a higher water input near its stem than do open-area rainfall or dicotyledonous tree species (Schroth et al. 1999). *Attalea maripa* is similarly resistant, for it often survives the initial burning of a new garden, making this pioneer species a long-lived one. In this regard, it is interesting to note that we observed numerous *ulu* monodominant patches, called *ulu co* (*A. maripa* forest), during along trek we riade into the headwaters of the Cuchivero River, which is the traditional

heartland of Hoti settlement. Our Hoti collaborators explained that some of the *ulu co* are clearly the living remains of past garden and settlement sites.<sup>6</sup> In other cases, the *ulu co* were found on ridge tops, where gardens are not usually located. However, we also noticed that some forest patches on ridge tops had been burned, and our collaborators confirmed that people initiated these fires during the height of the dry season. It is therefore possible that the ridge-top *ulu co* were established through human-induced seed depositions advantaged by human-set fires.<sup>7</sup> In sum, the generous endowment of palms such as *O. bacaba* and *A. maripa* throughout the Maigualida landscape may be interpreted as supporting the claim that "fire is everywhere in the Amazonian natural history" (Pyne 1998:88).

To harvest edible palm fruit or fronds for house thatching, the collector normally climbs the trunk (or an adjacent one) and cuts down the whole bunch or the leaves, as the case maybe. But on certain occasions the collector chops down the entire palm tree in order to harvest these products, a practice that appears to be destructive. However, this practice is usually reserved for very mature or senescent individuals that are past their fertility peak or no longer producing fruit. Our Hoti collaborators stated that individuals of *Oenocarpus bacaba* and *Attalea maripa* are cut down when they are "too tall and old" in order to make way for younger individuals that will then "grow faster and stronger." These perceptions are in fact consistent with the information found in the scientific literature, where it has been reported that *O. bacaba* individuals approaching senescence exhibit a reduction in growth rate, reproductive potential, and biomass generation (Balick 1988: 129). Moreover, although the senescent palm has fewer leaves, the open structure and horizontal orientation of the crown shade the plants growing underneath it. Therefore, cutting down the whole plant not only releases nutrients but also allows more direct insolation, which benefits seedlings, saplings, and young individuals. In this sense, the selective removal of unproductive individuals facilitates the development of newly productive ones, which also benefit from the nutrients released by the fallen trunk. As a result, the *O. bacaba* stands that we observed were made up of individuals of diverse sizes, ages, and phenological stages. Unfortunately, in the available literature there are no estimates of ages for the life expectancy and life stages of *Oenocarpus* sp. (Balick 1988:129), due to high plasticity and the inability to make correlations between size and age of this species (Balick 1986: 77), although leaf morphology is considered to be a good indicator of life stage in palms (Balick 1988:130).

The Hoti may also influence the distribution and regeneration of palms as a consequence of harvesting, handling, and consuming their fruit. The collection and transport of large quantities of fruit to settlements and campsites implies the formation of large seed banks in particular locations. For example, in May 1996 we visited the campsite of a Hoti nuclear family next to an *ulu* grove in the Upper Cuchivero region. The family had been staying at this camp for the past three to four weeks and reported that *ulu* fruit was the principal food they had consumed during that time. We observed that a few tall *ulu* trees had been felled recently and that huge piles of shells and seeds of the freshly eaten fruit were all around the small clearing where lean-tos had been built. The processing of palm fruit, especially its cooking, may also hasten germination



and growth. This is certainly the case with *Oenocarpus bacaba*, for which soaking the seeds in warm water or boiling them prior to eating increases the global percentage of seed germination from 42% to 98% (Balick 1988:122-123). With *Attalea maripa*, the hard shells are sometimes cracked open with a rock in order to look for larvae (*ulu abiye*), which are eaten or used as fish bait. In sum, Hoti strategies of exploiting and manipulating palms influence their distribution, density, and regeneration patterns.

## Management of Palm Grubs

Palm grubs, corresponding to the larvae of two weevil species, *hali bahteboha* and *uli ba'teboha* (*Rhinostomus barbirostris* and *Rhynchophorus palmarum*, respectively, Curculionidae, Order Coleoptera), are very common in the Hoti diet. Although we initially considered the weevil larvae wild resources, we soon became aware that the Hoti consciously manipulate their production and reproduction through a form of management that might be considered pseudo-domestication. Their management strategy relies on knowledge and exploitation of the relationship between these coleopteran insects and a few palm species, especially *hali ba'te hi* (*Oenocarpus bacaba*).

Using their knowledge of the specific reproductive ethologies of *Rhinostomus barbirostris* and *Rhynchophorus palmarum*, the Hoti re-create the environmental conditions needed to raise them. The female weevil deposits her eggs in the decaying pith of fallen stems of *Oenocarpus bacaba* and, to a lesser extent, of *O. bataua*, *Attalea maripa*, and *A. macrolepis*. The wood of these palm species is very fibrous yet soft to medium in hardness and decomposes relatively rapidly after the trunk falls down. As such, it provides the ideal incubation and nurturing medium for the developing weevils. So the Hoti cut the palms down in order to provide extra breeding grounds for the weevils. This practice is mostly reserved for *O. bacaba*, because the Hoti regard the other palm species as less reliable sources of weevil larvae production, but they occasionally fell the other species for this purpose as well. The stems selected for felling correspond to individuals approaching senescence and hence past their most productive stage. In fact, the Hoti assert that if a younger, more fertile individual is felled, the wood will not decompose fast enough and the weevils will not lay their eggs there. This may be due to the fact that the pregnant weevils are instinctively repulsed from laying their eggs in the logs of younger palms or that the slower decomposition rate of the latter does not allow the eggs and larvae to prosper; a more definitive answer will require further investigation. In any case, felling the older, larger, and taller individuals creates light gaps that benefit younger, smaller, and more fertile individuals (see the previous section).

We found that the harvesting of palm-grown weevil larvae was practiced most frequently at the Majagua and Mosquito communities, precisely where the human population density is lowest.<sup>8</sup> In these areas, the local landscape is sprinkled with small clearings or sometimes patches in closed canopy forest (20-40 m), where two to four felled trunks of *Oenocarpus bacaba* lie. The Hoti fell the palm stems and then leave them for a few months, thus allowing natural decomposition to begin, creating ideal conditions for the weevil larvae, which feed on the fibrous wood of the palm. After three to four months, the person who felled the stem will return to the site, usually in the company of

his spouse and/or children, in order to harvest the larvae and nymphs. The log is split open with an ax, and the inner fiber is sliced up with a knife and then meticulously sifted by hand for edible larvae. A large portion of the larvae are eaten raw on the spot; the rest are taken home and cooked in soups or wrapped in leaves and then roasted. If one waits any longer, the larvae will have become too mature, too adult-like, to be considered edible and thus, from the Hoti perspective, represent a loss of food resources.<sup>9</sup> However, it is not uncommon to find that some of the eggs have already reached the adult stage by the harvest date; the collectors generally ignore these individuals. Furthermore, it is also not uncommon for the collector to leave some ostensibly edible larvae behind. According to our Hoti collaborators, a large number of larvae and adults normally die trapped inside the palm trunk, if not liberated by the harvest procedure, so in that sense the harvest may actually provide a positive input to the local weevil population. In any case, the fixed period of larvae maturation and the natural mortality levels impose a fairly limited window of harvesting opportunity, which we interpret to mean that the collection outings are consciously planned from the moment of felling.

The harvest and consumption of weevil larvae occurs year-round, availability depending mainly on the level of human management. In the Majagua and Mosquito communities the larvae are harvested an average of three times per week. So it is fair to say that this resource makes a very substantial contribution to the Hoti diet, being especially rich in protein, fat, and carbohydrate content.<sup>10</sup> Moreover, it is a very reliable source of protein and fat that can be used to offset periodic shortages of fish or game.

Obviously, the management of palm larvae described here goes beyond simple foraging of natural resources and implies pseudo-domestication, by which we mean creating an interdependence among animal, plant, and human populations. The Hoti practice of felling older palm trees and harvesting weevil larvae from them has a direct influence on the abundance and regeneration of both the animal and plant species involved. At the same time, the subsistence economy of the Hoti is heavily dependent on the nutritional and other material benefits of the weevils as well as the palms. On the social plane, the *Oenocarpus bacaba* stands constitute one of the few types of natural resource that are invested with a certain "property value" by the Hoti. The stands are recognized to have owners, to whom prior rights of exploitation are accorded, and we have even heard of cases in which the stands were inherited from a previous owner. Indeed, the palm stands, along with other strategic resources (e.g., hunting trails, old gardens), seem to provide the material basis for territorial behavior among the Hoti, which in turn conditions various aspects of their settlement pattern and social relations (cf. Storrie 1999).

## Gap Cultivation

Another kind of creative disturbance behavior performed by the Hoti entails the cultivation of certain crop plants in natural gaps in the high forest along their walking trails. We observed two kinds of gaps being utilized in this fashion: natural tree-fall clearings and seasonally flooded open areas along creeks. The Hoti refer to these resource areas

as *bald balo* (trail garden). Like those found among the Kayapo (Posey 1983a, 1984) and Piaroa (Zent 1992:168-169), these trail gardens provide people with extra food supplies that can be used during their frequent trekking activities. The trail gardens are usually far from the settlements and, according to the Hoti, were much more extensive a generation ago. Some informants report that the bulk of their ancestors' diet consisted of palm fruits, wild game, honey, and cultivated plants from the trail gardens. Most of the cultigens planted in trail gardens are relatively short-lived plants that are favorite food items and also release nutrients when they die, such as maize, manioc, sweet potato, yam, ocumo, and sugarcane. Other cultivars, such as banana or plantain and papaya, can survive longer, although they eventually disappear when the surrounding trees overtake the clearing and close the canopy.

The peach palm, *leba hi* (*Bactris gasipaes*) is also planted in trail gardens, but its exploitation involves an interesting case of human introduction of a natural resource that apparently is being maintained due to its mutualistic interaction with the wild fauna of the region. According to Schultes (1994: 203), the peach palm is "unknown in the wild" but is "widely cultivated throughout tropical America." However, the majority of the harvests we observed and recorded in the field came from "wild" stands, according to the people who collected the fruit. They claimed that the agouti (*Dasyprocta leporina*) is responsible for the abundant proliferation of this species. Agoutis not only eat the fruit but also bury the seeds in the ground, thus in effect planting new trees and stands.

## Honey Extraction

One of the most distinctive features of the Hoti subsistence system is their avid procurement of honey. Although the Hoti spend a good deal of time year-round searching for new nests of *baila* "bees" (Meliponinae, Apinae), honey collection peaks during the dry season (December-March), and honey becomes one of the most frequently eaten foods. On dry-season treks, when access to cultivated foods is diminished, honey serves as the staple of dietary carbohydrates. In addition to honey, *baila held*, the Hoti consume certain types of bee pollen, *baila bu'kehu*, and pupae, *baila ilibo*, and also gather the wax, *baila 0*, which is used to manufacture torches, *baila boko*.

The Hoti possess a vast and complex knowledge of Hymenoptera biology, ethology, ecology, and geography, and we are only able to skim the surface of it at this time. We recorded 23 folk species of *baila*. However, since no bee specimens were collected (due mainly to lack of legal permits to do so), the correspondence of folk species with scientific species cannot be determined. The natural history of each species is well known. Walking through the forest, our Hoti companions would often point to the presence of different bees and mention something about their habits or habitats. The perception of bees in any context usually elicits a responsive action or at least a comment. The Hoti constantly monitor their environment for movements of bees and locations of their colonies, and this information goes to update their cognitive cartography of wild resources. Newly spotted beehives are quickly assessed with regard to size, potential amount of harvestable honey, and best time to harvest the product. In searching

for honey, the Hoti often make use of their knowledge of the tree species in which the bees prefer to nest. Our data show that at least a dozen local bee taxa are associated with specific trees, as shown in Table 3.5. This knowledge suggests potential interspecific co-evolutionary processes that deserve further study, since the biology and ecology of native Amazonian bees are poorly understood by Western science.

Honey-collecting trips are flexible events that can last a few minutes or several days. In the latter case, camp settlements are established and occupied until all the honey in the local area has been depleted. Once the hive has been spotted, the species identified, and the potential productivity and accessibility sized up, the extraction process commences quickly and usually involves one of the following techniques: climbing the tree where the nest is situated or a nearby tree, felling the tree containing the nest, or chopping a hole in the tree trunk. In the first technique the nest is attached externally to the trunk or tree branch and hence is directly accessible. If the bees are an aggressive, stinging species, a makeshift torch will be assembled (usually from dry palm leaves; see Table 3.3) and lit with fire before the collector approaches the nest too closely. Using the torch, the collector will apply smoke to ward off the enraged bees or even partially burn the nest itself in order to kill some of the warriors. When the threat of being stung has been diminished or removed, the collector will use a knife or a pole to knock the nest down to the ground, where it can be easily harvested. However, the vast majority of bee species exploited by the Hoti do not sting, so usually there is no need to apply fire. In the second scenario, the tree maybe too tall, access too difficult for the tree to be climbed easily, or the nest located inside the trunk, so the collector simply chops down the whole tree. If the hive is situated in a cavity inside the trunk and the entrance hole is too small for a person to gain access to it, the collector must chop out one or more openings to reach the honey.

Given the great diversity of bees and the complexity of their interspecific interactions, assessing the ecological impacts of honey extraction obviously is not a quick and easy exercise. Furthermore, we did not include apian biology and ecology as a focal subject in our original research design and therefore have not investigated this topic in as detailed and rigorous fashion as it deserves. However, based on the testimony of our Hoti collaborators, who do possess long-term, intimate knowledge of bees, as well as our own multiple observations of honey-harvesting procedures, we are able to offer some tentative conclusions about the global impacts of this subsistence activity on the surrounding environment.

We are concerned primarily with assessing the implications of harvesting practices in regard to the conservation of bee populations and the plants they pollinate and interact with. In some of the extraction events we witnessed, the collectors seemed to leave small portions of the nest behind, a practice that has been attributed elsewhere (Posey 1983b) to conserving the viability of the colony. By contrast, in other harvest events it appeared as though all of the available honey, pollen, pupa, combs, and wax were taken away. In any case, the queen, upon whom the survival of the colony depends, is generally not abducted or killed during the harvest. According to our Hoti consultants, the act of harvesting a nest does not doom the colony but instead incites the swarm to abandon the site and reestablish the nest in a nearby spot. If this is true, the predatory behavior of people functions as a catalyst to the migration and renovation of

**Table 3.5**  
Hoti bee-tree association

Bee taxon	Nest site (tree species, etc.)
<i>uli bāilā</i>	<i>yewi bāu<sup>h</sup>yai</i> [ <i>Protium tenuifolium</i> (Engler) Engler]
<i>luelāti bāilā</i>	<i><sup>h</sup>tubīlu<sup>h</sup>yai</i> [ <i>Terminalia amazonia</i> (Gmel) Exell] <i>bū<sup>h</sup>kiki<sup>h</sup>yai</i> [ <i>Jacaranda copaia</i> (Aubl.) D. Don] <i>hālī hōlō<sup>h</sup>yai</i> [ <i>Eschweilera parvifolia</i> Mart. ex A. P. D. C.] <i>bālīo<sup>h</sup>yai</i> ( <i>Pterocarpus rohrii</i> Vahl)
<i><sup>h</sup>wodekai bāilā</i>	<i>hālī hōlō<sup>h</sup>yai</i> [ <i>Eschweilera aff. pedicellata</i> (Rich.) Mori] <i>bū<sup>h</sup>kiki<sup>h</sup>yai</i> [ <i>Jacaranda copaia</i> (Aubl.) D. Don] <i>alawilī<sup>h</sup>yai</i> [ <i>Ouratea castaneifolia</i> (DC.) Engler] <i>yewi bāu<sup>h</sup>yai</i> ( <i>Protium</i> sp.) <i><sup>h</sup>kaba<sup>h</sup>yai</i> [ <i>Tachigali guianensis</i> (Benth.) Zarucchi & Herend] <i>hālī bāu<sup>h</sup>yai</i> [ <i>Progium sagotianum</i> Marchand]
<i>ba<sup>h</sup>ta bāilā</i>	<i><sup>h</sup>wi<sup>h</sup>wio<sup>h</sup>yai</i> , <i>balo<sup>h</sup>wa<sup>h</sup>ka<sup>h</sup>yai</i> [ <i>Guazuma ulmifolia</i> Lam.]
<i>iletia bāilā</i>	<i>hālī hōlō<sup>h</sup>yai</i> [ <i>Eschweilera parvifolia</i> Mart. ex A. P. D. C.] <i>alawilī<sup>h</sup>yai</i> [ <i>Ouratea castaneifolia</i> (DC.) Engler] <i>bū tawī</i>
<i>kwailēwa bāilā</i>	<i><sup>h</sup>kawile<sup>h</sup>yai</i> ( <i>Erisma uncinatum</i> Ward.) <i>bābāi<sup>h</sup>yai</i> ( <i>Ludwigia</i> sp.) <i>hālī bāu<sup>h</sup>yai</i> ( <i>Protium</i> sp.)
<i><sup>h</sup>kwa<sup>h</sup>laho bāilā</i>	<i>bū<sup>h</sup>kiki<sup>h</sup>yai</i> [ <i>Jacaranda copaia</i> (Aubl.) D. Don] <i>hālī wāiyo<sup>h</sup>yai</i> [ <i>Pseudolmedia laevis</i> (R. & P.) Macbride]
<i>a<sup>h</sup>tuwehai bāilā</i>	<i>lī<sup>h</sup>tawī</i> , <i>bū<sup>h</sup>kiki<sup>h</sup>yai</i> [ <i>Jacaranda copaia</i> (Aubl.) D. Don]
<i>bū bāilā</i>	<i>uli laudau<sup>h</sup>yai</i> ( <i>Sloanea</i> sp.) <i><sup>h</sup>tawī bokwa</i> [inside fallen log]
<i>čolobā bāilā</i>	<i>uli tabali<sup>h</sup>yai</i> [ <i>Ceiba pentandra</i> (L.) Gaertn.]
<i>lēikwa bāilā</i>	<i>lēikwa bē dekaibata</i> [subterranean]
<i>yewi bāilā</i>	<i>alawilī<sup>h</sup>yai</i> [ <i>Ouratea castaneifolia</i> (DC.) Engler]
<i>iyē<sup>h</sup>tela bāilā</i>	<i>hālī wāiyo<sup>h</sup>yai</i> ( <i>Pseudolmedia</i> sp.)
<i>hiti bāilā</i>	<i>wai<sup>h</sup>tukwa</i> (inside termite nest)

nests. Such movement may be beneficial from a production standpoint because it limits the buildup of parasites or fungi in the nest over time, which might weaken the colony, or because it precludes invasion by the aggressive, nonnative Africanized bees. Moreover, the Hoti claim that the building of a new nest results in an increase of nectar and pollen-gathering activity by the bees, due to the imperative of restoring the colony's food supply. In other words, the bees work harder when they have to establish a new nest. Having to collect more nectar and pollen, the bees are more apt to pollinate a greater number of flowers. The establishment of a new nest does not take very long, and the same colony of bees subject to human predation will be resettled, replenished, and ready to be harvested again in one or two years, depending on the species. By this

account, Hoti manage the bee populations and the honey they produce as if they were renewable resources, which may explain why this activity is sustainable at a certain low level of predatory pressure. In sum, Hoti honey-extraction practice may be regarded as ecologically conservative, because it does not imply the inevitable extinction of the colony, it accelerates the movement of bees within the local environment, it stimulates an increase of nectar gathering and hence pollination, and it is renewable after a one- or two-year wait.

The rather common practice of felling trees to facilitate the extraction of honey also leaves its mark on the landscape. The frequent creation of gaps in closed-canopy forest simulates small, natural disturbance events that trigger multiple dynamics in the local biotic communities and populations. It should be stressed that most of the felled trees associated with the collection of honey are old (partially or mostly hollow) or experiencing drying. Creating gaps where old trees once stood has the effect of speeding up the turnover of forest species and patches, which in turn contributes to the increase of local biodiversity, if only by creating more and diverse microhabitats. Along Hoti trails it is common to observe abundant traces of past honey-extracting episodes. Just to give an idea how intensive this impact can be, three of the large tagged trees in the 1-ha forest plot at Caño Iguana were felled for the purpose of honey gathering during our three-year research period, thereby opening up light gaps that were quickly colonized by other plant types (i.e., Cecropiaceae, Urticaceae, Piperaceae). A simple extrapolation of these results leads to the conclusion that one tree per hectare per year is felled by Hoti honey extractors. The real level of impact will, of course, vary according to settlement size and permanence and other variables, but it should nevertheless be clear that the very frequent creation of gaps by human honey gatherers must be taken into account when considering the variables that determine the floristic composition of the Maigualida region. However, more systematic studies of honey extraction and gap creation by the Hoti are needed in order to define just what their role is.

### Spatial-Temporal Context of Hoti Disturbance Behavior

The preceding description of Hoti disturbance behaviors and their environmental effects provides an essentially synchronic perspective of the possible anthropogenic creation of the Sierra de Maigualida landscape, necessitated in part by the space and time limitations of our field research project. However, especially given the small scale of disturbances represented in these examples, a diachronic perspective is obviously needed in order to grasp the full magnitude of human modification of the natural environment. Thus it is important to consider briefly the spatial-temporal context in which these behaviors occur.

The cultural and environmental history of the Hoti and the Sierra de Maigualida region they inhabit is a big question mark. Because contact with the Western world is barely a generation old, except for vague allusions there is no mention of the history in the literature, we have no idea about the antiquity or evolution of human settlement in the region.

Phytoecological studies in the Maigualida are incipient and confined mostly to the high-altitude, *tepuy* summit zones (>2000 m asl) (O. Huber pers. comm.). The ethnographic research realized since contact was established, beginning with missionaries', explorers', and journalists' accounts in the early 1970s and culminating with our own research at the end of the 1990s, points to considerable sociocultural, technological, and environmental changes during this period, which have affected some but not all communities (for more information, see S. Zent & E. L. Zent 2004). Such changes include migration to new habitats, larger and more permanent settlements, economic reorientations (notably greater emphasis on agriculture and fishing in some communities), and generalized access to Western trade goods. In regard to the last, it is important to note that the acquisition of steel axes may have facilitated tree felling, certainly one of the key forms of environmental disturbance by the Hoti. We therefore caution that the types of disturbance behavior reported in this chapter, and the implied environmental effects thereof, cannot be extrapolated in a simple and straightforward way into the past. Basically, the only information about the past that is available to us comes from the Hoti themselves. According to their oral history, the circum-Maigualida region, especially the upper Cuchivero, is their traditional homeland, and many more people lived there in the past than do today. Furthermore, they believe that the precontact Hoti did more trekking, relied to a greater extent on palm fruits, maintained more extensive networks of trail gardens, exploited palm grubs and honey at least as much as they do today, had very few steel tools, and made greater use of fire to fell trees and clear unwanted vegetation. A more complete diachronic picture of human impact on the Maigualida environment will depend on the expansion of research in this fascinating region. We think that several research lines could help to bring into focus this clouded history: archaeoethnobotany, paleoecology, patch dynamics, botanical inventory, community floristics, faunal censuses, and human-Hymenoptera-plant relationships.

## Discussion

Our Hot! case study provides various examples of how the subsistence activities of a foraging-oriented, indigenous human population in the tropical forest exerts a creative impact on the composition, diversity, configuration, and functional integration of the biological habitat. Although the precise history of this region and its people are not well known, we consider it likely that such impacts, compounded in time and space through long-term occupation of the Maigualida region, were indeed responsible for shaping and defining to a meaningful extent the floristic structure and composition of significant fragments of the forest. In other words, we interpret the data collected so far as supporting the hypothesis that human activities constitute a central variable in the formation and conservation of this ecosystem. This conclusion and the facts that support it contain important implications, both for the theoretical understanding of the generative relationship between small-scale, low-technology, foraging-dependent Amazonian Indians and the culturalized forests they inhabit and for the practical applicability and design of a biocultural conservation strategy in this environment.

Although high biotic diversity and speciation in the Tropics have not been fully explained (Pianka 1966), one appealing explanation perceives them as a function of the interaction of complex interspecific relationships, such as competition and predation, with disturbance events (Waide & Lugo 1992: 176; cf. Sousa 1984). Many of the traditional subsistence activities of native Amazonian human populations, such as those outlined in this chapter, encompass both processes simultaneously—that is, they are disturbance events interwoven with predatory and dispersal practices akin to those of nonhuman species. If, as reported, between 75% and 95% of tropical forest seeds are dispersed by animals (Janzen & Vazquez 1991; Julliot 1997; Pacheco & Simonetti 2000), then we wonder, What is the proportional responsibility of human dispersal and manipulation of plant reproductive material for species distributions and community composition patterns? In the first place, humans are more mobile and are capable of carrying larger amounts of fruits than are most other seed-dispersing animals.<sup>12</sup> Second, we contend that the seed handling by people has greater potential ecological impact than does comparable activity by nonhuman animals precisely because human predation and dispersing activities often occur in direct or indirect association with disturbance actions such as tree felling, fire setting, and faunal harvests. A good example of the interconnectedness and amplifying effect of different disturbance actions is provided by considering a series of disturbance events, starting with a fruit harvest and culminating in the founding of a base settlement, that we were able to monitor over the course of two years in the lower Mosquito region. First, felling two old *ulu* palm trees for the immediate purpose of harvesting the fruit created a small clearing. A temporary settlement was established nearby, and most of the fruit was eaten and then discarded at this campsite. The site was revisited a few months later, and the trunk was split open in order to harvest palm grubs. Sometime later a few individuals of maize, papaya, squash, and cotton were planted in the clearing, effectively establishing a trail garden. About six months after that, a more permanent dwelling was constructed and a swidden plot felled, burned, and planted in the same general location. Juvenile *A. tateia maripa* individuals were observed to be one of the most common weed plants in the garden.

One of the most significant forms of ecological disturbance attributed to forest-dwelling humans is the creation and manipulation of gaps in the forest cover. Gaps are considered central to the "structure and function" as well as to the maintenance of "high tree species richness" in tropical forests (Brokaw 1985:54). Studies carried out in different forest ecosystems around the world have shown that many species are dependent on gaps or open grounds (Sutherland 1998: 210). For example, some emergent tree species "may depend on growth in a gap to reach maturity" (p. 54). A big difference in the way gaps are created and succession instigated by humans versus natural processes is that the former cannot be described as a random or stochastic process. The Hoti case should well illustrate that gap making by people is biased toward the extinction of less useful plants and the immigration or succession of more useful plants. Posey (i., 8: 105) reports analogous behavior among the Kayapo, noting that gap management produces "resource islands" for humans and game animals. The research results reported for other traditional Amazonian groups (Denevan & Padoch

1987; Irvine 1989; Balee 1993; Zent 1995, 1997) also confirm the "utilitarian bias" of gap management by people.

The ecological impact of human disturbance behaviors can be analyzed as a function of three principal variables describing disturbance events: scale, frequency, and intensity (cf. Petraitis et al. 1989; Hoopes & Harrison 1998; Sutherland 1998). Scale, also referred to as size or magnitude, is defined as the amount of area or resources disrupted. Most of the disturbance areas created and/or manipulated by the Hotĩ fall in the range of very small (single tree falls, usually less than 200 m<sup>2</sup>), small (multiple tree falls, usually less than 0.5 ha), and medium (swidden plot felling and burning, usually less than 1 ha), the scale differences being correlated with different regenerative mechanisms as well as different recovery times (cf. Uhl 1983). Frequency, or periodicity, is the number of events per unit of time. The relevant literature mentions three basic categories for describing the frequency of ecological disturbances: high-frequency events (short recurrence intervals of 3-30 years), where the environments experiencing them are usually dominated by early succession species; low-frequency events (long recurrence intervals of 50-200 years), characteristic of environments dominated by late succession species; and medium-frequency events (recurrence intervals of 30-50 years), associated with environments having the greatest mix of early-succession and late-succession species and hence the highest levels of biodiversity (cf. Barbour et al. 1987; Pickett et al. 1992; Odum 1993; Meffe & Carroll 1994). It is significant to note that Hotĩ shifting cultivation practices (i.e., swidden-fallow cycles) and intermittent exploitation of hunting-collecting territories in conjunction with intergenerational settlement shifts correspond to the 30-50-year interval range. Intensity refers to the severity or lasting impact of the disturbance event in terms of the time and energy costs of recovery (sometimes conceived as scale  $\times$  frequency). Two intensity levels are usually distinguished: low intensity, which are localized and reversible, without large energy investments (stimulating colonization by early-succession species, eliminating some but not all seeds of late-succession species, and prolonging the succession process); and high intensity, which are extensive and require high energy investments to return to the original state (i.e., implying drastic structural and compositional changes). The disturbances observed among the Hotĩ tend to be of low intensity. There is no evidence to suggest that they are responsible for intensive modifications of habitat, such as the conversion of forest to savanna, although this possibility needs to be investigated in a few restricted locations, such as San Jose de Kayama, where some patches of savanna are found.<sup>13</sup> In sum, the case of Hotĩ disturbance behavior, analyzed here in terms of scale, frequency, and intensity, confirms the view that relatively unacculturated, indigenous peoples act as small-to-intermediate-impact disturbance agents in the Amazonian landscape. This role is consistent with the enhancement and maintenance of biodiversity levels and therefore should be taken into account when developing models for explaining the extraordinary richness of the tropical forest biota (Goldammer 1992; Balee 1998a).

»It should be clear from our discussion that the Hotĩ and other Amazonian Indians constitute an important component in the dynamic structure and function of Amazonian ecosystems as we know them today. What is the implication of this finding for

biological conservation planning? First, it is necessary to recognize that these people do not always conform to Western standards, ideals, or images of environmentally friendly behavior. The research results reported in this chapter do not support indiscriminate acceptance of the ecologically noble savage hypothesis, which supposes that the exploitative habits of indigenous peoples are perfectly adjusted to natural resource constraints and, therefore, that a state of environmental equilibrium prevails (cf. Redford 1991; Kidder 1998; Grande 1999). Rather, from our perspective these people are perceived as conscious and purposeful agents of ecological disturbance who seek to effectuate environmental change by manipulating biological and cultural processes in order to satisfy a resource production goal. However, we also emphasize the ethical neutrality of these results: disturbance behavior by humans neither necessarily induces environmental degradation or species extinction nor suggests that the potential increase of biodiversity due to human management will improve biospheric conditions (cf. Balee 1998a). But such behavior, independent of its valuation by contemporary environmental ideologies, is nevertheless meaningful for the biological composition and ecological organization of contemporary Amazonian ecosystems.

Although we have highlighted the role of Amazonian Indians as ecological disturbance agents, we should also reiterate that they have occupied this region for a very long time, and it would be highly inaccurate to accuse them of having caused the large-scale degradation of their habitat or the erosion of its immense biological wealth.<sup>14</sup> Obviously, the Indians have an intimate knowledge of their biotic surroundings, are skillful manipulators of ecological relationships and processes, and tend to pursue sustainable resource-management practices. The results of the present study show that forager groups such as the Hotĩ are small- and intermediate-disturbance providers, services that emulate natural processes and actually enhance biodiversity. Accordingly, we conclude that these people have much to contribute to biocultural conservation programs: their ethnoecological beliefs and practices provide models for a new environmental ethic; their subsistence behaviors supply vital inputs for ecosystem maintenance; and the people themselves constitute strategic human resources for implementing development initiatives. In this regard, perhaps the main threat to the compatible coexistence of indigenous human populations and the rich biotic diversity characteristic of their homelands stems from the rapid and drastic changes in social and economic lifestyle that these people are currently experiencing. Among the Hotĩ, as among other groups (cf. Mansutti 1988; S. Zent 1999), there is a definite trend toward larger and more stationary settlements, and consequently one can observe wild-resource depletions in the vicinity of these areas. Another problematic trend involves the growing use and dependence on Western goods, whereby former luxuries have become necessities, stimulating surplus production as well as the development of more consumer-oriented ideologies.<sup>15</sup> The great challenge for integrated biological-cultural conservation initiatives is to strike a balance between the modernizing socioeconomic institutions and the maintenance of biodiversity and ecosystem functioning. It is simply not realistic to expect that the Indians' lifestyles can be frozen in time or prevented from changing. In any event, we are once again reminded that the relationship between Amazonian Indians and the ecosystems they inhabit is a dynamic one. Strategies for biocultural conservation must embrace this essential truth.

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## Notes

1. Overlapping our research, Robert Storrie, a doctoral student from Manchester University, conducted fieldwork with the Hoti from 1994 to 1997. His doctoral dissertation (Storrie 1999) focuses on kinship, cosmology, and personhood.
2. Both resource types are intimately related in knowledge as well as practice. Thus hunting expeditions are often organized according to knowledge of the feeding behaviors of different game animals, the fruiting schedules of the plants they eat, and the localities where stands of these plants are found.
3. It is probable that steel tools were acquired by the Hoti relatively recently (see Coppens 1983) and, therefore, that shifting cultivation was less intensively practiced before the modern (i.e., postcontact) period (cf. Denevan 1992b). The corollary of this likely circumstance is that reliance on foraging was even greater in the recent past than it is today.
4. A similar argument is made by Fragoso (1997), who considers that the small-scale seed-dispersing behaviors of the lowland tapir influence the landscape-scale diversity and patchiness of vegetation in a Brazilian rain forest.
5. *Oenocarpus bacaba* has also been reported as the most abundant species in sample plots located in upland forests in the Brazilian Amazon (Ferreira & Prance 1998).
6. In some cases, our collaborators were able to recall who lived there.
7. Fragoso (1997) also observed numerous *Attalea maripa*-dominant stands in protected (i.e., uninhabited by humans) primary rain forest in northern Brazil. His research found that primary seed dispersal by tapirs and secondary dispersal by rodents, rather than edaphic factors, are mainly responsible for the clumped distribution of this species. Building on this insight, we argue that the *ulu co* phenomenon in the forests of the Maigualida region, which have long been occupied by humans, is best explained as the result of human transport and handling of seed material, along with the removal of competing species through fire application.
8. This would seem to indicate that the local populations of *Oenocarpus bataba*, *Rhinostomus barbirostris*, and *Rhynchophorus palmarum* have suffered some degree of depletion in the vicinity of the more nucleated, sedentary communities (probably due to greater exploitation pressure) and perhaps also that this form of resource management is sustainable only under the traditionally small, dispersed, and mobile settlement pattern.
9. We did witness a few exceptions to this norm, however. Members of one of the settlement units in the Mosquito region ate adult weevils, but not many of them.
10. Nutritional analysis of *Rhynchophorus palmarum* larva shows that its caloric value is 165 Kcal/100 g; its protein content, 7.33 g/100 g, which is superior to that of milk (3.1 g/100

V its fat content, 10.9 g/100 g; and its carbohydrate content, 9.4 g/100 g. It is also rich in vitamin A (equal to 85.0 *fig* retinol) and vitamin E (9.82 mg / 100 g fresh weight of alfa tocoferol) and contains 11 essential amino acids (Cerda et al. in press).

11. We encountered a fruit-bearing *Musa* stand in a trail garden in the Upper Cuchivero region that our Hoti guide claimed was at least 10 years old.

12. Fragoso and Huffman (2000) refer to essentially the same capabilities in arguing the particular importance of tapirs for plant diversity and distribution patterns in Amazonian rain forests.

13. We did observe the Hoti at Kayama burning the savanna grass during the late dry season, motivated by the stated desire to "clean up" the savanna and thus facilitate walking and permit better visibility for hazards such as snakes.

14. Some scholars believe that indigenous human populations are partly responsible for the conversion of forest to savanna habitat over long time periods in the Gran Sabana (Folster 1992) and the Sierra Parima (Huber et al. 1984; Smole 1989) regions of southern Venezuela, but these ideas are still somewhat controversial. In any case, the environmental modifications that occurred in these areas do not come close in scale or gravity to the devastating deforestation caused by the expansion of national and international social and economic frontiers into Indian-occupied lands in the last 30-40 years (cf. Fearnside 1987; Moran 1993).

15. For the nonmission Hoti, captive wild animals (mainly monkeys, parrots, parakeets, and toucans) have become a most valuable commodity, which they trade downriver to other Indians (Yabarana, Piaroa, E'nepa) in exchange for cash or Western manufactured goods. However, most animals die in captivity before an exchange can be made. We witnessed five infant or juvenile spider monkeys (*Ateles belzebuth*) taken alive in a two-week period in the Mosquito region. Not one survived long enough to be taken away and traded.

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