A CREATIVE PERSPECTIVE OF ENVIRONMENTAL IMPACTS BY NATIVE AMAZONIAN HUMAN POPULATIONS

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In the last few decades, the harmful impacts of people on the natural environment have been reported and condemned extensively (Prance, 1989; Whitmore and Sayer, 1992; Johns, 1992). Modern human activities are considered particularly dramatic in reducing the diversity of life and destroying natural habitats, increasing erosion, deforestation, and desertification processes, degrading the soils, limiting the supply of fresh water, and changing the global climate (Wilson, 1992, 1993; Peters and Lovejoy, 1992). One of the causes of these degrading environmental processes concens the need to increase food production due to the rapid growth of human population, which some authors believe has already exceeded the carrying capacity of earth (Daily and Ehrlich, 1992). A less explicit cause has to do with a human-centered economic and environmental ethic which ignores the value of services of nature and promotes both human abuse of the environment and unequal distribution of resources (Lovejoy, 1989). A radical shift in environmental ethics demands a new approach to nature, rejecting the widely accepted anthropocentric paradigm and exhorts strongly to adopt an ecocentric perspective in which environment encompasses humans and not the other way around (Jordan, 1995).

On the other hand, the less harmful or even creative impact of human practices on the environment is less researched and reported. Partially as a result of the facts mentioned above, human populations still maintaining a "traditional" (i.e. low-technology) way of life have been considered to trigger ecological processes somehow non-detrimental to the environment (Posey and Balée, 1989; Gómez-Pompa, 1991; Jiménez-Osornio, and Gómez-Pompa, 1991; Altieri, 1993). This paper explores a *working hypothesis* related to groups of human populations acting as disturbance agents in the Amazon. More than theoretical, this paper is descriptive and its data come mostly from a review, though non exhaustive of the human ecology literature. The basic idea is to illustrate human activities as potentially dynamic and central in the maintenance of the Amazonian ecosystem, including its richness and complexities. Underlying the argument of this paper is the attempt to contrast two ideological perspectives about human-nature interactions: the viewpoint supported by the mainstream western belief that humans form a system *apart* from nature, and the standpoint vindicated by more ecologically attuned theories which considers humans to be a *part* of nature and thus together comprising a rather dynamic system. The first ideology, however, has usually conceived of human behavior toward nature as that of stewardship; this *anthropocentric* view considers man as cardinal to maintain life. The second ideology, heralds a *biocentric* perspective, in which humans are equal to other species except that their behavior is still often perceived as damaging in general. The argument advanced here develops an *ecocentric* perspective, but even further, elaborating a holistic vision of the human-nature relationship as *art* (in its literal meaning from Latin *ars*, ability, expertise, skill), that is *creative*, triggering ecological processes beyond those attempting to satisfy their needs. Environmental ethic issues are highly controversial, and I am cognizant that this argument may sound somewhat polemical.

Theoretical Premises

There are at least three premises that underlie this paper"s assumption of native human populations in Amazonia as "creative" disturbance agents:

1. The concept of disturbance, as creative events, is a relatively new idea in ecological thinking (Sprugel, 1991). The more recent connotation of disturbance —as the trigger of ecological processes enhancing and providing the

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media 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. Although high biotic diversity and speciation in the tropics have not been explained successfully (Pianka, 1966), one appealing explanation perceives them as a function of complex biotic interactions (competition, predation, *etc*.) interplaying with disturbance events (Waide and Lugo, 1992:176). Some traditional Amazonian human activities are considered here as disturbance events interwoven with predatory and dispersive practices akin to those of non-human species. If, as reported (Janzen and Vázquez-Yanes, 1991:139), more than 75% of tropical forest seeds are dispersed by animals, then human dispersive practices and knowledge of seed biology may also be relevant or partly responsible for forest composition. Also, extractive and exploitative cultural behaviors (horticulture, hunting, fishing, gathering, *etc*.), entail potentially dynamic patterns of input-output to the global system.

2. Amazonian cultures constitute an integral part of ecosystems, along with non-human abiotic and biotic components. Therefore, cultures, biotic and abiotic elements are including and included within a set of hierarchical ecological systems from simpler to more complex (Odum, 1993). Such ecosystems exhibit a dynamic non-equilibrium, and it is precisely the tension experienced by the ecosystem between both states which allows for its continuity and prevalence (Meffe and Carroll, 1994). Heterogeneity and diversity are other pervasive characteristics of Amazonian ecosystems, as is the arbitrary nature of its boundaries.

3. Culture understood as a process, that is, constantly being transformed is a central analytical concept to understand human-environment interactions in the Amazon (Zent, 1992; Balée, 1989; Roosevelt, 1989). People"s capacity to create culture as "an extrasomatic means of adaptation" (Murphy, 1970) differentiate them from non-cultural species. Culture is normative, it has its own level of organizational unity, it is learned, and it permeates other behaviors through symbolic systems. Culture "reorders" nature and not simply just the other way around, that is, the interaction is bi-directional.

Although the modes of integration of the ecological system are different than the modes of integration of the human social system (Murphy, 1970), their systemic separation is valid only as an artifact of analytical abstractions, whereas in terms of biophysical reality both spheres constitute a whole unified system influencing and inducing changes at all levels (cf. Bennett, 1976). They are systems however, with an essentially different logic, without denying their interaction and mutual dependence in a spatial-temporal continuum. Flows of information, energy and matter will turn out different if humans are inside the (eco)system. Almost unique qualities of the human species, such as the capacity to manipulate and change the environment, the complex cognitive and emotional content reflected in the categorization and organization of labor activity, and the assignment of symbolic meaning to sensate and non-sensate reality (Ellen, 1979; Murphy, 1970) are central to understanding many environments" physiognomy. Equally important consideration in questions of adjustments to and management of resources should also be given to intervillage, interethnic and kinship relations (Jackson, 1984; Arvelo and Biord, 1994).

Amazonian Heterogeneity

The Amazonian portion of South America extends over 5,402,700 km² or about 30% of the subcontinent, comprising 3.6% of the earth"s surface area (Posey and Balée, 1989). The most common environmental distinction made in Amazonia is that of *varzea* or floodplains (covering approximately 2% of the surface of the region), and *terra firme* or uplands (about the remaining 98%). This general division limits the understanding of both cultural adaptation and evolution in the region, because it implies certain homogeneity of the ecological, economic and social behaviors of the native Amazonian human groups (Zent, 1992). On the contrary, Amazonia is a region essentially diverse both in terms of natural ecology and native human society (Moran, 1981).

Amazonian heterogeneity, supported by researches in biology, ecology, agronomy and anthropology document great diversity in the climate, topography, hydrology, soils, flora, fauna and adaptive strategies of the native human populations (Prance, 1978; Herrera *et al*., 1978; Gross *et al*., 1979; Schultes, 1979; Jordan, 1982; Hames and Vickers, 1983; Moran, 1991; Gentry, 1992). The relationships between these variables are complex and interwoven, creating a range of distinct environments with different sets of constraints for bioforms, including human population, use patterns, and settlement forms. To test the degree to which human activities have played a direct role in the actual creation of environmental heterogeneity is very difficult and remains a largely unproven hypothesis. Moreover, there is still limited data and research on this topic. It is indisputable, however, that human induced disturbances have had a significant impact on the present day tropical forest physiognomy (Schüle, 1992).

The presence of humans in Amazonia extends at least 12,000 years (Roosevelt, 1994). Therefore, humans may be responsible more for ecological processes than evolutionary ones. Moreover, because climatic changes during the Pleistocene and Holocene caused fluctuations in tropical forest biogeography, most of the current patterns of forest distribution and species composition are "closely related to the relatively short period of modern climate conditions" (Goldammer, 1992). However, data about human-induced fire events, as well as widespread deforestation activities during the Holocene, underline human responsability, and provide useful insight for understanding contemporary biodiversity dynamics (Stahl, 1996). In short, *both natural and anthropogenic disturbances* are responsible for the current configuration of the Amazon forest.

However, although human-induced disturbance events and impact on the Amazonian ecosystems has been considerable, in both temporal and spatial terms, they have been widely variable in type, intensity, periodicity, frequency, extent and duration. Therefore, historical or diachronic perspectives are vital in order to understand properly the dynamic processes of Amazonian cultures and their environmental impact.

Although few palynological studies have been carried out in the Amazon to describe accurately the geological landscape, it is believed that today"s forest cover occupies a considerably larger area than during the last glaciation (Goldammer, 1992). Records of pollen demonstrate that humans have been acting as disturbance agents in tropical American forests for at least 3,000 years (Flenley, 1992). Some areas, like the Southeastern Venezuelan forests, have been degrading toward savannas since at least 3500 years ago, partially as a result of human induced disturbances such as fires (Fölster, 1992). In the Sierra Parima, at the southern extremity of the Venezuelan Amazon, regarded to be the

Yanomami tribal homeland, we find another example of possibly man-made savannas, apparently caused by many centuries of human induced disturbances (Huber and Steyermark, 1983; Smole, 1980, 1989). These estimations are in agreement with theories stating that since the "Lower Pleistocene anthropogenic fire regimens shaped the vegetation cover" (Schüle, 1992:45). It has also been hypothesized that due to overhunting and extinction of pre-Pleistocene paleo-endemic megaherbivores human populations facilitated the regeneration process of forest formations. The argument follows that those megahervibores (*Megatherium*, *Eremotherium*, *etc*.) were successful in turning the Amazonian forests "into patchwork" through their predatory habits (Schüle, 1992). The extermination of megafauna by humans triggered natural succession processes at the end of the Pleistocene. The tropical Amazonian forest is thus, according to this hypothesis, "of indirectly anthropogenic origin" (Schüle, 1992:64). Furthermore, the reduction of "herbivores" methane production prevented a heating of the atmosphere through a build-up of CO_2 released by the dramatically increasing number of anthropogenic fires" (Ibid).

Few historical reconstructions have been published about the environmental activities of Amazonian groups before the arrival of the European colonizers. The interpretations described below come from a few archaeological and ethnohistorical investigations which suggest what could have happened in the Amazon before the European conquest.

Pre-Colonization ways of life

In 1976, W. Denevan estimated the precolumbian Amazonian population at 5,100,000. In 1992, after new studies by him and others, he revised slightly his estimates and calculated that about 5,664,000 people inhabited the Greater Amazon basin 500 years ago, ranging in densities from 1.4 to 13.0 km². Three hundred years ago, however, native population was reduced by 90%. Today over 300 different ethnic groups populate this region, reaching an estimated total of about 750,000 (Denevan, 1992a, 1992b; Hern, 1994; De Oliveira, 1994; Roosevelt, 1994, 1989; OCEI, 1993; Domínguez, 1989; Montero and Crespo, 1989; Chirif, 1989; Saul, 1989). Native use and management of natural resources has undoubtedly undergone many changes during the centuries of occupation. Early subsistence strategies cannot necessarily reflect those of 500 years ago or those of today. The observable behaviors today cannot be extrapolated freely to reconstruct potential subsistence strategies before the European conquest (Roosevelt, 1989:31).

The European colonization of the Americas had a huge impact on the native Amazonian human population. The changes suffered by native peoples were multiple, such as: demographic (Denevan, 1992a), economic (Beckerman, 1985), political (Whitehead, 1992), social (Murphy, 1960), religious (Butt Colson, 1985), and mythological (Hill, 1988) among others. The changes experienced in the different areas were of course dependent on the proximity and intensity of the contact. In this vein, the human landscape found by the Europeans constituted a range of settlements from densely to sparsely populated, and exhibited high as well as low levels of social complexity.

A "large proportion" of the aboriginal Amazon human population was concentrated in complex and large communities in the floodplain zones bordering the major rivers, especially the Amazon and Orinoco or in coastal areas (Roosevelt, 1989). Not surprisingly, then, the early focus of colonizing activity was concentrated there, where the native populations suffered sharp and fast depopulation and deculturation during the first centuries of the conquest. Some subsistence strategies before 500 years ago were apparently quite intensive and extensive. Archaeological remains support the interpretation of a vast population concentrated in many large settlements of "thousands of people" such as "extensive earthworks of monumental scale used for cultivation, water control, travel, defense, habitation and burial", and many under the rule of a few chiefs (Roosevelt, 1989; Denevan, 1992b). Sedentary patterns of settlement emphasize a more intensive use of land and human impact on the environment, along with complex networks of trade and interchange, potential social stratification and differential access to resources.

Areas beyond the major rivers, meanwhile, were less densely populated and were more isolated from direct contact with the European colonizers. Nonetheless, they too experienced effects of considerable magnitude. The area indirectly affected by colonization has been called the "tribal zone" by Ferguson and Whitehead (1992). These anthropologists consider three basic factors that in different degrees transformed native patterns of life in the tribal zone: disease, ecological change (modification of the plant and animal environment), and technological change. These are potential environmental factors because they are part of the broader context of a local culture-environmental complex.

This differential environmental disturbance has prompted some authors to state that contemporary composition and structure of "mature vegetation" is the "legacy of past civilizations" (Gómez-Pompa and Kaus, 1992, 1990). However, the magnitude of environmental change in this context was vast, heterogeneous and diverse. Denevan (1992b) for example, considers the 16th century Amazonian forest as "largely anthropogenic in form and composition", while the same landscape in the 18th century, after 90% of the native human population had been exterminated, was the product of natural processes of recovery and regeneration instead of "pristine forests" (Gómez-Pompa and Kaus, 1992). Even today it is estimated that 40% of the forests in tropical America are secondary, in part as a result of human disturbance (Brown and Lugo, 1990) although it is difficult to assess what proportion may be caused by "natural" disturbances. However, it is significant that one of the highest levels of floristic diversity and endemism has been found in the northwest South American forest (Gentry, 1992). As with natural disturbances, those induced by humans suggest that "pristine" environments may have never existed or are not exclusively good anymore. Gaps in the forest create habitats for many bioforms otherwise absent in these ecosystems and therefore contribute to biodiversity richness. When these disturbances are cultural, the dynamic could be based on knowledge about the local ecological processes. Patterns of vegetation succession at different ages and stages seem to be more prevalent in the current Amazonian landscape than realized before (Gómez-Pompa and Kaus, 1992). Here the articulation of ecological and technological variables provides a way to see the impact of a particular socio-cultural phenomena that is current though a historical product.

An illustrative case of the last statement are the extensive earthworks - mounds and raised fields - built in the Mojos region of Bolivia and the Western Llanos of Venezuela (Denevan, 1992b). The prehistoric modifications of the topographic environment probably led to local modifications in the biotic environment and affect present-day peoples living in these areas. Thus, W. Balée (pers. comm.) has found that the Sirionó people, previously thought to be primitive hunter-gatherers and incipient agriculturalists who lived in a state close with "primordial" nature, are specifically adapted to the forest covering these mounds. Thus, they locate their settlements and gardens, in these areas and also carry out foraging activities there.

Another example is the *Terra preta do indio* (Indian black earth), found in abundance in terra firme regions of Central and Northern Brazil. These soils are believed to be anthropogenic, not only rich in humic matter but also replete with pottery (thus clear evidence of former human occupation). They have also been associated with large and longevous settlements (in comparison with contemporary terra firme settlements of native ethnic groups), indicating a positive feedback between human occupation and use, and productivity or suitability for such occupation. These are widely considered to be among the most agriculturally productive soils in all of the South American tropical lowlands (Smith, 1980).

Post-Colonization ways of life

Contemporary Amazonian groups are considered to be the product of the enormous cataclysm that the colonization process triggered. Native levels of social and economic integration during pre-colonial times were essentially destroyed after colonization started. A clear derivative consequence of the vast cultural disruption was a lower impact of humans on the natural environment, thus allowing the initiation of regeneration processes. A less explicit consequence was the generation of new "ethnic boundaries" (Whitehead, 1994). But even though the new ethnic Amazonian landscape of today is the product of "radical transformations" that native populations suffered, these new cultural formations inherited modes of relating and integrating to their social and natural environment (not just forests also savannas, and other ecosystems). That is, although the dynamics of natural and social milieus are different and it is often difficult to trace the "ethnic continuity" of many contemporary Amazonian peoples, they nevertheless have maintained some degree of continuity in regards to cultural (environmental) and practical knowledge.

Today native human groups live mostly in low density of populations, independent and rather isolated from one another. They exhibit little or no social hierarchy and practice patterns of subsistence based mainly on shifting cultivation, hunting and fishing of relatively low intensity. Demographic factors have contributed greatly to the shift from the ways of life prior to colonization, but are not the only causes.

Ecological parameters that are visible, even measurable, today, have been shown to be the product of historical and prehistorical human activity. Some illustrative examples of the few reported in the literature are briefly summarized here.

1. Balée (1989), calculates that approximately 12% of Brazilian Amazonian forests are in fact anthropogenic, the result of past human clearance, management and manipulation (see also Goldammer, 1992). These "cultural" forests are rich in foods and materials utilized by contemporary Amazonian human populations and therefore are attractive places for locating settlements. Drawing evidence from botanical inventories, several quantitative analyses and soil samples, he documents carefully the following kinds of anthropogenic forests: palm forests (prevalent in *Mauritia flexuosa, Astrocaryum vulgare, Elaeis oleifera, Orbignya phalerata*, etc.) bamboo forests (characterized chiefly by *Guadua glomerata*), Brazil nut forests (*Bertholletia excelsa*), forest islands of the Central Brazilian Shield or *apête*, low *caatinga*, liana forests (including prominent members of the Araceae, Bignoniaceae, Caesalpiniaceae, Dioscoreaceae, Fabacea, Mimosaceae and Sapindaceae botanical families), bacuri forests (*Platonia insignis*), cacao forests (*Theobroma cacao*), and pequi forests (*Caryocar villosum*). Some of these are reliable phytoindicators of human disturbance such as *the peach palm (Bactris gasipaes*), the inajá palm (*Maximiliana maripa*), or babasú (*Orbignya phalerata)*, among others. Most of them have been found in association with archaeological remains. Maybe it is not speculative to state that Amazonian human populations are conscious of the phenology of the plants mentioned.

2. The Brazil nut forests (*Bertholletia excelsa*) of potential anthropogenic origin have been further explored by Chris Miller (1995 pers. comm.), of the Institute & Ecology at the University of Georgia, and Scott Mori (1992). Brazil nut trees are found especially in non-flooded forests in the Guianas, Colombia, Venezuela, Peru, Bolivia and Brazil (Mori, 1992). The density values of Brazil nut trees vary notably. In Eastern Amazonian Brazil, Miller found from nine to 26 reproductive trees per hectare in 10 plots (1995 pers. comm.), while other density values coming from Central Brazil report one tree (over 10 cm dbh) in a 100-ha plot (Mori, 1992). Miller calculates, however, that a normal density value should be around three reproductive trees per hectare and the estimated age of the trees around 250-300 years old. Although Miller intentionally searched for seedlings of this species, he found none. This added to his preliminary conclusion that, although difficult to test, stands of Brazil nut trees in such an elevated frequency may be due to human intervention. Brazil nut trees like other emergent trees such as Mahogany, are gap-dependent, meaning they need open areas to germinate and grow successfully. Thus, Miller finds it reasonable to assume that humans probably dispersed seeds of Brazil nut after clearing forest areas for cultivation. Furthermore, he reports to have found Brazil nut trees associated with *terra preta* and remains of pot sherds. As with the other forests reported by Balée, Miller's account points toward stands of trees facilitated or consciously created by human activities.

3. The management of forest succession by the Ka"apor, a small ethnic group living in the Brazilian Amazon, is another significant example. Balée and Gély (1989) analyze the Ka'apor management and use of primary and secondary forests, understood as the manipulation of "species and vegetational zones" by which "new vegetational zones and ecotones emerge". Furthermore, the Ka'apor manage particular populations of plants or animals based on sound autoecological knowledge. To start with, they recognize at least six major vegetational zones, some minor vegetational zones and four ecotones, based on the criteria of age, degree of manipulation, indicator species and structure and by anthropogenic contemporary and past activities. Each vegetational zone or ecotone is managed by the Ka'apor in terms of actual cultivation, facilitation and protection of vegetal and animal species. The Ka'apor forest management behaviors are classified by the authors as corresponding to a form of "intermediate disturbance" (cf. Connell, 1978) and certainly contribute to the maintenance and dynamics of the local forest.

4. The Kayapó management strategies and sound environmental knowledge have been widely reported (Posey, 1982, 1983, 1989, 1992; Anderson and Posey, 1989; Hecht and Posey, 1989). They are believed to have mi-

grated from a savanna habitat, and today inhabit a great "variety of tropical ecosystems" in an area of over 2,000,000 ha. in Northern Brazilian Amazon (Posey, 1982).

Kayapó management strategies include knowledge and use of: (1) abiotic factors such as the climatic and annual seasonal conditions, soil types and soil formations which in many well documented cases are the "outcome of human interventions" (Hetch and Posey, 1989); (2) biotic factors such as local fauna and flora (distribution, habitats, etiology, of trees, seeds biology, etc), associated vegetation types, the composition and structure of natural forest formation which the Kayapó replicate in their garden plots. Most important, the Kayapó are aware of the ecological interplay and interrelations between biotic and abiotic factors. Such knowledge constitutes the sound substrate of their cultural environmental management strategies. Few examples are illustrative here. Kayapó plant different associations of cultivars, distributed in the plot in such a way as to make the best use of soil nutrients. They are also sensitive to the natural recovery and regeneration of forests, meaning that they recognize that the interaction of biotic and abiotic factors contribute to shaping the forest's structure and composition. As with other Amazonian groups, the Kayapó use secondary forest formations as a sort of "game preserve" and as extractive sources of material and ideological resources. Furthermore, they control their use of fire recognizing its value to restore nutrients and to create habitats for early colonizer species. The richness of these forests are to a certain extent dependent on the human disturbances.

In terms of this paper, the Kayapó are most notable for their dispersive practices. Posey (1982) describes how they distribute seeds, roots and seedlings in forest clearings located close to streams. Plants such as wild manioc, wild varieties of yams, bush bean and wild varieties of kupa, constitute "cultural" vegetation formations that Posey called "forest fields". Reportedly the Kayapó also take a crucial and dynamic role in the formation of islands of woody vegetation known as *apeté*. The Kayapó transfer litter, termite nests and ant nests in order to disperse some plants and facilitate succession. While the nests serve as a substrate of organic material, the termites and ants compete among them and "consequently do not attack newly established" plants (Anderson and Posey, 1989). Around 90 to 107 (about 75%) of the plant species that make up the *apeté* were found to be planted or facilitated by humans as disturbance agents. That is, they are not domesticated but neither are they considered to be wild "since they have been systematically selected for desirable traits and propagated in a variety of habits" (Posey, 1992:47). Added to the semi-nomadic way of life of the Kayapó, their dispersive practices make them responsible for the physiognomy of vegetal and floristic composition of portions of the tropical forest. More important, these dispersive patterns were or are potentially "widespread throughout Amazonia" (Posey, 1982).

The Kayapó have also shown a considerable knowledge and management of insects and arthropoda. Their knowledge of stingless bees (*Meliponinae*) is reported by Camargo and Posey (1991). All bees (*Tetragona clavipes*, *T. dorsalis*, *Melipona seminigra*, *etc.*) occurring locally are named and recognized by the Kayapo using ecological, ethological and morphological characteristics. Kayapó knowledge of stingless bees includes their ontogeny, division of labor, castes, odor trails, defense activity and swarming behavior. This knowledge has enabled the Kayapó to manage or semi-domesticate the bees (for the purpose of harvesting wax, resin, pollen, larvae, pupae, and honey).

5. The contemporary Runa living in the Ecuadorian Amazon provide a case of "successional management" of forest structure and composition (Irvine, 1989). Comparative studies between unmanaged and managed 5 year old forest fallows showed that Runa management "increases the species diversity of trees greater than 10cm dbh" in two categories, planted trees (8% to 19%) and protected trees (6% to 16%) (Irvine 1989:234). Unmanaged fallow forest showed a canopy dominated uniformly by *Cecropia*, whereas managed fallow forest presented a more diverse canopy consisting of planted trees. Human disturbance activities decreased the presence of *Cecropia* by 20%, and the stem density of the fallow forest was reduced, probably as a result of weeding. The Runa facilitate and actively protect the succession of useful species which comprise around 14% to 35% of the canopy species diversity (domesticated, and semidomesticated). Irvine (1985) also found that caviomorph populations (agoutis and pacas) are favored by Runa management of garden and fallow habitats. The presence of these rodents is directly associated with the habitat managed by the Runa. Especially important is the Runa management of plant species such as *Bactris gasipaes, Mauritia flexuosa, Astrocaryum murumuru, Jessenia batatua*, and others, which act as game attractants, food and shelter for the animals. The Runa certainly show here their knowledge of the phenology of the local biota. The ethical regulation of hunting pressure —e.g. food taboos, although not reported for the Runas— of many Amazonian groups were possibly generated as "early as the Lower Pleistocene" (Schüle, 1992) and intended to avoid overexploitation of game in a poor environment. These "ecological hunting" practices are, however, fragile and dynamic. They may change if overabundance of game occurs or due to acculturation to western civilization.

6. The positive impact of swidden activity on game animal populations is well illustrated by the case of the Piaroa living in the Venezuelan Amazon. This idea, framed as the "garden hunting hypothesis" (Linares, 1976) states that the plants found in mature or abandoned gardens attract animal species which human predators hunt (Zent, 1992, 1997). By making gaps in the forest, humans enhance floral habitat diversity and create ecotones favorable as food-supply and shelter habitats for some animals. The "garden-forest mosaics" attract game animals that are more easily hunted in relatively concentrated spaces. More interesting, Zent argues that habitats modified by the Piaroa were intrinsically richer in food resources for certain game animals than primary forest habitats. His argument is supported by three main kinds of data collected to test the hypothesis: (1) random vegetation surveys (90 m^2) in garden (0-3 years old), old garden (4-6 years, 7-12 years), secondary forest (>12 years old), fluvial primary forest, and interfluvial primary forest habitats; (2) interviews among the Piaroa about the plant foods of different game animal species; and (3) census of the botanical composition within the quadrats. In this way, areas disturbed by the Piaroa are shown to have "the capacity to support higher densities of game animals". Some mammals eat garden crops (peccaries, deer, paca, agouti, and rat) while others, especially the

frugivorous bird species of the Cracidae (curasows and guans) and Ramphastidae (toucans and aracaris) bird families, benefit considerably from plants found in the old gardens (7-12 years old) and secondary forest habitats, while small birds (such as oropendola) eat plants from the recent fallow habitat (4-6 years old) (Zent, 1992, 1997). Furthermore, these animals constitute more than half of the total animal weight harvested by the Piaroa in a year. This suggests that the Piaroa have enhanced their own resource base by improving the resource food base of the animals that they hunt (Zent, 1992).

Faunal and floristic management of secondary forests by the Piaroa, as well as other traditional Amazonian native ethnic groups (see Posey, 1993 for example), appear to have two major goals: to maximize the botanical diversity of useful plants and to attract game (Zent, 1995). In this sense, man-made secondary forest figures to be a central resource among foraging-dependent societies, providing resources for subsistence and reducing human abuse of other kinds of forests (primary).

7. My ongoing research among the Hotï, a native group occupying the rain forests of the circum Maigualida area of Southern Venezuela, also provides different examples of the creative impact that low technology forest peoples have on the character and composition of their habitat[1]. An illustrative example is their exploitation of peach palm (*Bactris gasipaes*), which involves an interesting case of human introduction of a natural resource that apparently is being maintained due to its special interaction with the local wild fauna of the region. According to Schultes (1994), the peach palm, is "unknown in the wild" but it is "widely cultivated throughout tropical America". However, the Hotï, observed in the field harvesting that nutritious fruit, claimed that contemporary humans did not cultivate the plants that they have been harvesting, and there were only fuzzy recollections about whether ancestors cultivated this important food resource. Instead, they claimed that agoutis (*Dasyprocta leporina)* are responsible for the abundant proliferation of this species. Agoutis, according to the Hotï not only eat the fruit but they also bury the seed in the ground, thus in effect planting new individual trees. Another interesting and creative ecological behavior observed among the Hotï, refers to the planting of certain crop plants in natural tree fall clearings or gaps in the high forest occurring alongside of their tiny walking trails. These so called "trail gardens" (as designated in their own language *mana balo*), similar to those found among the Kayapó (see above), provide these people with extra food supplies which can be used during their frequent trekking activities. Most of the cultivars planted (plantain, banana, papaya, sweet potato, and yam) are relatively short lived plants which will not be found naturally in those environments and which release nutrients once they die. There is also evidence that the Hotï are active gap creators because they are avid honey collectors and one method for gaining access to hives found high up in tree trunks is to chop down the tree. The Hotï possess an elaborate knowledge at least 20 kinds of bees, including their habits, habitats and behavior. One can observe many felled trees during walks through the forest both near and far from their present communities, and indeed, the author observed honey being eaten on a nearly daily basis during the dry season. One can suppose that the many gaps they create as a result of their honey collecting activities help to intensify the dynamics of forest patches throughout their areas of occupation (Zent and López-Zent, 1996-1997 field notes). In the vein of the ideology embracing human-nature interactions, Hotï perceptions are revealed as ecocentric. Thus, some Hotï mentioned a tree as the allegedly material generator of all human beings[2]. Further inquiries and botanical collections revealed that the unique "mother plant" of humans according to Hotï belief is a Tiliaceae, probably from the *Apeiba* genus. The Hotï are not distinct from other Amazonian natives in this sense since it is not uncommon to find trees at the origin of life in Amazonian cosmogonies (cf. some origin myths, Boglar, 1978 for the Piaroa; or Jiménez *et al.*, 1994 for the Ye'kuana).

Final Remarks

The awareness of disturbance playing a central role in the structure and function of tropical forest has been crucial in the building of a new ecological paradigm (Waide and Lugo, 1992) based on the fundamental conception that the forest constitutes *dynamic* rather than constant ecosystems. Native Amazonian human populations have been acting as small to medium scale disturbance agents within the Amazonian landscape, thus, making a significant contribution to the richness of the tropical forest biota (Goldammer, 1992).

Indians" sensitivity and knowledge of the services of nature have allowed them to survive in the Amazon for very long spans of time. Their environmental consciousness represents strategies of resource management, that do not necessarily conform to the "environmental friendly" tendency of recent western standards (Johnson, 1992; Gómez-Pompa and Kaus, 1992). Nonetheless, Amazonian Indians have proven to be competent environmental managers and holders of a comprehensive ecological knowledge, including the phenology and etiology of biotic species and their interactions. Such knowledge, enacted through certain behaviors, turns into positive feedbacks in the ecosystems and generate important changes.

Many Native Amazonian human populations recognize the importance of managing plants and animals for the maintenance of their own complex ecosystems. Some, such as the Kayapó and the Runa, have shown empirically that they recognize the ecological composition and functioning of their local ecosystem. Indians acting culturally as disturbers, dispersers or predators, promote the maintenance of the Amazonian forest through a selective set of subsistence strategies which allow them to survive. It is possible to implement strategies that promote sustainability of Amazonian ecosystems based on some of the autochthonous management practices described above.

Native Amazonians undoubtedly can contribute to the building of a sound environmental ethic. Most ideologies among traditional Amazonian people —an old ideology for them, yet a new one for us— conceive of man-nature interaction's such that Nature (i.e. natural forces) has a much greater influence in controlling and shaping the world order (along with humans) than is expressed in western ideologies. More pragmatically, Native Amazonian people have taught the western world practices for exploiting natural resources which favor the environment in a sort of symbiotic or at least comensal way (besides the examples above see also Gómez-Pompa and Kaus 1990). Human cultural diversity is to some extent responsible for biodiversity richness, as well as the heterogeneity of forest composition and structure. It has been proved that a natural resource management plan increases its potential success if the local people are actively involved from the beginning in its design and implementation.

In this vein of ideas, it is worth mentioning an interesting example, the Palcazú Project, which along with traditional management practices pioneered a strip-cut technique of forest in the Peruvian Amazon. The Project, initially funded by the U.S. Agency for International Development and supported by the World Wild Fund for Nature, involves five native communities and 70 individual Amuesha Indians cooperated in the Yánesha Forestry Cooperative or COFYAL. The main goals of the project are to manage the communities' natural forests for sustained yield of wild products and protect the cultural integrity of the Amuesha people. Commercial strip cuts of sections of the forest (30-40 m wide) are practiced in cycles and sequences to maximize the persistence of mature or advanced regrowth of forests bordering the strips. It may take 6-10 years to complete one cycle of strip cuts and about 30-40 year rotation before harvesting a given strip. The main "ecological purpose of strip-cutting in these tropical forests is to promote natural regeneration of native species". The wood harvested is processed and marketed by the Amuesha, some high quality wood even being imported to the US (to musical instrument makers and artisans). After more than a decade of implementation of the project, "inventories of natural regeneration indicate superb regeneration and growth of hundreds of tree species" (Hartshorn, 1994; for more examples see Posey, 1992).

These integrative approaces to the management of tropical forests have multiple implications for the survival of the Amazonian forests and peoples, their rights and management strategies for the future. A sound approach to environmental management will benefit from the potential role of humans as allies of nature. A better comprehension of nature's services associated with the cultural induced disturbances could improve and inform strategies for the management of tropical forest ecosystems.

Furthermore, if environmental ethics and economics are to play a vital role in preserving biodiversity and fostering conservation worldwide, those fundamental differences between wealthy and non-wealthy countries' economic systems and conservation programs should be highlighted. The wealthy countries' demand for extraction and exportation of resources is an important factor that decreases non-wealthy countries' biodiversity. Empowering local, subsistence cultures certainly will contribute to the maintenance of tropical diversity (Oldfield and Alcorn, 1991).

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NOTES

[1] This research has consisted principally of surveys on four 1 ha ethnobotanical plots in different forests occupied by the Hotï. Individual interviews have been carried out among 125 Hotï about more than 2000 individual trees. The preliminary results of this work show that, similar to other native Amazonian peoples (Prance *et al*., 1987; Bennett, 1992), the Hotï make extensive use of their surrounding forests.

[2] López-Zent and Zent 1996-1998 personal field notes and reconfirmed by Robert Storrie pers. comm. 1997.

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