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Use of Tropical Rainforests by Native Amazonians

These sophisticated and complex agricultural systems can serve as models of sustainable agroecosystems

Darna L. Dufour

Indigenous peoples have lived in the rainforests of Amazonia for a long time, probably thousands of years. They were once more numerous and occupied more of Amazonia than they do today. Those groups known ethnographically live in interfluvial regions and share a broadly similar subsistence pattern based on horticulture, hunting, fishing, and collecting. They provide the best example of sustainable use of tropical rainforests under low population densities.

Of the ways in which Amerindians use the rainforest, the best documented are their diverse, multistoried agricultural plots, or swiddens. More recently studied is their management of swidden fallows, in which annual crops are combined with perennial tree crops and the natural process of reforestation. Some groups also modify what appears to be primary forest by planting along trailsides and campsites. The result of their agricultural practices is a mosaic of vegetational patches in different stages of succession and under differing degrees of management. This vegetational mosaic is then used for food, materials, and medicinals, as well as for hunting game animals.

The objectives of this article are briefly to summarize the history of indigenous peoples, describe some of the contributions anthropology and allied disciplines have made to understanding how these peoples use tropical rainforests, and, finally, to compare this knowledge briefly with patterns of use characteristic of other populations. Many examples are drawn from the Tukanoan Indians in the Colombian Vaupes region in Northwest Amazonia, the area with which I am most familiar.

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Much that has been considered natural forest is probably the result of centuries of human use

History of native Amazonians

When the Europeans arrived, the indigenous population of Amazonia was much greater than it is today. One estimate is that the Amerindians numbered approximately 6.8 million in an area of almost 10 million km^2 (Denevan 1976)[1]. Population density was highest in the floodplains of the major rivers, or what is referred to as *várzea,* and along the Atlantic coast. Early explorers such as G. Carvajal and F. Orellana reported dense settlements along the banks of the Amazon in the 1540s and a level of social organization referred to as a chiefdom (Roosevelt 1989). The remains of large middens (refuse heaps), as well as the extent and depth of *terra preta do indio*[2] (Indian black earth) provide additional evidence that the riparian zones of major rivers were heavily populated (Roosevelt 1989, Smith 1980). The interior forests and savannas, or *terra firme,* appear to have been much more sparsely populated (Denevan 1976).

The indigenous population in the floodplain declined rapidly, and, by only 150 years after Orellana's expedition, the chiefdoms were extinct (Roosevelt 1989). The severe depopulation that followed this contact is assumed to have been the result of a combination of disease, slavery, and warfare. The rate of population decline in the more isolated interior forest areas was probably lower than in the floodplain, because many of these groups had only sporadic contact with outsiders until well into this century (Denevan 1976).

In the early 1970s, the indigenous population of Amazonia was estimated at less than 500,000 (Denevan 1976). In Brazil alone, the population dropped between 1900 and 1957 from approximately 1 million to less than 200,000 (Ribeiro 1967). Amerindians are now confined to interior forests and savannas, and the once

[1]The use of Amazonia in this article follows that of Denevan (1976). It refers to greater Amazonia, which includes the tropical lowlands and plateaus east of the Andes and north of the Tropic of Capricorn, except for the Gran Chaco region. It is an area considerably larger than the drainage of the Amazon and its tributaries.

[2]*Terra preta do indio* is a soil darkened by the residue of repeated fires. It characterizes ceramics and other remains of human activity (Smith 1980).

densely populated floodplain is home to *caboclos,* the descendants of detribalized Indians and early European immigrants (Moran 1974, Parker et al. 1983). However, even in *terra firme,* it is clear that no present-day indigenous villages are as large as some of the villages were in the past (Nimuendajú 1939, Smith 1980). Understanding of indigenous use of Amazonian ecosystems is limited to *terra firme* forests, and these forests themselves may have been more heavily used in the past.

Amerindian use of forests for agriculture

Swidden plots. The traditional indigenous agricultural system is based on swidden cultivation (also known as slash-and-burn or shifting cultivation). In essence, this system involves felling and burning a patch of forest, cultivating and harvesting crops for a period of several years, and then allowing the forest to regrow for 15 years or more before the site is cleared again (Beckerman 1987). The felling and burning releases the nutrients stored in the forest biomass and makes them available to cultivated crops. The long fallow restores soil fertility, protects the physical properties of the soil, allows time for nutrient accumulation in the biomass, and helps control agricultural pest populations.

Amerindian swiddens are typically small, 0.4–0.6-hectare (Beckerman 1987), polycultural plots (i.e., they are planted in more than one crop simultaneously). Multiple varieties of the staple crops are planted in each swidden. Most groups of Amerindians also have monocrop swidden plots devoted to the dietary staple. The predominate staples are cassava (*Manihot esculenta* Crantz) and plantains and bananas (*Musa* sp.).

Cassava, or manioc, is a perennial shrub grown for its starchy roots. It is native to the neotropics, and well adapted to the low-fertility, acidic soils common in *terra firme* (Cock 1985). Cassava is cyanogenic, and varieties are recognized as being either bitter or sweet (i.e., containing high or low amounts of cyanide). The bitter-sweet distinction determines culinary use: bitter varieties are elaborately processed to reduce cyanide levels before being consumed, whereas the sweet ones can simply be peeled and boiled (Dufour 1988).

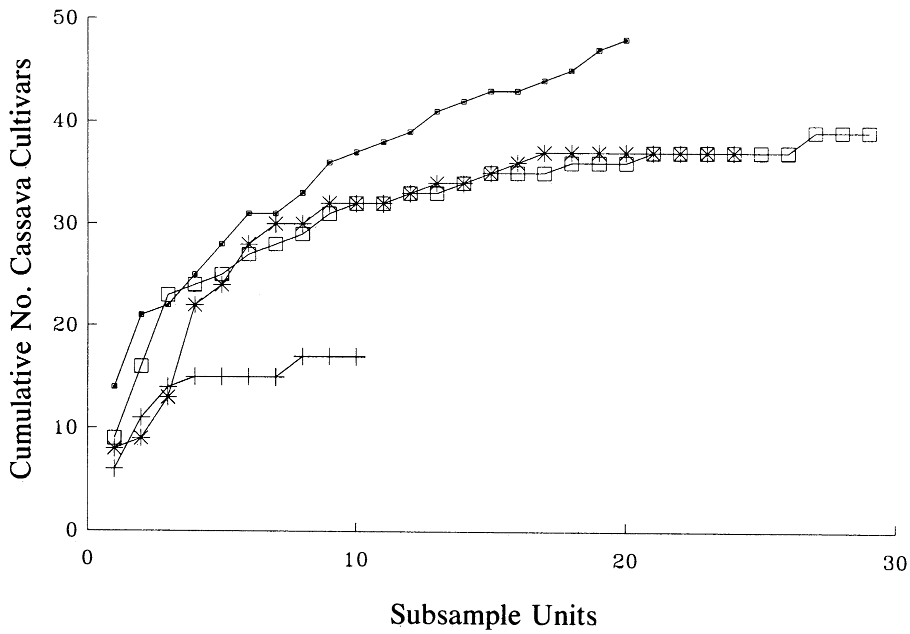


Figure 1. Cumulative number of cassava varieties in subsample units in four Tukanoan swiddens. Subsample units were randomly placed circles, 2 meters in radius.

The agricultural plots of Tukanoan Indians in northwestern Amazonia provide a good example of traditional swidden cultivation. Swidden plots are felled by individual households in well-drained soils in both primary and successional forests. Most households fell swiddens in both types of forest. Bitter cassava, the dietary staple, is densely planted over nearly the entire garden surface. Other crops, such as taro (*Colocasia* spp.), sweet potato (*Ipomoea* sp.), arrowroot (*Maranta ruiziana*), pineapple (*Anana sativa*), chili peppers (*Capsicum annuum*), mafafa (*Xanthosoma mafafa*), lulo (*Solanum* sp.), bananas, and plantains, are interplanted where microenvironmental conditions (such as drainage and ash concentration) are deemed most suitable. They are planted toward the center of the garden where the regrowth of the forest will be most easily delayed by weeding. Coca (*Erythroxylum coca*), which is a shrub, and tree crops such as guama (*Inga* sp.), uvilla (*Pourouma cercropiaefolia*), and peach-palm (*Bactris gasipaes*) are also interplanted with cassava toward the center of the garden.

Tukanoan swidden plots are polycultural. They are polyvarietal as well, but the diversity of cassava varieties is much greater than the diversity of the other crop species. For example, in identifying cultivated plants in subsample units in four Tukanoan swiddens[3] (Table 1), we found that each contained between 2 and 16 different crops, but as many as 17 to 48 different cassava varieties. On average, the four most common cassava varieties in each swidden accounted for only 38% of all cassava plants identified. We also found that, of all the cassava varieties reported, only the one or two sweet ones in each swidden were planted in a recognizable patch. The remaining ones were all interplanted. We found 4 to 17 bitter varieties per sampling unit (12.57 m^2), with a mean of 7.8 ± 3.72 (Figure 1).

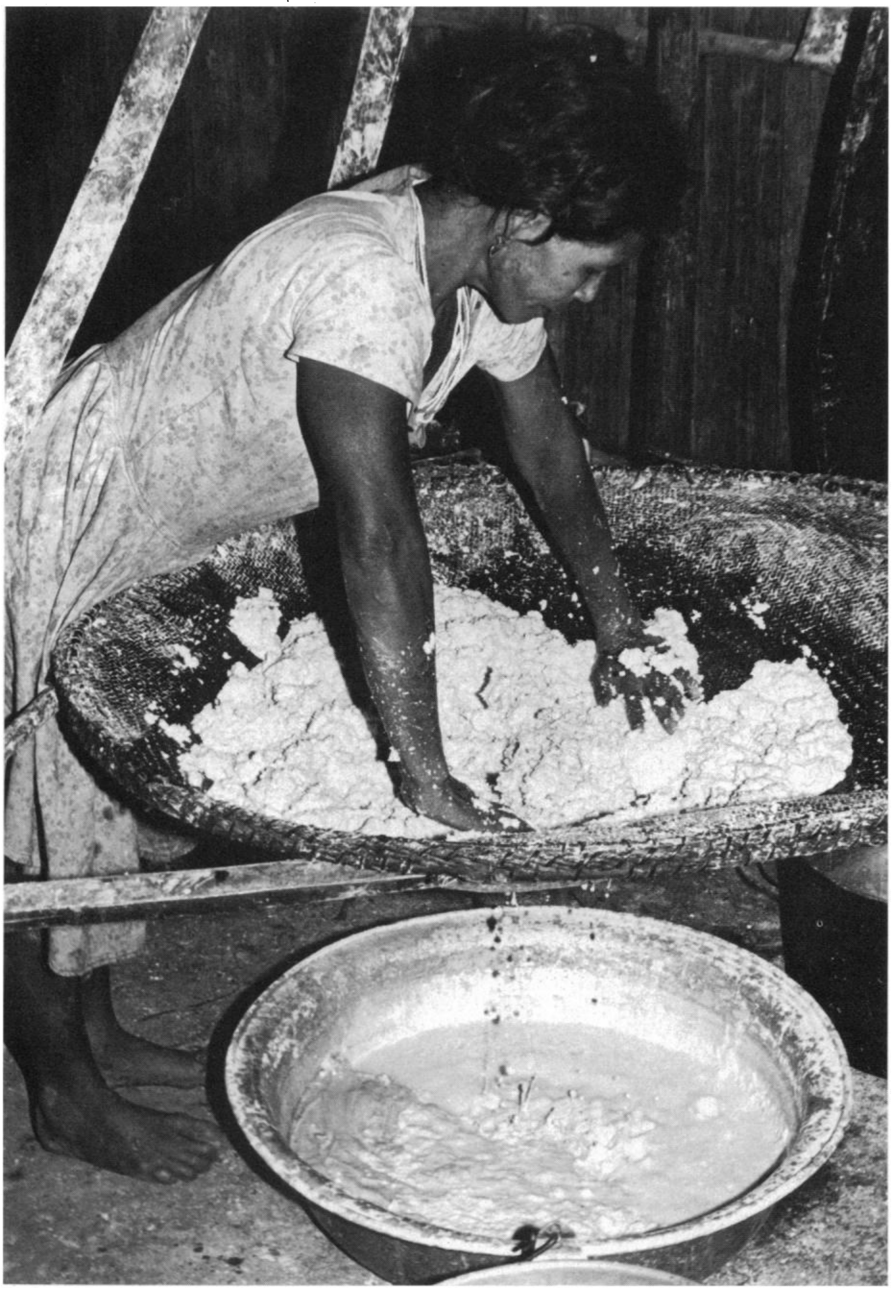
Tukanoan swiddens are most intensively used and managed from approximately the 12th through the 24th month after burning. During this time, the first cassava crop is being harvested and some areas of the swidden are weeded for replanting. A second, smaller cassava crop is planted in swiddens with good yields as the first is being harvested, so that cassava harvesting continues through approximately the 36th month. Other

[3] D. L. Dufour and R. Wilshusen, 1986, unpublished data.

Table 1. Number of crop species, cassava varieties, and varieties of other crops in sample units of four Tukanoan swidden plots in Northwest Amazonia.

				Cultivars	
Swidden	Size (ha)	Sample units	Crop species	Cassava	Other
Primary forest*	0.35	20	17	48	25
Primary forest	0.15	10	2	17	1
Rastrojo† (60-year)	0.78	29	10	39	11
Rastrojo (25-year)	0.70	25	6	37	5

Unpublished data from 1986. Sampling units were randomly selected circles of 2-meter radius. All plants in each circle were tagged and then identified by the garden owner. Names of cassava cultivars were systematically checked for overlap with each garden owner, but naming of cultivars between swidden plots was not cross-checked.
*Tall forests, not cut in the memory of current inhabitants, is assumed to be primary forest.
†*Rastrojo* is local Spanish for successional forest. Ages are estimated from informants' histories of use.



Tukanoan woman sieving grated cassava roots to extract the starch. This extraction is part of the process used to make cassava bread, the dietary staple in Northwest Amazonia.

crops are harvested as they mature and are needed. Tree crops such as uvilla and peachpalm mature in approximately three years and are harvested until forest regrowth dominates the plot.

Households establish one or two new swidden plots each year, and therefore they have access to a number of swiddens in different stages at any time: a newly planted swidden with immature crops, a cassava-producing swidden, and one or more older swidden or fallows with fruit trees, fish poisons, and medicinal plants. Some of the plots are contiguous and form a mosaic of patches of successional vegetation. Others are widely dispersed to take advantage of areas of particularly good agricultural soil and/or serve as bases for hunting and fishing.

Swidden fallows. The transition between a swidden and a swidden fallow is not sharp, and, certainly from the Amerindian point of view, the plot is not abandoned after the principal crop has been harvested. Denevan and Padoch (1988) examined the swiddens of Bora Indians living in the humid tropical rainforests of Peru at different stages of regrowth from the time of cutting. They found a continuum from a swidden dominated by cultivated grasses, forbs, and shrubs; to an orchard fallow phase, in which there was a combination of fruit trees, smaller cultigens, and natural vegetation; to a forest fallow that still contained economically useful plants, but became progressively more and more like the surrounding forest (Table 2). Some of the useful plants were nondomesticated plants that appeared in the natural reforestation sequence and were protected.

The Bora, therefore, practice a

form of agroforestry in which perennial tree crops are combined with natural forest regrowth (Denevan et al. 1984). Similar practices have been reported for other Amerindians and appear to be widespread (Balée and Gély 1989, Eden and Andrade 1987, Harris 1971, Posey 1984).

Forest-fields and trailside plantings. Posey (1984) has documented among Kayapo Indians in Brazil a much broader system of forest management, which he refers to as *nomadic agriculture*. Traditionally the Kayapo were seminomadic and spent much of the year trekking along an extensive system of trails between the Tocantins and Araguaya rivers and the north-south limits of the Planalto and Amazon rivers.

Anthropologists had assumed that the Kayapo lived by hunting and collecting wild plant foods during these treks. However, Posey (1984) found that the trailsides and campsites were actually planted with "numerous varieties of yams, sweet potatoes, Marantacea, Cissus, Zingiberaceae, Araceae, Cannaceae, and other unidentified, edible, tuberous plants," as well as fruit trees and medicinal plants. This planting was a conscious attempt to replicate naturally occuring concentrations of resources in primary forest. The plants used included both domesticates and semidomesticates (i.e., plants transplanted from primary and successional forest). These semidomesticates were also transplanted to old swiddens and naturally occuring forest gaps.

Ecological effects of traditional agricultural practices. The ecological effects of traditional Amerindian agricultural practices are still poorly understood. Swidden cultivation, as practiced by Amerindians with short cropping and long fallows, is considered a relatively benign disturbance (Herrera et al. 1981), and it does not seriously impair ecosystem function (Uhl 1987).

At the level of the individual swidden plot, a number of traditional farming practices are considered beneficial. For example, the use of shade trees, mixed cropping of species that differ in phenology, dense spacing of crops, and fallowing all help preserve soil organic matter, which is a critical factor in the maintenance of soil fertility in the deeply weathered and leached soils common in Amazonia (Ewel 1986). The species richness of the plots is assumed to confer pest protection and decrease the risk of complete crop failure (Ewel 1986; c.f. Brown and Ewel 1987). Planting many varieties of a staple crop may fulfill the same functions (Balée and Gély 1989, Beckerman 1983, Boster 1983, Parker et al. 1983).

Forest regeneration during the fallow is considered a key to the sustainability of swidden systems (Ewel 1986). Amerindian management of the successional process, by the selective weeding out of certain trees and the protecting and planting of others, appears to have a greater impact on species diversity than it does on forest regrowth in stature and biomass (Uhl 1987). Uhl (1983) has suggested that heavily managed successions in areas such as house gardens may grow to forest stature as fast or faster than natural ones (Uhl 1983).

Recovery to primary forest in terms of biomass and species diversity, however, is slow. Current estimates are that in areas like San Carlos de Rio Negro it will take 100 years or more for traditionally farmed sites to return to primary forest, and sites suffering greater disturbance will take even longer (Saldarriaga 1985, Uhl and Murphy 1981).

Given this long period of recovery, and the practice of cutting swidden plots yearly, it is clear that human settlements will be surrounded by a complex mosaic of agricultural and agroforestry plots, as well as forest in various stages of regrowth. In addition, in some areas, the species composition of the forests themselves will

Table 2. Harvestable plants found in Bora fields and fallows at different stages of regrowth after cutting. (Adapted from Denevan et al. 1984.)

Stage	Cultigens	Other useful plants
Newly planted field (0–3 mo)	None	Dry firewood
New field (3–9 mo)	Maize, rice, cowpeas	Various useful early successional species
Mature field (9 mo–2 yr)	Manioc, some tubers,* bananas, cocona, other quick-maturing crops	Some useful vines and herbs in abandoned edge
Transitional field (1–5 yr)	Replanted manioc, peanuts, pineapple, guava, caimito, uvilla, avocado, cashew, coca, barbasco, chili peppers, miscellaneous tubers	Useful medicinals and other plants within field; on edges, seedlings of useful trees appear; saplings of *Cercropia* and *Ochroma lagopus* in abandoned edges
Transitional fruit field (4–6 yr)	Peach palm, bananas, uvilla, caimito, guava, annatto, coca, some tubers, propagules of pineapple, other crops	Many useful soft construction woods and firewoods, palms (including *Astrocaryum*), useful vines, and understory aroids
Orchard fallow (6–12 yr)	Peach palm, some uvilla, macambo, propages	Useful plants as above and self-seeding *Inga*
Forest fallow (12–30 yr)	Macambo, umari, breadfruit, copal	Self-seeding macambo and umari; high forest successional species appearing; some hardwoods becoming harvestable (e.g., *Iriartea* sp.); many large palms (*Astrocarym hunicungo*, *Euterpe* sp., *Jessenia bataua*)
Old fallow (30+ yr)	Macambo, umari	Numerous construction, medicinal, handicraft, and food plants

Plant identifications are as follows: Annatto (*Bixa orellana*), avocado (*Persea americana*), banana (*Musa* sp.), barbasco (*Lonchocarpus* sp.), breadfruit (*Artocarpus incisa*), caimito (*Pouteria caimito*), cashew (*Anacardium occidentale*), chili pepper (*Capsicum* sp.), coca (*Erythroxylon coca*), cocona (*Solanum* sp.), copal (*Hymenaea courbaril*), cowpeas (*Vigna unguiculata*), guava (*Inga* sp.), macambo (*Theobroma bicolor*), maize (*Zea mays*), manioc (*Manihot esculenta*), peach palm (*Bactris gasipaes*), peanut (*Arachis hypogaea*), pineapple (*Ananas comosus*), rice (*Oryza sativa*), umari (*Poraqueilba sericea*), uvilla (*Pourouma cercropiaefolia*).

*These tubers include cocoyams (*Xanthosoma* sp.), sweet potatos (*Ipomoea batatas*), and yams (*Dioscorea trifida macrocarpa*).

Tukanoan woman harvesting cassava roots in a representative swidden in Northwest Amazonia. The palmate-leafed plant at lower left is cassava.

be the result of human endeavors to increase the density of useful plants. Such vegetational mosaics may offer advantages in terms of pest protection and be a way of risk spreading (Eden and Andrade 1987, Ewel 1986). For indigenous populations, these landscapes offer clear advantages in hunting and collecting.

Amerindian use of forests for hunting, fishing, and collecting

Hunting, fishing, and collecting are integral components of the subsistence pattern of Amerindians that cannot be considered apart from swidden agriculture (Balée and Gély 1989). In nutritional terms, these activities provide the sources of dietary protein, fat, and other nutrients that are critical supplements to the high-carbohydrate staples.

Faunal resources. Amerindians hunt a wide variety of animals, the numerically most important of which are primates and rodents (Redford and Robinson 1987). One of the explicitly recognized functions of swidden plots is to attract game animals for hunting. The roots, tubers, and low-successional vegetation of swidden are attractive to such game animals as rodents, peccary, and deer.

Crop losses due to predation are routinely compensated for by overplanting (Balée and Gély 1989, Carneiro 1983). Tukanoan women, for example, plant extra sweet-cassava for a small rodent, boo (*Dasyprocta punctada,* which averages approximately 2 kg in weight), and only complain when "he" seems to be eating more than "his" share. This rodent accounted for more than 20% of all animals killed during three-month-long observation periods in 1977, and women hunting in gardens with dogs were responsible for almost half of all kills (Dufour 1981).

The fruit trees in swidden fallows are attractive to a number of large game animals, especially tapir (*Tapirus terrestris*) and peccary (*Tayassu* spp.; Balée and Gély 1989, Chagnon and Hames 1979, Denevan et al. 1984, Dufour 1981, Posey 1984). The Kayapo purposefully disperse their gardens so as to attract game animals over a large area (Parker et al. 1983, Posey 1982, 1983, 1984). For this reason, Posey (1984) suggests that old swiddens be called "game-farm-orchards."

The effect of indigenous hunting practices on animal biomass and diversity is a complex question. Posey (1982) has argued that certain game species would not occur in forest unmodified by humans, and several of the important mammals such as deer, tapir, and collared peccary may reach higher densities in modified areas. Further, not all animals that frequent the swiddens are taken for food (Ross 1978), and researchers have described a number of ways in which the Amerindians may be regulating their hunting of game animals (Balée 1985, Beckerman 1980, Reichel-Dolmatoff 1976).

The only long-term study of the effects of indigenous hunting is Vickers' (1988) documentation of the hunting returns in a Siona-Secoya village in northeastern Ecuador over a 10-year period. His data suggest that some species were being depleted locally. These included the woolly monkey (*Lagothrix lagotricha*), a large forest understory bird called the curassow (*Mitu salvini*), and a large ground-dwelling bird, the trumpter

Oblique aerial view of swidden plots of different ages in Northwest Amazonia.

(*Psophia crepitans*). Other species, such as peccaries, tapir, deer, other primates, other birds, rodents, and reptiles, did not, however, show evidence of depletion. These data support the suggestion that the patches of successional vegtation created in swidden cultivation may allow some game species to survive near human settlements (Redford and Robinson 1987).

FISHING. The majority of the Amerindians in Amazonia rely on fish, rather than game, as their principal source of animal protein. In blackwater areas where rivers are small, such as northwestern Amazonia, fish can be considered part of the forest ecosystem, because nonpredatory fish feed primarily on forest products (Knöppel 1970). Tukanoan Indians recognize the importance of forests to fish (Chernela 1985, Dufour 1981). The flood forest, or igapo, is an important feeding ground for fish. The Indians have protected it from deforestation (Chernela 1985).

Other Tukanoan practices, such as the use of fish poisons, may negatively affect the local fish populations, but it is not clear to what extent. The fish poisons are the crushed roots, stems, and/or leaves of a variety of wild and cultivated plants. Their use was traditionally controlled by the village shaman (Reichel-Dolmatoff 1976) and typically restricted to small forest streams that could be temporarily dammed. The effects of these poisons appear to be temporary (several hours) and highly localized.

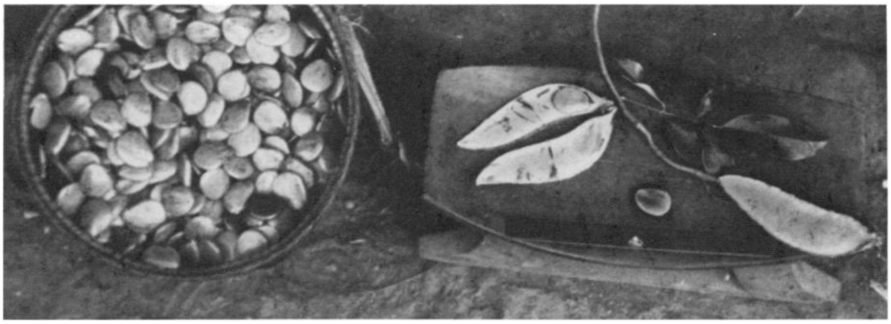
COLLECTING. Small vertebrates, such as frogs, as well as invertebrates, are important faunal resources that are collected. The use of insects for food is widespread (Dufour 1987, Posey 1978). The more commonly collected and consumed insects appear to be ants (especially *Atta* spp.), termites, and larvae of both Coleoptera (especially Buprestidae, Curculionidae, and Scarabaeidae) and Lepidoptera. Tukanoans harvest ants and termites at low but constant rates. Nests are never destroyed, and some colonies in favorable locations are actively protected. Palm grubs (Curculionidae) are a managed resouce: palms are cut with the expectation that they will be invaded by weevils and the larvae can be harvested at a later date.

Floral resources. Amerindians collect a wide range of plants and plant products as food and for use in housing, tool manufacture, craft production, and medicine. The role of collected plant foods in the diet ranges from trail snacks and emergency foods to important sources of nutrients. Palm fruits and Brazil nuts are well-known examples of wild plant foods. Less well-known are oil seeds such as *Erisma japura* and the legume *Monopteryx angustifolia*, which are seasonally important in the diets of some groups (Dufour and Zarucchi 1979).

Plant foods are collected from the entire range of successional vegetation types, from nondomesticated herbs such as *Phytolacca rivinoides*, which grow in newly burnt swiddens, to the seeds of the rubber trees, *Hevea* sp., which grow in primary forests (Dufour 1981). In collecting plant parts (fruits, nuts, and seeds) from the litter on the forest floor or from living trees, humans are competing with other herbivores, but the impact of their activity on the forest is minimal. When trees are felled to harvest fruit or other parts, the impact is greater. Localized depletion of products such as cedar (*Cedrela odorata*) for canoes and palms for roof thatch has been documented (Vickers 1988).

Some of the more important collected plant foods appear to be from anthropogenic forests, that is, forests that are the result of human disturbance. Balée (1989) has argued that babassu palm (*Orbignya phalerata*) forests and Brazil nut (*Bertholletia excelsa*) forests, among others, should be considered anthropogenic, because the predominance of these trees in the forest is associated with evidence of

Tukanoan boy fishing with hook and line from a small dugout canoe.



Seeds of *Monopteryx angustifolia*, a seasonally important wild plant food in Northwest Amazonia.

human settlement. Babassu palms tend to be the dominant, or at least an important species in burned forest clearings because of the manner in which they germinate: the apical meristem grows downward, rather than upward, and remains protected underground for a year or more (Anderson and Anderson 1985, Balée 1989). Brazil nut forests, at least in some areas, appear on or near *terra preta* sites (Balée 1989). Furthermore, Kayapo actually plant Brazil nuts as a source of food for themselves and the game they hunt (Posey 1985). Balée (1989) estimates that at least 11.8% of *terra firme* in the Brazilian Amazon is covered by anthropogenic forests.

Contrasts with nonindigenous farmers

Indigneous peoples are not the only ones who have a detailed knowledge of the local Amazonian ecosystems in which they live. The long-term residents of Amazonia, the *caboclos* (also *riberenos, mestizos,* or *campesinos*), do as well. The *caboclos* are the rural peasantry of Amazonia, and they are now the principal inhabitants of the *várzea*, the narrow but productive floodplain of Amazonian rivers (Parker et al. 1983). Their use of resources resembles that of Amerindians, from whom many are descended, but they are more oriented to market economies and typically quick to respond to market opportunities (Padoch 1988, Parker et al. 1983).

For example, the *caboclos*, studied by Padoch (1988) along the Ucayali River in Peru, recognized a complex set of ecological zones in the riparian environment and used them to advantage. They cash-cropped rice on the seasonally flooded mud flats of the river and cultivated subsistence and market crops on the *restingas* (river levees). On the poorer soils of the higher areas, they had intensively managed for subsistence crops the swidden plots, which gradually turned into orchards and then forest fallows. Some orchards were used for as long as 30 years, and the forest fallows were weeded selectively to maintain a high proportion of useful species.

Like Amerindians, *caboclos* use a wide variety of forest products as food, medicinals, fiber, and building materials. They also collect nontimber forest products such as palm fruits, Brazil nuts, and rubber for commercial sale (Padoch 1988, Parker et al. 1983). At least for Brazil nuts and rubber, their collection practices are productive and environmentally conservative, and they provide examples of the sustainable use of Amazonian forests (Fearnside 1988).

The newest immigrants to Amazonian rainforests are the *colonos*, or colonists. *Colonos* are the subsistence farmers who went and still go to the Amazon as part of resettlement schemes promoted by government agencies (Moran 1988). The majority see the rainforest for the first time when they arrive in the Amazon, and, understandably, they have little knowledge of how to make a living in it.

In his study of Brazil's Transamazon Resettlement Scheme in the 1970s, Moran (1988) found that the *colonos* treated the forest as an enemy rather than a resource. They cleared more land per year, but cultivated less, and they were less successful agriculturally than *caboclos* living in the same area. They gradually learned, however, to clear less land, work it more intensively, and use some of the resources of the forest.

Changing views of native Amazonian resource use

Recent studies have considerably refined understanding of the ways in which Amerindians use the tropical rainforest. Originally anthropologists and ecologists envisioned swiddens, fallows, and forests as more or less separate entities. Now, however, we understand more clearly the process of swiddens becoming forests, the length of time involved, and the degree to which human management is part of the transition.

The distinctions between domesticated and wild plants, or natural and managed forest, are also not as sharp as we thought they were. Much of what has been considered natural forest in Amazonia is probably the result of hundreds of years of human use and management (Posey 1984, Smith 1980). We are not certain how specific human activities may have changed Amazonian ecosystems over the long term, but they were certainly an essential component. Future research will have to take into account the long history of occupation and use of these forests by Amerindians.

The agricultural systems of Amerindians and *caboclos* have proven to be more sophisticated and complex than we imagined. There is a growing recognition that these agricultural systems have a great deal to offer in the design of sustainable agroecosystems (Denevan et al. 1984, Ewel 1986, Hart 1980). Further study of these systems that explicitly recognizes and incorporates the detailed knowledge and long experience of Amerindians and *caboclos* is needed. Such study will require the collaboration of anthropologists and ecologists.

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References cited

Anderson, A., and S. Anderson. 1985. A "tree of life" grows in Brazil. *Nat. Hist.* 94(12): 40–47.

Balée, W. 1985. Ka'apor ritual hunting. *Hum. Ecol.* 13: 485–510.

______. 1989. The culture of Amazon forests. In D. A. Posey and W. Balée, eds. Special issue: *Resource Management in Amazonia: Indigenous and Folk Strategies. Adv. Econ. Bot.* 7: 1–21.

Balée, W., and A. Gély. 1989. Managed forest succession in Amazonia: the Ka'apor case. In D. A. Posey and W. Balée, eds. *Resource Management in Amazonia: Indigenous and Folk Strategies. Adv. Econ. Bot.* 7: 129–158.

Beckerman, S. 1980. Fishing and hunting by the Barí of Colombia. Pages 67–109 in R. B. Hames, ed. *Studies in Hunting and Fishing in the Neotropics.* Bennington College, VT.

______. 1983. Barí swidden gardens: crop segregation patterns. *Hum. Ecol.* 11: 85–101.

______. 1987. Swidden in Amazonia and the Amazon rim. Pages 55–94 in B. L. Turner and S. B. Brush, eds. *Comparative Farming Systems.* Guilford Press, New York.

Boster, J. 1983. A comparison of the diversity of Jivaroan gardens with that of the tropical forest. *Hum. Ecol.* 11: 47–68.

Brown, B. J., and J. J. Ewel. 1987. Herbivory in complex and simple tropical successional ecosystems. *Ecology* 68: 108–116.

Carneiro, R. 1983. The cultivation of manioc among the Kuikuru of the upper Xingu. Pages 65–111 in R. B. Hames and W. T. Vickers, eds. *Adaptive Responses of Native Amazonians.* Academic Press, New York.

Chagnon, N., and R. B. Hames. 1979. Protein deficiency and tribal warfare in Amazonia: new data. *Science* 20: 910–913.

Chernela, J. 1985. Indigenous fishing in the neotropics: the Tukanoan Uanano of the blackwater Uaupés River basin in Brazil and Colombia. *Interciencia* 10: 78–86.

Cock, J. H. 1985. *Cassava: New Potential for a Neglected Crop.* Westview Press, Boulder, CO.

Denevan, W. M. 1976. The aboriginal population of Amazonia. Pages 205–234 in W. M. Denevan, ed. *The Native Population of the Americas.* University of Wisconsin Press, Madison.

Denevan, W. M., and C. Padoch. 1988. The Bora agroforestry project. In W. M. Denevan and C. Padoch, eds. Special issue: *Swidden-Fallow Agroforestry in the Peruvian Amazon. Adv. Econ. Bot.* 5: 1–7.

Denevan, W. M., J. M. Treacy, J. B. Alcorn, C. Padoch, J. Denslow, and S. F. Paitan. 1984. Indigenous agroforestry in the Peruvian Amazon: Bora Indian management of swidden fallows. *Interciencia* 9: 346–357.

Dufour, D. L. 1981. Household variation in energy flow in a population of tropical forest horticulturalists. Ph.D dissertation, State University of New York, Binghamton.

______. 1987. Insects as food. *Am. Anthropol.* 89: 383–397.

______. 1988. Cyanide content of Cassava (*Manihot esculenta,* Euphorbiaceae) cultivars used by Tukanoan Indians in Northwest Amazonia. *Econ. Bot.* 42: 255–266.

Dufour, D. L., and J. L. Zarucchi. 1979. Monopteryx Angustifolia and Erisma Japura: their use by indigenous peoples in the northwest Amazon. *Bot. Mus. Leaf. Harv. Univ.* 27: 69–91.

Eden, M. J., and A. Andrade. 1987. Ecological aspects of swidden cultivation among the Andoke and Witoto Indians of the Colombian Amazon. *Hum. Ecol.* 15: 339–359.

Ewel, J. J. 1986. Designing agricultural ecosystems for the humid tropics. *Annu. Rev. Ecol. Syst.* 17: 245–271.

Fearnside, P. M. 1989. Extractive reserves in Brazilian Amazonia. *BioScience* 39: 387–393.

Hames, R. B. 1979. A comparison of the efficiencies of the shotgun and the bow in neotropical forest hunting. *Hum. Ecol.* 7: 219–252.

Harris, D. R. 1971. The ecology of swidden cultivation in the Upper Orinoco rain forest, Venezuela. *Geogr. Rev.* 61: 475–495.

Hart, R. D. 1980. A natural ecosystem analog approach to the design of a successional crop system for tropical forest environments. *Biotropica* 12: 73–83.

Herrera, R., C. F. Jordan, E. Medina, and H. Klinge. 1981. How human activities disturb the nutrient cycles of a tropical rainforest in Amazonia. *Ambio* 10: 109–114.

Knöppel, H. 1970. Food of central Amazonian fishes: contribution to the nutrient ecology of Amazonian rain forest streams. *Kiel Amazoniana* 2: 257–352.

Moran, E. F. 1974. The adaptive system of the Amazonian Caboclo. Pages 136–159 in C. Wagley, ed. *Man in the Amazon.* University of Florida Press, Gainsville.

______. 1988. Following the Amazon highways. Pages 155–162 in J. S. Denslow and C. Padoch, eds. *People of the Tropical Rainforest.* University of California Press, Berkeley.

Nimuendajú, C. 1939. *The Apinaye.* Anthropological series no. 8. Catholic University of America, Washington, DC.

Padoch, C. 1988. People of the floodplain and forest. Pages 127–140 in J. S. Denslow and C. Padoch, eds. *People of the Tropical Rainforest.* University of California Press, Berkeley.

Parker, E., D. A. Posey, J. Frechione, and L. F. Da Silva. 1983. Resource exploitation in Amazonia: ethnoecological examples from four populations. *Ann. Carnegie Mus.* 52: 163–203.

Posey, D. A. 1978. Ethnoentomological survey of Amerind groups in lowland Latin America. *Fla. Entomol.* 61: 225–229.

______. 1982. Keepers of the forest. *Garden* 6: 18–24.

______. 1983. Indigenous ecological knowledge and development of the Amazon. Pages 225–256 in E. Moran, ed. *The Dilemma of Amazonian Development.* Westview Press, Boulder, CO.

______. 1984. A preliminary report on diversified management of tropical forest by the Kayapó Indians of the Brazilian Amazon. In G. T. Prance and J. A. Kallunki, eds. *Ethnobotany in the Neotropics. Adv. Econ. Bot.* 1: 112–126.

______. 1985. Indigenous management of tropical forest ecosystems: the case of the Kayapó Indians of the Brazilian Amazon. *Agroforestry Systems* 3: 139–158.

Posey, D. A., J. Frechione, J. Eddins, L. Francelino da Silva, D. Myers, D. Case, and P. Macbeath. 1984. Ethnoecology as applied anthropology in Amazon development. *Hum. Organ.* 43: 95–107.

Redford, K. H., and J. G. Robinson. 1987. The game of choice: patterns of Indian and colonist hunting in the neotropics. *Am. Amthropol.* 89: 650–667.

Reichel-Dolmatoff, G. 1976. Cosmology as ecological analysis: a view from the forest. *Man* 11: 307–318.

Ribeiro, D. 1967. Indigenous cultures and languages of Brazil. Pages 69–76 in J. H. Hopper, ed. *Indians of Brazil in the Twentieth Century.* Institute for Cross-Cultural Research, Washington, DC.

Roosevelt, A. 1989. Lost civilizations of the lower Amazon. *Nat. Hist.* 98(2): 75–83.

Ross, E. 1978. Food taboos, diet, and hunting strategy: the adaptation to animals in Amazon cultural ecology. *Curr. Anthropol.* 19: 1–19.

Saldarriaga, J. G. 1985. Forest succession in the upper Rió Negro of Colombia and Venezuela. Ph.D. dissertation, University of Tennessee, Knoxville.

Smith, N. J. H. 1980. Anthrosols and human carrying capacity in Amazonia. *Annals of the Association of American Geographers* 70: 553–566.

Uhl, C. 1983. You can keep a good forest down. *Nat. Hist.* 92(4): 71–79.

______. 1987. Factors controlling succession following slash and burn agriculture in Amazonia. *Ecology* 75: 377–407.

Uhl, C., and P. Murphy. 1981. A comparison of productivities and energy values between slash and burn agriculture and secondary succession in the upper Rió Negro region of the Amazon. *Agro-Ecosystems* 7: 63–83.

Vickers, W. T. 1988. Game depletion hypothesis of Amazonian adaptation: data from a native community. *Science* 239: 1521–1522.