THE ETHNOBOTANY OF THE AMAZON INDIANS AS A TOOL FOR THE CONSERVATION OF BIOLOGICAL DIVERSITY

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RESUMEN: En los últimos años las organizaciones conservacionistas han incrementado el uso de datos etnobotánicos. Se subraya la importancia de la preservación de las culturas indígenas en base al hecho de que la población de los Indios Amazónicos ha disminuido de 6 millones a 200.000 en los últimos 500 años desde que se inició la colonización. La contribución de la Etnobotánica a la conservación toca los tres aspectos de la biodiversidad: diversidad de especies, diversidad genética y diversidad de hábitats. La etnobotánica tradicional relativa a la catalogación de las especies utilizadas por las comunidades locales es un enfoque a nivel de especie. Se ha obtenido información más estructurada a partir de los recientes datos sobre la etnobotánica cuantitativa de algunas tribus amazónicas, y se ha mostrado hasta qué punto los Indios Amazónicos usan los árboles del bosque, por ejemplo, el 100% por hectárea en el caso de los Indios de Ka'apor. El estudio de un gran número de variedades de cada especie cultivada muestra que las comunidades locales utilizan una amplia gama de diversidad genética. Por ejemplo los indios Tukano reconocen 137 variedades de mandioca. Este mantenimiento y uso de la diversidad genética contrasta con la agricultura moderna que utiliza pocas variedades y es propensa a las enfermedades. Las comunidades locales son también perfectamente conscientes de las diferencias de hábitats y nombran diferentes tipos de vegetación que manejan de formas distintas. Esto incluye tanto los tipos de vegetación natural como los diferentes pasos en la sucesión que ellos crean en sus sistemas agroforestales. Se requieren más estudios sobre su clasificación ecológica porque pueden ser útiles tanto para la conservación como para los sistemas de uso sostenibles. Finalmente se presenta una leyenda india sobre el origen del cultivo Guaraná para enfatizar la importancia de este aspecto de la Etnobotánica. Cuando la cultura se pierde y las leyendas, mitos y tabúes desaparecen, los pueblos indígenas dejan de ser buenos gestores de su tierra y la conservación desaparece. Parte de la Etnobotánica contemporánea incluye la promoción y preservación de la cultura local.
PALABRAS CLAVE: Etnobotánica, Amazonia, indios amazónicos, biodiversidad.

SUMMARY: In recent years greater use of ethnobotanical data has been made by conservation organisations. The importance of the preservation of indigenous cultures is also stressed in light of the fact that the population size of Amazonian Indians has fallen from over 6 millon to 200.000 in the last 500 years since colonisation began. The contribution of ethnobotany to conservation touches on all three aspects of biodiversity, species diversity, genetic diversity and habitat diversity. Traditional ethnobotany involved with the cataloguing of species used by local peoples is a species based approach. Recent data on quantitative ethnobotany from several Amazonian tribes has provided more structured data and has shown the enormous extent to which Amazonian Indians use the forest trees, for example, one hundred per cent of the trees on a hectare in the case of the Ka'apor Indians. The study of the huge number of varieties of each cultivated crop shows that the local people use a wide range of genetic diversity. For example the Tukano Indians recognise 137 named varieties of cassava. This maintenance and use of genetic diversity contrasts with modern agriculture that uses few varieties and is disease prone. Local peoples are also acutely aware of habitat different ways. This includes both natural vegetation types and different steps in the succession which they create in their agroforestry systems. There is a great need for further study of their ecological classification because it can be useful to both conservation and sustainable systems of use. Finally an Indian legend about the origin of the crop Guaraná us given to emphasise the importaance of

this aspect of ethnobotany. When culture is lost and legends, myths and taboos die out the indigenous peoples are no longer good managers of their land and conservation breaks down. Part of contemporary ethnobotany involves the encouragement and preservation of local culture.
KEY WORDS: Ethnobotany, Amazonia, Amazonian indians, biodiversity.

INTRODUCTION

It is no coincidence that various international conservation organisations are increasingly becoming interested in and also are supporting the science of ethnobotany. For example, the World-wide Fund for Nature (WWF) is currently preparing a manual of ethnobotany and it has funded several ethnobotanical research projects around the world. Ethnobotany is a most valuable source of information for conservation in many different ways. However, as we link ethnobotany with the conservation of biological species and natural ecosystems we must not forget about the conservation of the source of our ethnobotanical information, the local peoples of the world. The extinction of culture is occurring much more rapidly and is better documented than the extinction of species. I hope that the combination of conservation thinking and ethnobotany will also lead to a greater emphasis on cultural preservation. The loss of and acculturation of tribal peoples places a great urgency on ethnobotany today. While we must try to salvage with considerable urgency as much of the information as possible from local peoples, I hope that we will also use our information to preserve and to benefit the local peoples with whom we work. The link between ethnobotany and conservation is important anywhere in the world that there are indigenous or local people that have unstudied information about the uses of and ecology of plants.

However in this paper I will draw largely from the Amazon region where I have the most experience. The growing practical use of ethnobotany for conservation is leading to a more scientific approach to the subject which is essential if we are to provide useful data.

Biodiversity is a term that is now known far beyond the laboratories of professional biologists and was a topic of world-wide debate during the recent United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Biodiversity is a useful concept because it is a concept that combines the totality of biological information that we should be seeking to conserve: that is ecosystem diversity, species diversity and genetic diversity.

Ethnobotany of today, if it is to serve conservation, should also be examining all three aspects of biodiversity and so this paper is framed mainly around biodiversity with a little about other aspects at the end.

SPECIES DIVERSITY

Much of the earlier work by ethnobotanists has been in the collection and identification of the species used by local peoples, especially when the work has been carried out by botanists rather than anthropologists. As a result we now have a great deal of knowledge about which plants of Amazonia are used by the local people. Table 1 is a typical listing of this sort for some of the plants used by the Karitiana Indians. It is used here as an example because these data have not yet been published elsewhere and so draws attention to some interesting uses of plants. The pioneer work of ethnobotanist Richard E. Schultes over many years has produced an extensive catalogue of the medicinal plants of the north-western part of Amazonia. SCHULTES & RAFFAUF (1990) describes 1516 medicinal and toxic species in a work that

is much more than a catalogue because it is the collaboration between an ethnobotanist and a chemist demonstrating the interdisciplinary nature of ethnobotany. However, many other ethnobotanists have produced species lists with use and very little extra information.

The more recent studies of quantitative ethnobotany attempt to systematise these sorts of data (PRANCE & al. 1987). From the earlier studies it was obvious that the Amazonian Indians use a lot of plant species and this was often quoted in the case for conservation by conservationists, but nowhere was there any quantitative data to show exactly how much the forest Indians depended upon forest products. Each study inventoried a hectare of forest near to an Indian village. This involved the collection and identification of every tree of 10 cm diameter or more on the sample plot. Following this various Indian informants were shown the trees or the specimens from the trees and the uses were recorded. The first such study was carried out by BOOM (1985a, 1985b, 1987, 1989) with the Chácobo Indians of Bolivia and it showed that they have uses for 75 of the 91 species (82 per cent). This included 95 per cent of the individual trees (619 out of 649). A second study of the Ka'apor Indians of Maranhao, Brazil (BALÉE, 1986) found that they had a use for every single species of tree in the sample hectare.

The uses included food, fibres, construction and craft materials, fuel, medicines and the

Prance Voucher N°	Species	Family	Karit.	Name Use
21.263	*Piper consanguineum* Kunth	Piperaceae	Ngo*-Peke-tek	Leaf tea brewed to aid female fertility
21.268	*Piper piresii* Juncker	Piperaceae	Ngopo-idn	Leaf tea used to aid female fertility
21.274	*Piper attonoides* Yuncker	Piperaceae	Mbi-ki-ap	Chewed roots used as cure for toothache; Leat tea used for stomach upsets
21.265	*Serjania paucidentata* DC.	Sapindaceae	Tin	Leaves used as a fish poison
21.266	*Tanaecium nocturum* (Barb. Rodr.) Bur. & K. Schum.	Bignoniaceae	Samedu-ap Pum-ap	Leaf tea used as treatment for diarrea mixed with leave of 21277
21.277	Leguminosae	Leguminosae	Nin-tigumu	Leaves mixed with 21266 tocure diarrea
21.271	*Mabea* sp.	Euphorbiaceae	Ngo-piki-korop	Women chew leaves to reduce menstrual flow
21.272	*Hirtella racemosa* Lam.	Chrysobalanaceae	Moroya-nyon-pisugnu	Leaves rubbed on legs to repel snakes
21.276	*Salacia apacifolia* (Macbr.) A.C. Smith	Celastraceae	Ngo-pu-hok	Mashed leaves used as a bath to ward off evil spiritis.
21.279	*Swartzia arborescens* (Aubl.) Pitt.	Leguminosae	Hi-op	Leaves used to kill pain or as a tea mixed with other leaves to insure future health of children
21.280	*Sciadotenia brachypoda* Diels	Menisppermaceae	Mbo-tut	Leaves mashed in water and rubbed on swellings
21.283	*Ischnosiphon* cf. *martianus* Eichl.	Marantaceae	Ngo-pa-toma	Mashed leaves used to reduce fever in children.
21.285	*Sorocea muriculata* Miq. in Mart.	Moraceeae	Ngo-gura	Mixed with 21278, 21279, 21288, 21290, 21295 21296 when a child dies to conceive again.
21.278	*Micropholis madeirensis* (Baehni) Aubrév.	Sapotaceae	Pupi-kuku-ap	Leaves mixed with 21285 for conception
21288	*Micropholis venulosa* (Mart. & Eichl.) Piérre	Sapotaceae	Ngo-pi-huka-ap	Leaves mixed with other leaves to conceive again, see 21285
21293				Tea used for headache
21.296	*Clarisia racemosa* Ruiz & Pavoz	Moraceae	Epe-se	Leaves mixed with other leaves to conceive again, see 21285
21.299	*Symphonia globulifera* L.f.	Guttiferae	oku-it	Leaf tea used to cause children to grow
21.298	*Smillax* sp.	Smilaceae	Ngo-piki	Leaf tea used as a female contraceptive
21.310	*Anthurium* sp.	Araceae	Ngo-piki-horop	Tea from tuber-like roots used as a female contraceptive
21.311	*Pleonotoma* aff. *orientalis* Sandw.	Bignoniaceae		Used to reduce swellings

TABLE 1: Some plants used by the Karitiana Indians of Rondônia State, Brazil. * Ngo is the Haritiana word for forest.

two products which they already commercialise, rubber latex and Brazil nuts. BOOM (1990) also studied the Panare Indians at Corozal near Manupure in the Venezuelan Amazon. This tribe had uses for 56 per cent of the species in the sample hectare. The full data for these studies are given in the original papers cited above and were summarised in PRANCE & al. (1987). These and other subsequent studies of quantitative ethnobotany (e.g. Alexiades, in prep., Milton in prep.) have shown unequivocally that these native peoples depend heavily upon the forest species. If one relies to that extent upon the rainforest trees it is not in one's interest to destroy all the forest for agriculture. Many of the forest Indians live by making small clearings for their swidden agriculture and on extraction and hunting from the forest. These studies are also useful because they produce a more complete record of the forest products that are used and have been useful to justify extractive forest reserves (ALLEGRETTI, 1990; SCHWARTZMAN, 1989). There are still many traditional uses of plants by local peoples that have not yet been recorded and so which ethnobotany is now involved in many new techniques we should not forget to catalogue all uses of plants that we encounter.

GENETIC DIVERSITY

One of the strengths of indigenous agriculture is the number of varieties of any crop which they use. Every tribe I have visited in Amazonia has a large number of varieties of cassava *(Manihot esculenta* Krantz). For example, on a short trip to the Jarawara Indians on the Purus river we collected 22 named varieties. The record must be the Tukano Indians of the upper Rio Negro where CHERNELA (1986) recorded 137 varieties of cassava. BOSTER (1984) recorded 50 named varieties of cassava among the Aguaruna Indians of Peru. The Jarawara Indians when questioned about these varieties gave three main reasons for planting different varieties. Firstly different varieties mature at different times from planting. This will give a harvest over an extended period. Secondly different varieties are better for the differentend products. Some varieties make better farinha flour, others are better for tapioca and others make better cassava beer. Thirdly local ecology is taken into consideration and some grow better on one soil type or with greater shade than others.

This use of many varieties is not confined to their staple agricultural crop, and they often have named varieties of fruit trees. For example, there are several varieties of umari (*Poraqueiba sericea* Tul.) used by the Bora Indians of Peru. One of the best examples of genetic diversity is to visit an Andean potato market where there is always and abundance of both species and varieties of potatoes (see BRUSH & al. 1981).

The use of numerous varieties means that these indigenous crops have a broad genetic basis which is in marked contrast to the products of modern agriculture where plant breeders are interested in quantity but not in genetic diversity. The result is that our modern crops are easily susceptible to disease. The indigenous systems are much better protected from disease because of the amount of genetic diversity which they use. They act as a much better example about the importance of this aspect of biodiversity. Although KERR & CLEMENT (1980) drew attention to the importance of the genetic diversity of indigenous crops in Amazonia there is still very little work being carried out on this aspect of ethnobotany by botanists who document properly and collect living and herbarium samples of cultivated varieties. This is an area where there is room for considerably more research. KERR & CLEMENT describes the cultivated varieties of several crops including *Dioscorea* for which the Desâna have eight cultivars and also for sweet potato (*Ipomoea batatatas* Lam.) and several fruit trees such as

abiu (*Pouteria caimito* (Ruiz & Pavon) Radlk.). The Desâna also have 40 cultivars of cassava.

ECOSYSTEM DIVERSITY

The indigenous peoples of Amazonia classify many different types of vegetation and they also create a succession of vegetation types through their agriculture systems. The study of the ecology of Amazonian Indians is another promising field that is of vital concern for conservation because it can give many useful hints about sustainable management of the region. Many Indian agroforestry systems, in marked contrast to development projects and cattle pastures, produce a reasonable yield over a sustained period of time.

The ethnoecology of only two groups of Amazonian Indians have been well studied, the Kayapó and the Bora. A detailed study of the agroforestry methods of the Bora Indians of Loreto Department in Peru was carried out by William Denevan and Christine Padoch, together with an interdisciplinary team (DENEVAN & PADOCH, 1988; DENEVAN & al. 1984, 1985). They studied a series of former fields from three to nineteen years old. These fields were in different stages of regeneration after the initial stages of regeneration, and all stages were yielding useful products. The success of their methods is based on felling comparatively small areas each year with forest nearby and, after an initial crop of cassava or some other herbaceous crop, creating a system that is close to a natural succession using a diversity of colonising light-demanding species such as the fruit tree *Pourouma cecropiifolia* Mart. in the first stages. The nineteen year old forest still contained a small orchard of macambo (*Theobroma bicolor* Humb. & Bonpl.) with edible seeds and 22 other useful species. Their method gradually transforms a field into an extraction forest. This system has already been transferred into various peasant villages in the upper Amazon and some of these have been studied and shown to yield well and to be profitable in a market economy, especially the villages of Tamshiyacu and Santa Rosa (see PADOCH & DE JONG, 1989; PADOCH & al., 1985; PADOCH, 1990). This emphasises the need to study the ethnoecology of the campesiños and caboclos as well as the indigenous peoples. The campesiños have adopted many practices of the indigenous peoples, but have also had to contend with more marketing and trading of their products. While many of their systems are not as elegant as those of the Indians, there is much to learn from both their successes and mistakes and this area has been much neglected until recently by ethnobotanists.

One of the best studies of local perception of ecological zones is that of FRECHIONE & al. (1979) who studied caboclo use of natural resources in the vicinity of lake Coari in Amazonas, Brazil. They found that the caboclo recognised 40 different resource units. This is a study that anyone embarking on ethnoecology should read because it shows how aware local people are of their environment and all the different niches which it offers.

Another good example of an ethnoecological study of indigenous agricultural systems is the Kayapó Indians of Pará, Brazil (POSEY 1982, 1983, 1984, 1985; HECHT & POSEY, 1979). The Kayapó have many different terms for both the natural vegetation types and their own man-made vegetation. Their agroforestry system is successful in the poor soils of the terra firme forest which are carefully managed (HECHT & POSEY, 1979). They have many other interesting management practices. For example, they plant trees and herbs along their trails through the forest. To the uninitiated the forest looks natural, but in fact the trailside is a carefully managed ecosystem with plantings to provide the necessities of life to those that use the trail. These plantings include food plants, medicinal plants and other useful species. In these plantings they have made use of shade tolerant species that grow well under the natural

forest canopy. This is an example that could be followed more by sustainable development projects. The Kayapó also use the natural light gaps in the forest to plant crops. They use a wide range of crops such as cassava, taro, yams, beans and cupa (*Cissus gongylodes* Burch ex Baker) in these light gaps that are either natural tree falls or where they have cut down a tree to collect the fruits.

One of the most interesting aspects of Kayapó ecology is their management of savanna or cerrado vegetation. Many of the clumps of forest within the cerrado vegetation in their territory are man-made *apêtês* as they are culled. ANDERSON & POSEY (1989) listed 1 20 useful species in the apêtês around the village of Gorotire. These forest islands are made gradually from a small beginning using termite nests, leaf litter and other organic matter in carefully selected sites that retain water. The initial plantings are carefully protected and then the size of the island is increased with more and more useful species of medicinal plants, game attractants, foods, firewoods and many other uses. The apêtê were historically useful in times of war when they provided shelter and supplies as well as strategic sites for ambushing enemies. Further details of the fascinating apêtê system are given in ANDERSON & POSEY (1984; 1985) & POSEY (1984b).

The Indian systems of management describes above show that their methods are based on diversity of species rather than on monoculture. Their use of species diversity, habitat diversity and of genetic diversity means that their systems are entirely different from current development strategies where uniformity is the rule. The Indian methods follow much more closely the natural vegetation and also serve to retain the nutrients in the system and so they thrive in this region of poor soil. For a summary of indigenous agroforestry strategies see ALCORN (1990). If we are looking for sustainable development we need to expand our studies of indigenous ethnoecology using a multidisciplinary approach that brings understanding of all the details.

THE VALUE OF FOLKLORE

An aspect of ethnobotany that is important for application to conservation is that of the myths and legends of the Indian tribes. The legends give a species value to many plants and animals in the forest and so they are keen to protect rather than destroy these plants. The taboos which they have also aid conservation. It is useful to collect and to respect these legends. Two examples of such plant legends are given below.

A legend of the Mundurucu Indians tells of an old man who lived with his daughter beside a small stream. His daughter Ruda was beautiful and had taken good care of her father since her mother died. They lived alone, far from the rest of the tribe, because the man was afraid that his daughter might become pregnant. One day, the father noticed that Ruda was very sad, and he was furious when he discovered that his worst fear had come true: Ruda was pregnant. In his rage he wished to kill her because it was so shameful. As he was planning how to kill his daughter, a white man came along and persuaded him to let Ruda have her baby because it was the dolphin that had made her pregnant. The white man was the god Tupa in disguise. The Indian belief or excuse for an unexplainable pregnancy which blames the dolphin has passed into rural Amazonian society. Caboclos often tell how the dolphin dons a top hat to cover his blow-hole, disguises himself as a human and appears at a party and seduces the young girls Many Amazonian parents still blame the dolphin for children which are born out of wedlock.

Several months later, a lovely baby girl was born and Ruda called her Mani. She was talking from the day she was born and was helping her

mother with the work by the time she was six months old. She brought great joy to the Mundurucus and the whole tribe would bring her presents. However, Mani was a spirit child and did not belong on earth, and after a year she died and returned to the sky.

The birds stopped singing, the water lily flowers withered, and there was great mourning. Ruda buried Mani in front of her house and planted a beautiful garden around her. However, a strange plant came up in the middle which the Mundurucu had never seen before. It had a large white root, just like Mani's body, and so the Indians called it 'Manioca', or house of Mani's body. Many Amazonians still believe today that if a child is very precocious or learns to speak too soon, it will die young.

Guaraná is one of the most popular Amazonian beverages today. This caffeine-rich soda drink, made from the seed of the guaraná plant (*Paullinia cupana*), is the coca-cola of Brazil. Long before it was turned into an item of commerce, the Maué Indians used to roast the seeds, grind them into a powder and mix the powder with water to make a drink before setting off for a day's hunting or work in the fields. With the stimulation of these seeds, they were not hungry and had enough energy to last through the day without food.

The black seed of guaraná is surrounded by a white pulp called the aril, which in turn is enclosed by a bright red outer shell. When this shell opens, the fruit has an eye-like appearance, which obviously gave rise to the Indian legend for guaraná. However, this attractive and conspicuous fruit evolved to capture the attention of birds, which eat the pulp and reject the seed but in the process disperse it round the forest.

Maué legend tells of a time when the tribe was going through many tribulations. They had lost much of their land in wars with neighbouring tribes. A wonder child was born to an elderly childless couple. The boy became the tribe's leader and helped them to defeat their enemies and to prosper. The evil gods were jealous of the good fortune of the Maué people and plotted to destroy this remarkable boy. One of the evil spirits, Jurupari, turned himself into a poisonous snake. The gods also caused a fruit tree to bear delicious fruits, and the snake waited in its branches. Eventually the boy hero climbed the tree, was bitten by the snake and fell down dead. There was great mourning throughout the tribe and their fortunes began to decline. However, Tupa, the good god, sent lightning to strike the child's mother but, before she died, he hold her not to despair as great good would come out of this apparent disaster. The mother was instructed to take the eyes of the child and plant them in a field. Out of the left eye came a new plant they had not seen before which they called guaraná, or the living eye, and out of the right eye, wild guaraná. The strength given by guaraná maintained their tribal superiority. The fact that the legend includes the wild guaraná, the many wild species of *Paullinia,* is significant. To maintain many crop plants the genetic material of the wild species is essential for properties such as disease resistance. It is essential to conserve the wild relatives of crop plants. The guaraná legend draws attention to an adds to the Indians' respect for the wild species.

Most of the plants which the Indians cultivate and some of the wild species have similar legends attached to them. The respect for plants and for nature is something that has often been lost in Western society. As we develop sustainable land-use systems in Amazonia and elsewhere they will succeed better if economic motives are not allowed to totally dominate and the sacred or spiritual is also recognised.

CONCLUSION

If there is to be a future for the great biological diversity of the Amazon rainforest it will

be based on achieving a reasonable balance between conservation and sustainable utilisation. This can only be reached if we have adequate knowledge of the ethnobotany and ethnoecology of the indigenous peoples who have lived in the forest for several millennia. It is unfortunate that ethnobotany is still such a minor component of the research interests of most universities, botanic gardens and other research centres. One of the compelling motives for the expansion of our science of ethnobotany is the role it can play in conservation and sustainable development.

REFERENCES

ALCORN, J.B. (1990). Indigenous agroforestry strategies meeting farmers' needs. In: A.B. ANDERSON (ed.). **Alternatives to deforestation.** pp. 141-151. Columbia University Press, New York.

ALLEGRETTI, M.N. (1990). Extractive reserves: an alternative for reconciling development and environmental conservation in Amazonia. In: A.B. ANDERSON (ed.). **Alternatives to Deforestation.** pp. 252-264. Columbia University Press, New York.

ANDERSON, A.B. & POSEY, D.A. (1984). Management of a tropical scrub savanna by the Gorotire Kayapá of Brazil. **Adv. Econ. Bot.** 7:159-173.

ANDERSON, A.B. & POSEY, D.A. (1985). Manejo de cerrado pelos índios Kayapó. **Bol. Mus. Paraense Emílio Goeldi,** Sér. Bot. 2(1):77-98.

BALÉE, W. (1986). Análise preliminar de inventario florestal e a etnobotânica Ka'apor (Maranhao). **Bol. Mus. Paraense Emílio Goeldi,** Sér. Bot. 2(2):141167.

BOOM, B.M. (1985a). Amazon Indians and the forest environment. **Nature** 314:324.

BOOM, B.M. (1985b). 'Advocacy botany' for the Neotropics. **Garden** 9(3):24-32.

BOOM, B.M. (1987). Ethnobotany of the Chácobo Indians, Beni, Bolivia. **Adv. Econ. Bot.** 5:1-68.

BOOM, B.M. (1989). Uses of plant resources by the Chácobo. **Adv. Econ. Bot.** 7:78-96.

BOOM, B.M. (1990). Useful plants of the Panare Indians of the Venezuelan Guayana. **Adv. Econ. Bot.** 8:57-76.

BOSTER, J.S. (1984). Classification, cultivation, and selection of Aguaruna cultivars of Manihot esculenta (Euphorbiaceae). **Adv. Econ. Bot.** 1:34-47.

BRUSH, S.B.; CARNEY, H.J. & HUAMÁN, Z. (198l). Dynamics of Andean potato agriculture. **Econ. Bot.** 35:70-88.

CHERNELA, J.M. (1986). Os cultivares de mandioca na área do Uaupés (Tukano). In: D. RIBEIRO (ed.). **Suma Etnológica Brasileira 1.** pp. 151-158. Etnobiologia, FINEP, Petropolis.

DENEVAN, W.M. & PADOCH, C. (1988). Swidden-fallow Agroforestry in the Peruvian Amazon. **Adv. Econ. Bot.** 5:1-107.

DENEVAN, W.M.; TREACY, J.M.; ALCORN, J.B.; PADOCH, C.; DENSLOW, J. & PAITAN, S.F. (1984). Indigenous agroforestry in the Peruvian Amazonian: Bora Indian management of swidden fallows. **Interciencia** 9:346-356.

DENEVAN, W.M.; TREACY, J.M.; ALCORN, J.B.; PADOCH, C.; DENSIOW, J. & PAITAN, S.F. (1985). Indigenous agroforestry in the Peruvian Amazon: Bora Indian management of swidden fallows. In: J. HEMMING (ed.). **Change in the Amazon Basin Vol. I: Man's impact on forests and rivers.** pp. 137-155. Manchester University Press.

FRECHIONE, J.; POSEY, D.A. & DA SILVA, L.F. (1979). The perception of ecological zones and natural resources in the Brazilian Amazon: an ethnoecology of Lake Coari. **Adv. Econ. Bot.** 7:260-282.

HECHT, S.B. & POSEY, D.A. (1979). Preliminary results on soil management techniques of the Kayapó Indians. **Adv. Econ. Bot.** 7:174-188.

KERR, W.E. & CLEMENT, C. (1980). Práticas de conseqüencias genéticas que possibilitaram aos índios de Amazônia uma melhor adaptaçao ás condiçoes ecológicas da regiâo. **Acta Amazonica** 10:251-261.

PADOCH, C. (1990). Santa Rosa: The impact of the forest products trade on an Amazonian place and population. Adv. Econ. Bot. 8:151-158.

PADOCH, C.; CHOTA LNUMA, J.; DE JONG, W. & UNRUH, J. (1985). Amazonian agroforestry: a market-oriented system in Peru. **Agroforestry Systems** 3:47-58.

PADOCH, C. & DE JONG, W. (1989). Production and profit in agroforestry: An example from the Peruvian Amazon. In: J.O. BROWDER (ed.). Fragile Lands of Latin America, pp. 102-112 Westview Press, Boulder, Colorado.

POSEY, D.A. (1982). The keepers of the forest. **Garden** 6(1):18-24.

POSEY, D.A. (1983). Indigenous ecological knowledge and development of the Amazon. In: E. MORAN (ed.) **Dilemma of Amazon development.** Westview Press. Boulder.

POSEY, D.A. (1984a). A preliminary report on secondary forest management by the Kayapó Indians of the Brazilian Amazon. In: G.T. PRANCE & J. KALLUNKI, (eds., Ethnobotany in the Neotropics. **Adv. Econ. Bot.** 1:112-126.

POSEY, D.A. (1984b). Keepers of the campo. **Garden** 8(6):8-12,32.

POSEY, D.A. (1 985). Native and indigenous guidelines for new Amazonian development strategies: understanding bioiogical diversity through ethnoecology. In: J. HEMMING (ed.). **Change in the Amazon Basin Vol I: Man's impact on forests and rivers.** pp. 156-181. Manchester University Press.

PRANCE, G.T.; BALÉE, W.; BOOM, B.M. & CARNEIRO, R.L. (1987). Quantitative ethnobotany and the case for conservation in Amazonia. **Conservation Biol.** 1:296-310.

SCHULTES, R.E. & RAFFAUF, R.F. (1990). **The healing forest: medicinal and toxic plants of the Northwest Amazonia.** Dioscorides Press, Portiand.

SCHWARTZMAN, S. (1989). Extractive reserves: the rubber tapper's strategy for sustainable use of the Amazonian rain forest. In: J.O. BROWDER (ed.). **Fragile Lands of Latin America: Strategies for Sustainable Development.** pp. 150-165. Westview Press, Boulder,.