ETHNOBIOLOGY, PHILOSOPHY AND METHODOLOGY: AN INTRODUCTION

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Introduction

Ethnobiology is essentially the study of beliefs about and knowledge of biology by any society, i.e., the role of nature in belief systems and human adaptation. Thus ethnobiology is closely related to human ecology, but with emphasis upon the cognitive categories and concepts used by the people under study.

Indigenous knowledge does not fit into neatly defined categories and sub-fields as Western science attempts to organize itself artificially. Rather, folk knowledge is an interwoven matrix of plants, animals, energies, rituals, spirits, ceremonies, myth, hunting, gathering, gardening, singing, and dancing. Thus ceremonial cycles that include specific rituals requiring certain sacred plants and animals used while singing and dancing to create necessary spiritual energies to insure good crops and hunts may be ordered through mythological sequences. This interrelatedness of the "natural and social worlds" necessitates an interrelated, interdisciplinary (as well as cross-cultural) approach to the study of different cultures: ethnobiology provides that interrelatedness.

Ethnobiological methodology begins by investigating indigenous concepts and relationships between and within cognitive categories. Patterns of naming and classification (typologies and taxonomies) provide discovery principles for indigenous logic and linkages between concepts. Elaboration of sub-categories in itself serves as an internal (emic) guide to cultural systems, providing an index of cultural significance. Likewise, superordinate categories or higher level hierarchical relationships in any taxonomic system may be indicators of symbolic significance.

Once indigenous categories of natural phenomena are discovered, scientific specialists can begin to gather data consistent with their respective sub-fields (eg., ethnoentomology, ethnobotany, ethnozoology, ethno-parmacology ethnopedology, ethnogeology, ethnoapiculture, etc.). Not all beliefs about and knowledge of natural phenomena by the culture under investigation are going to coincide with Western science, but all data must be carefully recorded regardless of belief or disbelief by the scientific specialist. Some indigenous concepts may generate new ideas for testing (hypothesis generation); some ideas may be unanalyzable and simply archived; some beliefs may appear to be illogical nonsense, but eventually be shown to be social mechanisms for the regulation of food supplies

020 Los Ensayistas : Summer, 1985

or maintenance of ecological balance (i.e., food taboos and mythological animals, cf. Ross, 1978; Smith, 1984). Methodologically one can never disregard anything that appears to be contradictory or nonsense: contradiction and anomaly are two of the major cultural guides for ethnobiologists and must be investigated to the fullest extent possible. In this way, ethnobiology differs from biology: science tends to treat such phenomena as being statistically insignificant data, whereas ethnobiologists must treat contradiction and anomaly as central to the development of research models.

In addition to these theoretical considerations, there is much practical information that can be gathered while investigating folk concepts and systems of classification. Knowledge regarding ecological zonation, natural resource distribution, biological heterogeneity, and integrated plant and animal management are but a few practical categories of knowledge proven profitable for scientific investigation (cf. Posey, 1983a, b, 1984; Parker et al, 1983). This paper deals principally with such categories, drawing examples from a variety of Amazonian societies.

It is important to emphasize, however, that ethnobiology is not only a methodology, but also a philosophy. The underlying principle of the philosophy is to provide a cultural bridge of understanding between diverse cultures. As such, ethnobiology can mediate between different logical and scientific systems to provide new ideas about and greater support for ecologically and socially responsible change.

To be more specific, ethnobiological research can provide the data necessary to argue forcefully for the protection of indigenous peoples and their lands in order to preserve these societies and their knowledge that form a valuable human resource for the world as a whole.

Following are suggested main categories for ethnobiological research, with examples to illustrate types of information available through the investigation of each category:

1. <u>Ethnotaxonomy and Emic Methodology</u>

Pionerring work by Conklin (1954) began to relate cultural beliefs with classification of the natural world as perceived by non-Western societies. Berlin (1972, 1976) and Berlin et al (1966, 1973) outlined the basic principles of folk taxonomic systems and proposed a hierarchical model that corresponds closely to Linnean scientific classification, itself firmly rooted in European folk taxonomies. Basic differences between Western scientific and folk taxonomies seem to be (a) that folk taxonomies are "flat" (i.e., have many folk "genera," but few higher, superordinate classification levels that characterize the hierarchcal Linnean system); and (b) that many intermediate

levels (superordinate and subordinate) of classification in folk systems are implicit and unnamed (i.e., "covert," cf. Berlin et al, 1968). Yet given these peculiarities, folk taxonomies still show a high degree of correlation with Western concepts of genus and species (Hunn, 1975, 1976).

Hays (1982) and Hunn (1982) have attacked the traditional bias toward the "hierarchical" model and proposed a more "utilitarian" model to describe folk classification systems. This utilitarian approach seems to facilitate data generation, while minimizing the imposition of paradigms of category and hierarchy implicit in Berlin's model. Problems of set overlap and superimposed, alternative classification systems are also solved, since utility of a species can coincide with behavior-based classification, being united by the utility of the species in question. Perhaps even more importantly, the practical component of the species to the culture under investigation gives a much more reasonable strategy of correlating classification data with observable social phenomena substantiated by ethnographic and ethnobiological data.

One of the principal purposes of ethnotaxonomic studies is to investigate the universality of human classification capacities. The thrust for such studies in ethnoscience is attributed to Lévi-Strauss (1966). Berlin and Kay (1969) tackled the difficult domain of color terms in relation to human perceptual capacities, which led to interesting studies of "salience" (Dougherty, 1978), "cognitive processes" (Hunn, 1975), and "natural discontinuities" (Hunn, 1977), i.e., the universal psychological and physiological predisposition for human classification. Search for universals continues with the studies of patterns of universal "growth" of ethnobiological nomenclature (Berlin, 1972) and sequence of life-form recognition (Brown, 1977, 1979).

These theoretical issues have important implications for the practical nature of field investigation. Posey (1981, 1983d) has shown that the degree of differentiation within a certain cognitive category of a folk taxonomic system can serve as an indicator of cultural significance and provide an <u>emic</u> guide to further investigation. Furthermore, higher-level (superordinate) named categories seem to be indicators of symbolic importance of the species in question (Posey, 1984a).

This is illustrated by the following example taken from the Kayapó classification of insects. Insects are classified with other animals with shells but no flesh (cf. Posey, 1983c). To date 14 morphologically based groups of insects have been discovered, all considered Basic Object Level (BOL) categories, i.e., distinguished principally upon the recognition of "natural discontinuities" in morphological form, cf. Hunn, 1977; Dougherty, 1978; Posey, 1983d). Of these 14 BOL categories, only three show significant further differentiation of sub-categorization, all of which are social insects (ants, wasps, bees). Thus it can be predicted that social insects are of greater significance in the Kayapó culture than other insects. In fact, they provide some sources of food and useful products (especially bees, cf. Posey, 1983e, g), but are most important for their epistomological significance: the Kayapó believe their social organization was patterned after the studies of social insects by an ancient shaman (cf. Posey, 1983f).

In addition to the subordinate differentiation of ant, bee, and wasp BOL categories, all social insects, including termites, are classified under the only named superordinate category found for insects. This "superordinate" label (ñy, (nhy) seems to be an indicator of the symbolic significance of social insects. In fact, wasp nests are the symbolic "natural models" for the Kayapó universe; ants are seen as man's counterparts and are sources of powerful hunting magic; bees hunt, pillage and raid like Indians; and termites are the weaker human forces associated with non-Indians (see Posey, 1983d; Camargo and Posey, 1984). These symbolic relationships are encoded in the famed Kayapó "fight with the wasps".

From this example a hypothetical methodological model can be proposed relating named ethnotaxonomic categories with cultural salience. The principles are:

1. subordinate category differentiation is an index to cultural (utilitarian) significance: the more extenxive the sub-categorization, the more significant the species.
2. superordinate categories that are named are indicative of symbolic significance and can be predicted to figure importantly in myth and ritual.
3. either of these indicators (subordinate or superordinate differentiation) can be used as internal (emic) guides to cultural systems, i.e., offer folk categories for further investigation.

This model deals only with named (labeled) categories and ignores "covert" (unnamed) categories. It is therefore not intended to be adequate for the thorough investigation of any cultural system, but rather to serve as an emic generative methodology for cultural investigation that follows indigenous markers rather than presumed structural rules.

2. Ecological Zones and Resource Units

A great obstacle to the Western understanding of tropical areas has been the tendency to generalize about ecology and ignore highly variable "ecological zones" (Moran, 1981). The Kayapó Indians see their environment in an expanded series of "ecozones." The term "ecozone" is

used to indicate an ecological zone recognized in other cultural systems (i.e., an emic cognitive category) that may or may not coincide with scientific typologies.

Kayapó village sites are purposefully selected to be near a variety of these ecozones. The distinct advantage is that Kayapó villages are in the midst of maximum species diversity because each zone provides natural products and attracts different game species during different seasons (Bamberger, 1967; Posey, 1983a). Location of the Kayapó village of Gorotire and the surrounding diversity of ecological zones is represented in Figure 1.

Each ecological zone has associated with it specific plants and animals. The Kayapó have a well-developed knowledge of animal behavior and know which plants are associated with particular animals. In turn, plant types are associated with soil types. Each ecological zone, therefore, is an integrated system of interactions between plants, animals, the earth--and, of course, the Kayapó.

Concentrations of specific resources characterize certain ecological zones for the Kayapó. These concentrations perceptually reduce the heterogeneity of the forest to known "resource islands" that can be periodically exploited for specific products and purposes. Figure 2 is modified from a map drawn by a Kayapó informant and indicates "resource islands" along a trail connecting the village of Kubenkrakêin and the abandoned site of Pykatôti.

Indians and caboclos also classify their ecological world by vertical levels. Figure 3 shows a representative sample of ten vertical levels recognized by Indians and caboclos. These idealized folk units are divided into terrestrial/arboreal levels (T 1-5) and aquatic levels (A 1-5):

a. Terrestrial/Arboreal Levels:

T - 1: area below ground level, where most burrowing animals and large roots/tuber are found.

T - 2: ground level to approximately 20 cms. below, where organic matter is concentrated and the plant/animal communities associated with the superficial root zone are located.

T - 3: understory (one to ten meters above ground), which predominates in capoeira or "open forest." This is the area of smaller trees and shrubs and is attractive to many birds and mammals; when this zone exists, hunting is good.

T - 4: middle canopy (seven to 15 meters above ground), which occurs in most mature forests and is the principal zone for arboreal mammals and large birds (eg., macaw, parrots, etc.).

T - 5: high canopy (15+ meters above ground), which characterizes the terra firme high forest. This is known to have arboreal mammals and birds, but hunting them is difficult because of the height. Forests with T-5 zones are more useful for their forest products, including castanha (nuts) and hone.

b. Aquatic Levels:

A - 1: surface level (zero to one meter below surface), where water-surfaces insects and top-feeding fish, as well as water snakes, are found.

A - 2: upper level (one to four meters below surface), where the most number of fish and eels can be caught.

A - 3: middle level (four to ten meters) is less productive, but hosts some fish species.

A - 4: lower level (various depths from A-3 to bottom) is the least productive zone.

A - 5: river (lake) bottom, which is rich in bottom-feeding fish and sting-ray species.

Classification of vertical microenvironmental levels has as its basis a functional component: where to find certain natural resources. Each aquatic level, for example, is noted for certain species of fish, turtles, snakes or aquatic plants. Likewise, each terrestrial/arboreal level has varying concentrations of mammal, bird, and insect rescources. There are also "transitional corridors" which are relatively open spaces between terrestrial/arboreal levels and are the spaces most useful for searching for animal movement. These are perhaps best thought of as vertical hunting zones (cf. Posey, Frechione, and da Silva, 1984).

Folk knowledge of ecological relationships within and between natural categories extends far beyond those mentioned herein. This evidence, however, is sufficient to substantiate the intricacy of information available from folk and indigenous sources about ecological zones and natural resource distribution.

3. Biological Heterogeneity and Resource Management

No people are more cognizant of biological diversity and resultant natural resource potential than are indigenous groups. Take, for example, the following areas of ethnobiological knowledge:

a. Gathered Products

Gathering refers to procurement of wild plants, animals and animal products, and various inert elements for food, materials or medicines. The array of wild plants collected by Amazonian Indians is known to be extensive, but

taxonomic, pharmacological, and nutritional data remain scanty. A limited number of wild food sources has been described in detail (eg., Cavalcante, 1972, 1974).

Gathered plants are used for cordage, thatch, oils, waxes, fuels, ointments, tools, ornaments, perfumes, timber, pigments, dyes, bums, resins, and fibers, to name a few (eg., Verdoorn, 1945; Steward, 1948; Prance et al, 1977). Many plants also have medicinal value (cf. Kreig, 1964; Poblete 1969), but ethnopharmacology is a regrettably underemphasized field of research. Table 1 lists some representative plants gathered by Amazonin Indians and the uses of these plants (see also Fidalgo and Prance, 1976); Prance et al, 1977).

Insects are another major gathered product (Ruddle, 1973). Entomophagy, insect eating, is widely reported (cf. Smole, 1976:163-167); Beckerman, 1979:538-539; Posey, 1980) but not systematically studied in the Amazon. However, substantial evidence now documents the importance of bees (Apidae) and bee products (resin, wax, honey, pollen) to indigenous groups (see Posey, 1981, 1982b).

The initial developmental value of indigenous and folk knowledge concerning gathered products is likely to be based in the identification of products having pharmacological and industrial applications within the Western system (Elisabetsky and Posey, 1984). Indigenous knowledge of wild plants has already made significant contributions to modern pharmacology (see, for example, Kreig, 1964). Generally, indigenous peoples have not benefitted from this application of their knowledge. An equitable system of remuneration is required if this type of development is to be successful both economically and ethnically.

Gathering could also be part of an integrated development plan with the collection and marketing of already important wild forest products (eg., Brazil-nuts and rubber) taking place during the appropriate season. When given the opportunity, Amazonian Indians have proved themselves quite capable of successfully directing such enterprises. For example, the Gavioes of Central Brazil now profitably collect and market Brazil-nuts in their area. This is due in large part to their having taken control over the production, transport, and marketing of their products (Ramos, 1980). In this case, it is important to note that in some areas of Amazonia a dense stand of Brazil-nut trees "...generates more revenue than an equivalent area of pasture" (Bunker, 1981:56) devoted to cattle herding.

Indigenous ethnoentomological knowledge is being utilized by a group of Sanema (Yanomamo) Indians who have established bee hives with plans to market the honey (UMAV, 1982, personal communication).

Some potentially valuable wild plants may also be suitable for more controlled production. For instance, Calathea lutea, a tall herb that grows wild in swamps in the Amazon Basin produces a wax similar to carnauba. This plant is easy to cultivate and harvest, and could provide jobs and income while exploiting otherwise unusable swampy areas in the region (NAS, 1975:137-140).

These brief examples indicate that indigenous knowledge of gathered products has potential for inclusion in development planning.

b. Game

Indians hunt many forms of mammals and birds (see Table 2 for an example of game species hunted by the Yekuana). The Jivaro have knowledge of the significant details of animal behavior, including cries and calls, preferred foods, types of excrement, scents, teeth marks on fruit, etc. (McDonald, 1977; Ross, 1978). According to Hames (1979): 7-8, 20), some Yekuana and Yanomamo alternate hunting activities among a number of hunting zones to benefit from the increased fauna produced by an "edge effect" linked to numerous overlapping biotopes of the hunting zones. Reichel-Dolmatoff (1978:286) states that Desana shamans continually inventory resources and game to channel group exploitative activity. These represent indigenous attempts at resource management.

Game animals are efficient in the use of available food, with high protein-to-fat ratios and resistance to diseases (Sternberg, 1973; Surujbally, 1977; de Voss, 1977). Some game animals could potentially be cropped in a form of "semi-domestication" in abandoned garden sites (see section on Natural and Human-Made Resource Units below) or in an integrated management system combining the animals with plantations of fruit-bearing trees favored by the animals and to which they are attracted (Smith, 1977). This "game farm" strategy has been suggested as a viable system for sustained Amazon development (Goodland and Bookman, 1977; Smith, 1977; Goodland, Irwin, and Tillman, 1978; Vasey, 1979).

The immediate application of game farming would be to improve the subsistence methods and diets of small farmers (Goodland, 1980:17). It is also important to note that some small mammals, such as the agouti (Dasyprocta sp.) and capybara (Hydrocherus hydrochaeris), and birds, like the currasow, might be susceptible to "semi-domestication" in enclosed areas (fences, abandoned garden sites or areas adjacent to household gardens) for significant surplus production and sale.

c. Aquaculture

One of the most promising strategies of aboriginal resource utilization with potential for large-scale development is aquaculture, or systems of water resource management (Goodland, 1980:14). Indigenous populations in

Amazônia make use of numerous species of fish, reptiles, and water mammals, as well as some forms of riverine and lacustrine vegetation.

Amazônia contains the most diverse freshwater fish fauna in the world (Smith, 1981:18). Fish provide substantial portions of protein for most indigenous groups (Sternberg, 1973; Ross, 1978). Fish also have high qualities of essential amino acids (Bell and Canterbury, 1976) and are superior to meat animals in terms of feed/protein conversion ratios as illustrated in table 3.

During the past two decades, commercial fishing in Amazônia has become a profitable industry. However, little is actually known of the life cycles of even the most important commercial fish species (Smith, 1981:121), although research with the Kayapó has shown the Indians knowledgeable about irrigation and mating patterns of a large inventory of species (Petrere, 1984).

Turtles are also efficient in meat/protein production (Smith, 1974:85). Turtle mean is a delicacy in many parts of the world, and would be a highly exportable and valuable commodity. Since aboriginal times, Indians have corralled turtle-breeding groups for year-round cropping of their meat and eggs (Sternberg, 1973:258; Smith, 1974:85).

Caimans (various species) may prove important in large-scale aquaculture because they too can be bred in captivity (Montague, 1981). They can provide both meat for local consumption and skins for export. They also play an important role in nutrient cycling in Amazonian waters (Fittkau, 1973).

The manatee (Trichechus inongrus) can also be managed to produce meat while at the same time contributing to the larger aquacultural system by keeping waterways clear of vegetation and releasing large amounts of nutrients into the water to stimulate primary fish production (Sprugeon, 1974:239; Myers, 1979:178).

Lacustrine and riverine vegetation do not appear to have been directly exploited to any great degree by indigenous groups in Amazônia. However, some groups in the Xingú River area did make a kind of salt by burning the leaves of the water hyacinth (Eichhornia crassiper). Nonetheless, this vegetation shows considerable potential for inclusion in highly productive aquaculture. Water hyacinth (Eichhornia crassiper) purifies water (1/3 hectare can purify one ton of sewage per day) and filters out toxic heavy metals (Myers, 1979:78). A variety of other water plants that form familiar "floating meadows" generate as much as seven tons of biomass per hectare per day (Myers, 1979:78). These floating meadows provide food for numerous invertebrates which in turn are consumed by fish (Smith, 1981:13).

Detailed studies of Amazonian aquatic ecosystems and their relationship to terrestrial environments are only now being undertaken (Goulding, 1980; Smith, 1981). These studies suggest that the clearing of várzea forest, a process alien to indigenous societies but comon to development projects, has a direct, adverse effect upon aquatic fauna (Gottsberger, 1978; Goulding, 1980:252-253; Smith, 1981: 125-127). These data support the ethnoecological knowledge of indigenous groups who are well aware of the interrelationship between the forest and aquatic fauna (see, for example, Chernela, 1982).

As noted above, some aquatic faunal and floral species appear to present possibilities for surplus production within an integrated system of management (Ackefors and Rosen, 1979). The potential for implementing aquatic management systems is an area requiring considerably more study. As Goulding (1980:254) points out, "... a better understanding of the natural fisheries and their proper management will be the best method for assuring a continual supply of fish...for [the] years to come." Those persons possessing the best understanding of the natural fisheries are the indigenous populations who have successfully exploited these resources for millenia.

d. Agriculture

The domesticated plant inventories of the indigenous populations of Amazônia are extensive, yet their potential for consumption and industrial uses is poorly evaluated and largely ignored by development planners. An exemplary list of some major cultivars is provided in Table 4. Some of the aboriginal domesticates are well-known and form an impressive list of New World inventions (Ucko and Dimbleby, 1969). Many other cultivars remain unknown, or if known, are seldom utilized in Western agriculture (eg., Kerr, et al, 1978; Kerr and Posey, 1984).

Numerous Amazonian domesticates demonstrate a great economic potential and lend themselves to large-scale exploitation (Williams, 1960; NAS, 1975). Indigenous uses of these plants include more than just foodstuffs, plants are frequently used as medicinals, insect repellents, dyes, and raw materials for production. Indigenous varieties of cultivars attest to the great diversity of genetic stock and afford the opportunity for scientific experimentation in crop adaptations to various tropical soils and environmental factors.

The Western approach to agricultural development has been to eliminate complexity and impose a limited and controlled range of specific cash crop monocultures. In the process, the local natural environment has been destroyed, perhaps irretrievably in light of predictions about the effects of the current rate of deforestation (Denevan, 1981; Myers, 1981). The genetic diversity and economic utility of

local wide and domesticated plants is being lost (Gottlieb, 1981). The attempt to impose mid-latitude agricultural practices has resulted in soil erosion, soil compaction, leaching, and the outbreak of epizooic pests and diseases, with concommitant rapidly decreasing agricultural yields (Lovejoy and Schubart, 1980; Sioli, 1980).

Justification for the imposition of mid-latitude agricultural methods traditionally has been that the shifting cultivation systems of the indigenous populations are primitive and inefficient. However, scientists now recognize that the range of indigenous agricultural systems is more complicated and, generally, better adapted to tropical conditions than was previously assumed (Geertz, 1963; Conklin, 1969; Dickinson, 1972; Vickers, 1976; Frechione, 1981; Lovejoy and Schubart, 1980).

Indigenous agriculture depends heavily upon native plants which demonstrate an adaptation to localized climatic conditions (Lathrap, 1970:37-38; Alvim, 1972, 198). They have also been found to be more efficient in their utilization of micro-nutrients and less dependent upon nutrients considered essential for good soil fertility in the mid-latitudes (Hecht, 1981, personal communication). Indigenous farmers act upon their knowledge of the localized adaptation of certain domesticates by developing what might be termed intragarden microzonal planting patterns which match specific cultivar varieties with soils, drainage patterns, and other climatic features (Leeds, 1961:19; Johnson, 1974; Smole, 1976:132-135; Hames, 1980:20-21; Frechione, 1981:55).

Indigenous agricultural systems generally result in positive soil conservation effects. For example, aboriginal field utilization practices minimize the time that soils are exposed to the destructive impact of direct sunlight and tropical rains. Vegetative cover is maintained at various heights to deflect the impact of tropical rainfall and provide sufficient shade, thus helping to prevent rapid erosion and leaching.

Indigenous horticulturalists usually rely on small, dispersed garden sites. Garden dispersal contributes to the maintenance of the ecosystem and the success of native horticulture. The spatial dispersal minimizes the epizooic growth of insect pests and plant diseases (Pimental, et al, 1978; Posey, 1979; Stocks, 1980), thus eliminating the need for expensive and environmentally dangerous pesticides. Garden dispersal also stimulates the growth of wildlife populations (Linares, 1976; Ross, 1978; Hames, 1979). Perhaps most important, indigenous agricultural systems always include "natural corridors" between garden sites. These natural corridors form valuable ecological refuges for plant and animal species (Gomez-Pompa, et al, 1972; Lovejoy and Schubart, 1980; Posey, 1983a, b). Therefore, species are not only protected from extinction but are reserved close at hand for re-establishment in the "abandoned fields" (Posey, 1984b).

Shifting cultivation gardens are highly productive in terms of yields per unit of labor expended (Carneiro, 1961): 53; Harris, 1972-247) and yield per unit of land actually under cultivation (Carneiro, 1961:52-53). Manioc and plantain, for example, are especially productive relative to the yield of calories per hectare. The Barafiri Yanoama are capable producing 23.16 tons of plantain per hectare, yielding 15.6 million calories per hectare from the edible portion of the fruit (Smole, 1976:150). The Yekuana have produced as much as 30 tons of manioc per hectare, yielding 23.8 million calories from the raw tubers, and approximately 6 million calories per hectare from processed manioc products (Frechion, 1981:101).

The idea that indigenous shifting cultivators of Amazônia are incapable of producing significant crop surpluses is no longer generally accepted (Carneiro, 1961; see also Kloos, 1971:38-39; Allen and Tizon, 1973; Smole, 1976:192-193). Recent research also indicates that properly managed monozoned and basically monocultural gardens planted in native cultigens are no more deleterious to the forest ecosystem than are polycultural gardens (Harris, 1971; Frechione, 1981:102-105).

Tropical forest cultivators can produce surpluses through shifting cultivation with a minimal amount of labor expended, but they generally lack the necessary economic and political stimuli to do so (Carneiro, 1961:54; Allen and Tizon, 1973). As early as 1930, Nimuendaju 1974:115-116) noted that the Ramkokamekra were capable of producing surplus manioc flour, but were deterred from doing so consistently because they lacked the means of transporting this surplus to the marketplace.

Thus, although shifting cultivation is usually discounted as a focus of possible development in Amazônia (Goodland, 1980:14-15), it clearly does have developmental potential. Marketable surpluses of native cultigens can be produced immediately under long-fallow systems; however, it is usually these areas that lack the transportation facilities and stable markets necessary to encourage such development.

Shifting cultivation can also serve as the basis for the development of ecologically sound and profitable models for agricultural development (see, for example, Dickinson, 1972; Janzen, 1973; and Siolo, 1980:266-269), and as an initial stage in an integrated agro-forestry system (Denevan, et al, 1982).

e. Natural and Human-Made Resource Units

A further manifestation of sophisticated and ecologically sound adaptations to tropical forest ecosystems

by the indigenous populations of Amazônia is their recognition and utilization of "resource units," both natural and human-manipulated. The procurement of resources from these units tends to overlap the measure or statistically quantifiable neat boundaries of hunting, gathering, and horticulture, thereby making it difficult for Western science to recognize or measure the effects of the use of such areas (Posey, 1983a, b).

Resource units are intimately known and periodically visited to harvest produce. Some are the result of naturally occurring concentrations of trees, plants, and animals. Others are artificially induced. For example, the Kayapó Indians systematically gather a variety of forest plants and replant them near camps and major trails to produce artificial resource concentrations that may be denoted as "forest fields" (Posey, 1983a).

Abandoned garden sites could be considered yet another type of resource unit. Although the principal agricultural production from shifting cultivation gardens culminates in two to three years, the sites are not totally abandoned after this period (cf. Basso, 1973:34-35; Bergmann, 1974:147-148; SMole, 1976:152-156; Hames, 1980:9). In addition, indigenous populations gather a range of plants which appear in abandoned sites as part of the natural reforestation process (Yde, 1965:28, 54; Denevan, et al, 1982; Posey, 1984b). A representative inventory of these plants for the Kayapó are listed in Table 5.

Abandoned garden sites also produce a variety of foods which attract wild animals such as wild pig, coati, paca, agouti, deer, and others (Gross, 1975: 536; Ross, 1978:10), as illustrated in Table 6. Many birds, particularly sparrows, macaws, and parrots, are attracted to these areas and are hunted by the Amerinds (Ross, 1978:10). The Kayapó are aware of the attractiveness of these abandoned garden sites to wildlife populations, and in dispersing their fields great distances from their villages maximize the area they can efficiently manage. This large-scale management strategy produces forest reserves where game is attracted in artificially high densities, thereby improving yields from hunting efforts.

Resource units should be identified, initially preserved and studied, and then evaluated on the basis of their potential economic value vis-à-vis alternative development schemes that might eliminate these units. Study of indigenous knowledge of these units also provides invaluable information on ecosystemic relationships.

4. Cosmology

Further information concerning the complex ecosystems of Amazônia and the various ways in which they can be exploited may be found expressed, directly and indirectly, in the cosmologies, myths, and rituals of the indigenous

TABLE 1

REPRESENTATIVE GATHERED PLANTS OF THE TROPICAL FOREST AND THEIR USES

(BASED UPON LOWIE, 1948:7-10)

Common Name(s)	Scientific Name	Use
DRUGS AND POISONS		
Assacu, possumwood, sandbox tree	*Hurs crepitans*	fish drug
Ayahuasca, cayapi, yage, huni	*Banisteriopsis* spp.	hallucinogenic drug
Cunambi	*Clibadium surinamense*	fish drug
Curare, curari	*Strychnos toxifera*	hunting poison
Curupa	*Mimosa aracioides*	cathartic drug
Floripondia, campa, datura	*Datura arborea*	hallucinogenic drug
Guayusa	*Ilex* sp.	anesthetic agent
Parica, yupa, niopo	*Mimosa acacioides*	hallucinogenic drug
Timbo	*Paullinea pinnata*	fish drug
Yoco	*Paullinia yoco*	hallucinogenic drug

TABLE 1 (cont.)

Common Name(s)	Scientific Name	Use
FOODS AND MANUFACTURES		
Almecega	*Tetragastris balsamifera*	resin used for fuel
Ambaiba	*Cercropia* sp.	various products
Anaja, palm	*Maximiliana regia*	fiber used in basketry
Andirobá, Brazilian mahogany	*Carapa guianensis*	oil used for fuel
Angelim	*Andira* sp.	wood for canoes
Aratazeiro	*Anonaceae* sp.	wood for bows
Arrow reed	*Gynerium saccharoides*	arrow shafts
Assaí palm	*Euterpe oleracea*	fruit eaten
Palm	*Attalea humboldtiana*	fruit eaten
Palm	*Attalea spectabilis*	fruit eaten
Pine tree	*Araucaria brasiliensis*	nut eaten
Babassú palm	*Orbignya speciosa*	oil and fruit eaten
Bacaba palm	*Oenocarpus bacaba*	oil for cooking
Bactrix marajá, palm	?	fruit eaten
Brazil nut, Pará nut	*Bertholletia excelsa*	nut eaten
Buriti, muritî, achua, palm	*Mauritia flexuosa*	numerous products
Bussú palm	*Manicaria saccifera*	leaves for thatch

TABLE 1 (cont.)

Common Name(s)	Scientific Name	Use
Itauba	Ocotea megaphylla	wood for canoes
Itauba	Silvia itauba	wood for canoes
Itauba	Silvia duckei	wood for canoes
Jabotá	Cassia blancheti	bark for canoes
Jatahy	?	bark for canoes
Jauary	Astrocaryum jauary	various products
Jerimũ, jerimum	?	fruit eaten
Manga, mango	Mangifera indica	fruit eaten
Masaranduba	Mimusops excelsa	fruit eaten
?	Moronobea coccinea	gum used for glue
Nibi	Carludovica sp.	vine used in basketry
?	Oenocarpus sp.	fruit eaten
Palo de balsa	Ochroma sp.	wood for rafts
Pau d'arco	Tecoma sp.	wood for bows
Paxiuba, pashiuba palm	Iriartea ventricosa	materials for houses
Leopardwood	Brosimum aubletii	wood for bows

TABLE 1 (cont.)

Common Name(s)	Scientific Name	Use
Cabacinho	Theobroma sp.	pith eaten
Cajũ, Cajueiro	Anacardium occidentale	fruit eaten
Camayuva cane	Guadua sp.	arrow shafts
Carayuru	Bignonia chico	pigment from leaves
?	Carludovica trigona	material for baskets
Castanha, Brazil nut	Bertholletia excelsa	nut eaten
Cedar	Cedrela angustifolia	wood for canoes
Cumarũ	Coumarouna odorata	condiment from bean
Cupuassũ	Theobroma grandiflorum	pith eaten, oil from seeds
Curauá	?	fiber for cordage
Curuá piranga	Attalea monosparma	leaves for thatch
Embira	Couratari sp.	fiber for cordage
Palm	Euterpe oleracea	fruit eaten
Greenheart	Nectandra rodioei	seeds eaten
Guaraná	Paullinia sorbilis	medicine and condiment
?	Hymenaca courbaril	resin used as glaze
Iacareva	Calophyllum sp.	wood for canoes

TABLE 1 (cont.)

Common Name(s)	Scientific Name	Use
Pequí, pequiã	Caryocar villosum	seeds for oil and food
?	Pratium heptaphyllum	resin used for fuel
Siriva palm	Cocos sp.	wood for clubs
Tucumã	Acrocomia officinalis	cordage and edible fruit
Tucumã	Bactris setosa	cordage and edible fruit
Tucumã	Astrocaryum tucuma	cordage and edible fruit
Urucurí palm	Attalea excelsa	resin used as glaze

TABLE 2

GAME ANIMALS MOST FREQUENTLY HUNTED BY
THE YEKUANA OF SOUTHERN VENEZUELA,
FROM FRECHIONE, 1981:50

Scientific Name	Common Name
BIRDS	
Ahinga ahinga	Heron
Ara macao	Macaw
Cairina moschata	Duck
Colinus cristatus sonnini	Quail
Columba subvinacea purpureotineta	White-tipped dove
Columba cayenninsis	Forest dove
Cripturellus soni soni	Ponchita
Cripturellus undulatus	Forest chicken
Leptotila verreauxi	Ruddy pigeon
Mitu tomentosa	Crestless currasow
Neochen jutaba	Duck
Odonthophorus gujanesis	Wood quail
Ortalis motmot motmot	Cuacharaca
Pauxi pauxi	Black currasow
Penelope granti	Guan
Penelope marail	Forest turkey
Phamphastos sulfuratus	Toucan
Tinamus major serratus	Great tinamou

TABLE 2 (Cont.)

Scientific Name	Common Name
MONKEYS	
Alouatta seniculus	Howler monkey
Ateles belzebuth	Spider monkey
Cebus apella fatuellus	White monkey
Callicebus torquatus lugens	Window monkey
Pithecia chiropes	Saki
TERRESTRIAL MAMMALS	
Cuniculus paca	Lapa
Dasyprocta aguti lunaris	Agouti
Dasyprocta fuliginosa	Picure
Dasypus novemcintus	Armadillo
Hydrochoerus hydrochoerus	Capybara
Mazama nemoriaga	Brocket deer
Tapirus terrestrius	Tapir
Tayassu pecari	White-lipped peccary
Tayassu tacaju	Collared peccary

TABLE 3

FEED CONVERSION RATIOS

(FROM ACKEFORS AND ROSEN, 1979)

	Dry weight feed: live weight	Dry weight feed: shredded weight (flesh)
Cow	7.5:1	12.6:1
Pig	3.25:1	4.2:1
Chicken	2.25:1	3.0:1
Rainbow trout	1.5:1	1.8:1

TABLE 4

COMMONLY CULTIVATED FOOD PLANTS OF AMAZÔNIA (BASED PRIMARILY UPON LOWIE, 1948:3-5 AND DENEVAN, 1974:101)

Common Name	Family Name	Scientific Name
TUBERS		
Arracacha	Umbelliferae	*Arracacia xanthorrhiza* Bangr.
Achira	Cannaceae	*Canna edulis* Ker.
Dali-dali	Marantaceae	*Calathea allouia* (Aubl.) Lindl.
Cupa	Vitaceae	*Cissus* sp.
Taro*	Araceae	*Colocasia esculenta* (L.). Schott
Yam*	Dioscoreaceae	*Dioscorea alata* L.
Yam	Dioscoreaceae	*Dioscorea trifida* L.
Sweet potato	Convolvulaceae	*Impomoea batatas* (L.) Lam.
Manioc	Euphorbiaceae	*Manihot esculenta* Crantz
Arrowroot	Marantaceae	*Maranta arundincacea* L.
Yam bean	Leguminosae	*Pachyrrhizus tuberosus* (Lam.) Spring.
Potato	Solanaceae	*Solanum tuberosum* L.
Tania	Araceae	*Xanthosoma sagittifolium* (L.) Schott

TABLE 4 (cont.)

Common Name	Family Name	Scientific Name
FRUITS AND SEEDS		
Bacaiuva palm	Palmae	*Acrocomia* sp.
Cashew	Anacardiaceae	*Anacardium* occidentale L.
Pineapple	Bromeliaceae	*Ananas comosus* (L.) Merr.
Peanut	Leguminosae	*Arachis hypogaea* L.
Pigeon pea*	Leguminosae	*Cajanus cajan* (L.) Millsp.
Jack bean	Leguminosae	*Canavalia ensiformis* (L.) DC.
Chili pepper	Solanaceae	*Capsicum* spp.
Papaya	Caricaceae	*Carica papaya* L.
Piqui	Caryocaraceae	*Caryocar* spp.
Star apple	Sapotaceae	*Chrysophyllum cainito* L.
Watermelon*	Cucurbitaceae	*Citrullus lanatus* (Thunb.) Mansf.
Lemon*	Rutaceae	*Citrus limon* (L.) Burm. f.
Orange*	Rutaceae	*Citrus* sp.
Squash	Cucurbitaceae	*Cucurbita* spp.
Hyacinth bean*	Leguminosae	*Dolichos lablab* L.
Surinam cherry	Myrtaceae	*Eugenia unifora* L.
Peach palm	Palmae	*Guilielma gasipaes* (HBK.) Bailey
Mangabeira	Apocynaceae	*Hancornia speciosa* Gomes

TABLE 4 (cont.)

Common Name	Family Name	Scientific Name
?	Leguminosae	Inga spp.
Bottle gourd	Cucurbitaceae	Lagenaria sp.
?	Sapotaceae	Lacuma sp.
Mango*	Anacardiaceae	Mangifera indica L.
Plantain, Banana*	Musaceae	Musa x paradisiaca L.
Granadilla	Passifloraceae	Passiflora ligularius Juss.
Avocado	Lauraceae	Persea americana Mill.
Lima bean	Leguminosae	Phaseolus lunatus L.
Kidney bean	Leguminosae	Phaseolus vulgaris L.
Guava	Myrtaceae	Psidium guajava L.
Sicana	Cucurbitaceae	Sicana odorifera (Vell.) Naud.
Frutas de lobo	Solanaceae	Solanum lycocarpum
Pepino	Solanaceae	Solanum muricatum Ait.
Cocona	Solanaceae	Solanum quitoense Lam.
Topiro	Solanaceae	Solanum topiro
Cacao	Steculiaceae	Theobroma cacao L.
Corn	Gramineae	Zea mays L.
OTHER		
Sugar cane	Gramineae	Saccharum officinarum L.

TABLE 5

REPRESENTATIVE PLANTS COMMONLY FOUND IN REFORESTATION SEQUENCE OF "ABANDONED" KAYAPÓ FIELDS AND ANIMALS ASSOCIATED WITH EACH (BASED UPON POSEY, 1982a)

PLANT	KAYAPÓ NAME	ASSOCIATED ANIMAL*	USE OF PLANT: Man	USE OF PLANT: Animal
Humeria balsamifera	bà-rerek	A,B,C,D,E	eat fruit	eat fruit
Psidium guinaensis	kamokãtytx	F	eat fruit	eat fruit/leaves
Zinziberaceae	madn-tu	F	tea from leaves	eat leaves
Paschieria sp.	pita-teka		use for paint	
Cataset sp.	pitu		medicinal	
Bignoniaceae	ngra-kanê	C,F	medicinal	eat leaves
Cisampelus sp.	tep-kanê	C,D	fish bait	eat fruit
Piperaceae	màkrê-kanê	A,B,C,D	fish bait	eat fruit
Amasonia sp.	pidjô-râ		prophylaxis	
Oenocarpus distichus	kamêrê	A,B,C,D	eat fruit	eat fruit
Macrostaychia sp.	kukrytmka	F	use wood	?
Monotagima sp.	kûryre	F	eat leaves/roots	eat leaves/roots
Myrsia sp.	kônôkô	A,C,D,F	eat fruit	eat fruit/leaves
Cecropia leucocoma	atwỳra'ô'	H,F		

TABLE 5 (cont.)

PLANT	KAYAPÓ NAME	ASSOCIATED ANIMAL	USE OF PLANT Man	USE OF PLANT Animal
Paullipodiaceae	tôn-kanê		medicinal	
Clarisia ilicifolia	pidgô-nirê	F	medicinal	eat leaves
Centrosema carajaense	akrô		fish poison	
Cassia hoffmannseggii	pidjô-kakrit	C,D,F	medicinal	eat fruit/leaves

*Animals:

A - white-lipped peccary
B - white paca
C - agouti
D - tortise
E - red paca
F - red agouti
G - deer
H - tapir

groups of the region. These concepts influence, and are influenced, to varying degrees by perceptions about the ecosystems with which the indigenous populations interact and provide important information on ecological interrelationships critical to the functioning of micro-ecosystems.

McDonald (1977) and Ross (1978) have suggested the possible operation of myth-based food taboos in preventing the over-exploitation of various fauna. Reichel-Dolmatoff (1976, 1978) has discussed the Desana shaman's attempts to manage the group's use of natural resources by using sanctions and cosmological constructs which promote the maintenance of balance in a closed system of economic, social, and spiritual forces. Posey (1983a) has sketched the function of Kayapó ceremonial cycles in dispersing knowledge concerning the systematic utilization of renewable resources. Furthermore, myth has been shown to encode intricate ecological relationships between the human and natural worlds (Berlin and Berlin 1979; Chernela, 1982).

Concluding Comments and Suggestions

Methodology for eliciting ethnographic and ethnobiological data is a well-defined aspect of anthropological training. Obviously anyone interested in ethnobiology should ideally study anthropological theory and field methods. For those wishing to conduct ethnobiological research, but with little or no training, I offer a few concluding comments and suggestions.

The major problem any investigator confronts in dealing with other cultures (including "experienced" anthropologists!) is the inadvertant imposition of one's own ideas and cultural categories one one's "informants" or, "cultural consultants." Non-verbal forms of communication often prejudice or limit data acquisition (reactions of disbelief by the researcher, or of disgust or disapproval, etc.). It is essential to set the necessary tone for a sharing relationship between equals, rather than a surbordinate giving of information by the "inferior" Indian (which is the greatest "sin" of a true scientist!).

Questioning is the principal vehicle for restricting the generation of information from informants. The question: "How many types of X are there?" presumes that X is a valid cross-cultural category and, furthermore, that there are types of X recognized and named by all cultures. "Is this the larva of X butterfly?" imposes the notion of metamorphosis that may not explain ontogeny in all societies. "How do you cure disease X?" implies the universally recognized nature of disease X, which may be several diseases instead of one for the native curer. "Why don't you treat the unconscious person?" imposes Western notions that unconsciousness is the sign of sickness and all sicknesses are bad: the native may see "unconsciousness" as a sacred state and desirable. "When do you eat your major meals?" imposes ideas of fixed meal times that simply do not exist in many tribes. "What are your religious beliefs about X?" assumes falsely that religious beliefs are always separated from biological reality. These are but a few examples of questions that restrict and mislead, rather than facilitate and generate significant and insightful data.

In general, the fewer questions asked the better. Likewise, the more "open" (non-restrictive) the question the more freedom the informant has to answer with his own concepts and logics. A "generative methodology" is always the best for eliciting, i.e., a system of generating data that relies upon <u>the informant's</u> introduction of topics and explanation is least likely to prejudice data. Myths and folklore are easily accessible and provide reliable indigenous categories relatively free from imposed outside paradigms. A myth with plant, animal, and human elements included within it may encode perceived interrelationships recognized by that culture. Interpretation of myths and folklore to discover these relationships is indeed difficult, but at the very least concepts mentioned in the myth can generally be assumed to be indigenous.

When questioning is utilized, one should begin by showing an object and simply saying: "Tell me about this." Such questions avoid the use of a name for a category of object that may or may not be names. "What can you tell me about shrubs?" for example, is an unsophisticated question because it assumes an intermediate level category of plant ("shrub") that does not exist as a named category in many languages.

From initial responses, the investigator can select words used by the informant for further eliciting. For example, if in the response to "Tell me about this." the informant replies, "it's the pupae of a bee," then the investigator can feel free to ask about the concept of "bee" and "pupae"--and, furthermore, hypothesize as to the existence of a concept of biological metamorphosis. If the informant responds to "tell me about pupa" by saying "it emerges from eggs and eats shrubs," then the researcher can proceed with investigations of concepts of "egg," "shrub" and "metamorphosis" (the latter of which must remain as a hypothetical "covert" concept because it has never been introduced directly by the informant).

"Generative methodology" is tedious and frustrating. There are definitely more rapid ways to gather data, but the question is one of quality, not quantity of data. When the researcher imposes or introduces concepts not "elicited," he can never be certain that the responses that result reflect a cultural reality of the culture under study or simply the desire of the informant to please his guest. Thus every

effort must be made to create thoughtful questions stripped of as many ethnocentric concepts as possible.

A great shortcoming of field researchers is to arrive with research questions already completely formulated. Much data can be produced with preconceived research questions, but they rarely reflect the internal logic and reality of any culture other than their own. Certainly it is acceptable to arrive in the field, for example, to collect plants. If in the collection of plants the researcher finds there is a category of "medicinal plant," then, and only then, can he study medicinal plants of that culture. If within the category of medicinal plants occurs "anticonceptional" plants, then the researcher can study "anticonceptional medicinal" plants as a valid project. If "fertility" plants are co-classified or co-named by informants with "anticonceptional" plants, then the researcher can postulate a category of "human sexual fertility plants," but is unjustified in doing so until such linkage is made by informants. Absence of such linkage, or even denial of such by informants, does not negate that the two are related in our scientific logic, but to falsely assume such linkage in other cultures is to close channels of investigation. That is, Indians may link "fertility" with "anticonceptional" with a number of other human conditions, thereby broadening the investigator's vision of interrelated properties of human physiology and medicinal properties of medicinal plants. It is, therefore, essential to trust your informants to lead you along <u>their</u> trails of investigation.

It perhaps is not necessary to warn researchers of the problems of language use. There is never any substitute for using the native language. Any time an intermediate language is used (eg., use of Portuguese with Brazilian Indians) there are always insurmountable problems of concept translation.

Despite the problems of perfecting ethnobiological research, there is much that any scientist can do in the field to gather ethnobiological data. The simple tasks of collecting name, basic use, preparation, behavior or habits of the species known by the Indians, special properties or traits recognized, and importance in myth or folklore or ceremony, etc., should be as routine as recording the collection data, collector's name and habitat.

In the final analyses, there are five fundamental rules for anyone interested in ethnobiological research:

(1) investigate the knowledge of other cultures with the idea that their sciences also developed to classify, catalogue, and explain the natural world.

(2) treat infromants considered in their own cultures as experts as you would specialists or experts in your own culture.

(3) do not assume too little of your informants. They may know many things in great detail that are little known or completely unknown in our own science.

(4) let your informants be the guides, both in eliciting significant cultural categories and in developing avenues of field research.

(5) do not dismiss too quickly things that on the surface appear to be nonsense. They may be codifications of evolutional relationships or mythological animals that function to protect natural resources and maintain the ecological balance.

No serious ethnobiologist has ever suggested that Western scientific concepts must be abandoned in order to study non-Western science. Ethnobiologists only ask that scientists shed their mantles of superiority in order to seriously study indigenous knowledge, not only to record biological concepts of other cultures, but also to generate new ideas and hypotheses that will enrich our own knowledge. This is the strength of ethnobiology: to provide a theoretical framework for the integration of our own diverse sub-fields of social and natural science with other scientific systems. Philosophically, ethnobiology mediates between diverse cultures to provide a discipline dedicated to mutual respect and understanding between diverse peoples.

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GARIMPAGEM IN AMAZONIA: AN INTRODUCTION TO A GOLD-RUSH

David Cleary

The exact date is uncertain, and in only five years the facts surrounding the discovery of the huge gold deposit that came to be known as Serra Pelada have already become encrusted by myth, but enough reliable witnesses of the birth of Serra Pelada are still present in the area to enable a reasonable accurate reconstruction. The most generally accepted version is that sometime in December 1979 or January 1980, Sr. Genésio Ferreira da Silva, owner of the estate 'Três Barras', about 80 kilometers south of the town of Marabá, Pará, encouraged his employees to look for gold on his land after hearing of mineral strikes in the general area. Soon afterwards a labourer known only as Aristeu announced that he had panned a stream running through the estate (or talked to garimpeiros he had noticed working the stream according to one version) and found an abnormally high amount of gold present. Despite da Silva's attempts to maintain secrecy and exploit the deposits exclusively, the news proved impossible to contain and by March 1980 there were already about five thousand people working the gold deposits. Within a few months the rush had swollen to such dimensions that reports began to be carried on the national press and television,[1] and the Brazilian public saw for the first time the remarkable, Dantean scenes of what appeared to be a human anthill covered with tens of thousands ragged labourers, who had removed an entire hill and transformed it into a man-made canyon using little more than spades and pickaxes. The Brazilian government was moved to mount a project of direct intervention in a garimpo for the first time, and took Serra Pelada under its control in May 1980.

In this dramatic fashion Brazil at large became aware of another social actor on the Amazonian stage; the garimpeiro, traditionally thought of as a semi-itinerant miner of placer gold deposits using simple, labour-intensive technology diametrically opposed to the capital-intensive high technology methods of the large mineral firms who until then had dominated public perceptions of mineral exploitation in Amazonia. The human agglomerations that result from the discovery of a gold deposit and its exploitation by garimpeiros are known as garimpos.

Establishing the scope and importance of garimpagem in contemporary Amazonia is not easy. Official statistics are universally unreliable; more trustworthy but still imperfect figures can be found in reports issued by the Brazilian National Department of Mineral Production (DNPM) and it is upon these sources that the following discussion is based.

In terms of gold produced the most important areas are Serra Pelada, Tapajós and Cumarú, all in Pará state.

Besides these there are also important garimpos in Roraima (Santa Rosa, Serra do Tepequém), Rondônia (Madeira river), Amapá (Lourenço, rivers Acari and Sucunduri), Mato Grosso (Poxoreó, Alta Floresta) and Maranhao (Gurupi and Maracassumé rivers).

The first point that should be made about the population involved in garimpagem is that it fluctuates according to a variety of factors, the most important being the time of year in areas of garimpagem, as rainfall makes garimpagem more difficult by flooding the claims. The agricultural cycle within and beyond Amazonia is also important, as garimpos attract a great number of people from rural areas who work in the garimpos for part of the year and return to agriculture for the rest. Although all the major areas of garimpagem produce at least some gold all the year round, generally speaking the period from April to November, the Amazonian dry season, is the time of most intense activity. Estimatioas of the garimpeiro population vary widely; what can be said with certainty is that it is extremely large and has grown markedly during the 1980.

In 1980, a workgroup of the DNPM put the garimpeiro population of Brazil at around 200,000 (DNPM 1980:I). Guimaraes et. al. (1982) give a population of 148,200 in July 1981, of whom just over 100,000 were to be found in Amazonia. But the now defunct FAG (Foundation for Assistance to Garimpeiros) put the 1973 population at 284,000 even before the rush that began with Serra Pelada (FAG 1973). All these figures suffer from the lack of knowledge government agencies have of garimpos, due partly to the isolation of many of them, partly to the DEPM's chronic lack of resources, and partly to garimpeiro suspicion of the Brazilian government. Many garimpeiros have not forgotten the military operation that expelled them from Rondônia in 1970, and for four years the Figuereido regime made no secret of its desire to hand Serra Pelada over to the state-owned Companhia do Vale do Rio Doce, which would have involved the expulsion of the vast majority of the garimpeiros working there. The only garimpos for which reasonably accurate figures exist are Serra Pelada and, to a lesser extent, Cumarú, since entry and exit is tightly controlled by state, federal and military police in these areas. Despite this, it seems likely that even the highest of the figures above is considerably below the true figure.

This can be inferred from a variety of sources. The imminent reopening of Serra Pelada with a new batch of barrancos (claims) demarcated by the DNPM means Serra Pelada alone will house 120,000 garimpeiros in 1985, not to mention the many thousands who live in nearby shanty-towns such as Curionópolis, Eldorado, and Serra Verde, who arrived in the area hoping to work in Serra Pelada but will not have the opportunity. In Tapajós a long-established gold area has been sprouting new garimpos at an impressive rate despite