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Disaggregating Amazonia: A Strategy fo Understanding Biological and Cultural Diversity

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Indigenous Peoples and the Future of Amazonia

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Disaggregating Amazonia

A Strategy for Understanding Biological and Cultural Diversity

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We are fortunate to be living in a period when Amazonia is no longer a terra incognita, no longer a region characterized simply as green hell, or as paradise. Over the past several decades, an increasing number of scholars in biology, anthropology, and geography have undertaken research into Amazonian ecosystems and in doing so have begun to tear the veil that hid the reality of Amazonia: its enormous environmental and cultural diversity—a diversity that makes our statements about it always partial views of the whole.

Despite general acceptance of the great diversity that Amazonia represents, treatment of the region by both scholars and policy makers tends to aggregate the region into two broad types of landscapes: *terra firme*, or uplands, making up 98 percent of the region, and *várzea*, or floodplains, making up about 2 percent (e.g., Meggers 1971). Exceptions to this tendency include Denevan (1976), Schubart and Salati (1982), Vickers (1984), and Prance and Lovejoy (1985). The terra firme–várzea classification fails to distinguish between regions in their degree of fragility and resilience or their primary and secondary productivity—to name just two important sets of criteria for structural and functional diversity in Amazonian ecosystems.

Despite the virtual explosion of research in Amazonia over the past 20 years (Barbira-Scazzocchio 1979; Hames and Vickers 1983; Hemming 1985; Herrera and Moran 1984; Moran 1983; Prance and Lovejoy 1985; Salati et al. 1984; Schmink and Wood 1984; Sioli 1984; and Wagley 1974, to list just a few of the edited collections that attempt to capture the rapidly developing literature; see also reviews by Moran [1982] and Sponsel

[1986]), we are still limited by our inability to compare results from one site to another. Findings from one site either are viewed as generalizable to the entire region or are presented as having unique, site-specific characteristics.

Most anthropologists accept the terra firme–várzea dichotomy and place data from areas as ecologically different as the Xingu basin, the Rio Negro basin, and the central Brazilian savannas into the category of "terra firme adaptations" (or into the even more aggregating "lowland South America"). Thus, evidence from ecosystems with widely different soils, above-ground biomass, and water regimes is used to support radically opposing views explaining cultural evolution, village size, and population mobility (see Gross 1975 vs. Beckerman 1979; Harris 1977 vs. Chagnon 1968). The distinction between terra firme and várzea glosses over important differences, especially within the vast terra firme.

Because the terra firme–várzea descriptive scheme has been widely used by biological and social scientists, it has found its way into government policies toward the Amazon. The treatment of the terra firme as a vast homogeneous region leads to policies which presume that the outcome of development projects can be constant across the region. This became patently manifest in the planning documents for the Transamazon Highway. In one document, for example, projections were made as to farmers' expected grain output that did not make allowances for variation in soil quality, slope, and climate (Ministerio da Agricultura 1972). The same yield expectations were used for areas to be occupied between the Tocantins and Madeira rivers. Four years later, farmers' performance was measured against this fixed standard, without adjustments for variable conditions (Moran 1981).

The Amazon is a very diverse region, with a multiplicity of ecosystems that reflect the variable geologic history, vegetations that have been present, and past human uses. Alarming rates of species and cultural loss have taken place in recent years—and we do not even have a framework within which to understand the significance of the losses. Are *all* ecosystems of Amazonia equally biodiverse? Has deforestation in one area the same impact as in another? What is the evidence for prehistoric environmental modification? Are ecosystems with species dominance more "manageable" or more fragile than those in which dominance is absent? Is endemicity greater in some areas of Amazonia than others? If so, what are the implications? Have native Amazonians passively adapted to the constraints of Amazonia, or have they actively modified ecosystems to meet their needs and, in doing so, created anthropogenic ecosystems? These and many other questions like them suggest themselves immediately when we consider Amazonia as an area characterized by variability rather than by homogeneity.

The major challenge for research in ecological anthropology in Amazonia in the decade ahead is to understand the relationship between cultural and ecological variation through time and space. Whether human populations have simplified ecosystem diversity or whether they are responsible for creating some of the diversity we see today has relevance for future management efforts in the Amazon. Until we disaggregate Amazonia we will persist in destroying its biological and cultural diversity.

Studying Human Adaptive Strategies

The persistence of the terra firme–várzea scheme is no accident. It is a scheme broad enough to speak across the biological and social sciences, allowing the integration of findings from each. Any framework that would hope to improve on this dichotomy must be based on criteria that are meaningful across a range of biological and social science disciplines.

One approach that has been used elsewhere (Moran 1979), which addresses the varied concerns of the physical, biological, and social sciences, is based on human adaptability to constraints. The study of human adaptability emphasizes the plasticity of human responses. It uses a broad array of data that includes physiological, behavioral, and cultural adjustments to specific problems and opportunities confronted by inhabitants of a particular environment. This approach focuses on how human populations, in interacting with each other and their environments, attempt to accommodate themselves to specific resources and situations that they face. As a result, the environment ceases to be either an overgeneralized context for human action or a determining force and becomes instead a constraint or opportunity to which a human population may or may not respond (Moran 1979:5).

This approach is applicable to a region as diverse as Amazonia. Such an approach clearly identifies constraints and opportunities and the human responses to them. Constraints such as low biological productivity, low above-ground biomass, high frequency of plants with toxic secondary compounds, and drought-related stress require adjustments by resident organisms. Tables 3.1 and 3.2 illustrate the ecosystems and constraints and opportunities that are discussed briefly in this chapter and at greater length elsewhere (Moran 1990). Choosing a constraint or limiting factor as the basis for understanding biological and human responses allows researchers to focus on the dimensions of human action that have immediate significance for the actors, and it requires, at least initially, that all levels of response to the problem be considered. Both site-specific and aggregate data are important in answering distinct questions, but they may not be used as proxies for each other.

Such a scheme, however, is insufficient by itself. It serves as a useful point of departure for understanding the interrelations of people with their habitat. People interact at several levels and with things other than the habitat. They interact with each other as individuals and as members of social groups. And whether as individuals or as members of groups, they interact also with external forces. This latter focus in research has become increasingly important in ecological anthropology and has been labeled by several investigators as "political ecology" (Sheridan 1988; Wolf 1982). In this chapter I begin with a consideration of habitat diversity in Amazonia and then return to considerations of political economy, political ecology, and history.

The Major Ecosystems of the Amazon

In what follows I would like to propose a framework for Amazonia that focuses on both constraints and opportunities and that permits finer distinctions than are now possible using the gross dichotomy between terra firme and várzea.

Várzea Ecosystems

The várzea should be disaggregated into at least three distinct regions—the upper floodplain, the lower floodplain, and the estuary. The variability present in this aquatic environment, however, is much greater than this threefold division would imply and merits further disaggregation based on future studies of these areas (see Table 3.1 for a summary of the constraints and opportunities present in the floodplain ecosystems).

The *upper floodplain* is highly variable in environmental characteristics, depending on the geological areas from which its sediments are derived. A recent research report on the alluvial soils of the upper Amazon concludes that upper floodplain soils are significantly diverse in chemical and physical properties. Soils carried by streams with headwaters in the eastern Peruvian cordillera (e.g., Rio Mayo) generally have both high base status and pH values (6.5 to 8.5). Those developing in sediments eroded from the calcareous sedimentary deposits of the Andean foothills of both Ecuador and Peru (e.g., Rio Cashiboya) tend to be slightly acid (pH 5.0 to 6.5) but present no serious chemical or mineralogical constraints. By contrast, floodplain alluvial soils originating in the eastern portion of the Peruvian basin (e.g., Rio Yavarí floodplain) tend to be strongly acid (pH

Table 3.1 Amazonian Várzea Ecosystems: Constraints and Opportunities

Estuary	Lower Floodplain	Upper Floodplain
Daily cycle of flooding with the tides	Reduced floodplain	Higher incidence of whitewater rivers with nutrient-rich sediments from Andes
Rich alluvial deposition year-round	Fed by effluents from Guiana and Brazilian shields	Meandering rivers creating diversity in aquatic habitats
Less species-diverse, greater dominance	Great seasonal fluctuations in river level	Fish-rich várzea lakes
Many plants of economic value	Species-diverse, little dominance	More seasonal pattern of flooding
Rich riverine and marine fisheries	Rich riverine resources	

Source: Moran 1990.

4.0 to 5.0) and have levels of aluminum saturation exceeding 85 percent (Hoag et al. 1987:78–79).

Thus, anthropologists will need to specify the qualities of the alluvium in the upper floodplain—rather than simply allude to the presence of alluvium—if they are to understand the constraints and opportunities under which a population lives. In those areas of the upper floodplain with high acidity, lower nutrient content, and high aluminum saturation, population densities tend to be lower because of lower crop productivity. Furley (1979) has noted that the floodplains in the Rondônia region tend to be very acid hydromorphic gleys that are of less agricultural value than the high base-status soils of the terra firme of Rondônia—an observation that should put everyone on guard against the common generalization that várzea soils are more fertile than terra firme soils. What is true in the aggregate may not be true at a finer scale of resolution and may lead one unwittingly to overlook differences between local areas occupied by populations one is studying.

Two other constraints present in the upper floodplain that should be included in the analysis of human adaptability are altitude and slope. It is generally understood that above-ground plant biomass and productivity tend to decline with altitude in the rain forest, and this trend has important consequences for animal biomass and productivity, the efficiency of hunting effort, and other matters hotly debated in the anthropological literature (Vickers 1984). Although slope is not generally given much attention in research on lowland South America, it requires management to avoid soil loss. In the upper floodplain slope can be expected to have particular significance.

On the positive side, the region is enriched by meandering rivers that create numerous habitats for terrestrial animals and fish. Humans in this region had to relocate their settlements often due to the landscape changes brought about by the rivers, but they rarely moved far. There is considerable value in remaining in a region as well endowed as this one (Christine Padoch, personal communication, 1990; see also Hiraoka 1986, 1989). In addition, people in the upper floodplain have maintained regular economic exchange relations with populations in the Andean region that further stabilized them over time and in space. Studies in this region have been numerous and are sometimes better known by their reference to the *montaña*, or montane rain forests, which I will discuss later in this chapter. Rainfall in these areas is very high and agriculture has variable potential—but overall, soils have higher levels of nutrients than in areas of the lower Amazon. Many notable studies have been carried out in these areas in recent years, among them those by Vickers (1976), Johnson (1975, 1982, 1989), Behrens (1986, 1989), Johnson and Behrens (1982), Bergman (1980), Hern (1976, 1988), and Ross (1978).

By contrast, the *lower floodplain* conforms better to our current image of the floodplain: it is characterized more by oportunities than by constraints. The lower floodplain is enriched by alluvium from the high Andes, and its nutrient-rich rivers support large fish populations that account for 90 percent of the fish biomass in Amazónia (Junk 1984:215). The major constraints in this ecosystem are the variability and unpredictability of water levels and flooding. This unpredictability tends to require complex ethnoecological knowledge for predicting water levels in order to produce the large crop surpluses that potentially are possible.

The lower floodplain area seems to have supported both large populations and complex cultural systems with stratification (Myers 1989; Porro 1989; Roosevelt 1980, 1987, 1989). The complexity of managing this area is evident in the nonreemergence of intensive systems of agriculture in the lower floodplain since the depopulation events at the time of European contact (Sweet 1974). The ability to predict floods, build raised fields, and develop fast-growing varieties of crops is an essential component of várzea agriculture. Our best opportunity to understand the use of this region lies in the intensive study of *caboclo* and *ribereño* populations who have lived in this region since the demographic disaster of the seventeenth and eighteenth centuries (Denevan and Padoch 1988; Hemming 1978, 1987; Hiraoka 1986, 1989; Padoch and deJong 1989).

The *estuary* extends from the mouth of the Xingu River to Marajó Island at the mouth of the Amazon. The estuary differs from the lower floodplain in that it is filled by oceanic tides twice daily rather than only once a year for several months as is the case farther upriver. This regular inflow leads to very different adaptive strategies and a very different ecology. The estuary is not particularly rich in plant biodiversity but is characterized instead by species dominance, and many of the dominant species are palms of economic value. This pattern is probably the result of long-term manipulation by human populations who realized long ago the advantages of this region for net yield and for its location near riverine and oceanic aquatic resources. Fisheries in this area take advantage of both types of resources, and extractive activities are both high yielding and sustainable.

Intensive systems of management have been documented in the estuary (Anderson and Ioris 1989; Anderson et al. 1985), notably in agroforestry management supporting up to 48 persons per square kilometer and giving a rate of return higher than that documented for any other region of Amazonia (although this may be due to proximity to the large market of the city of Belém). Intensive management has been possible without any apparent deforestation. Agriculture in the estuary is more difficult and less productive than is plant extraction (Anderson and Ioris 1989). The estuarine ecosystem resembles a system in perpetual secondary succession owing to the frequent fall of trees and the dynamic impact of the aquatic environment on the landscape.

Terra Firme Ecosystems

At least five distinct ecosystems can be defined for the terra firme, given our current knowledge of environmental constraints: the well-drained savannas, the black-water basins, the vine forests, the montaña, and the poorly drained savannas (see Table 3.2 for a list of constraints and opportunities offered by these ecosystems). It is to be hoped that other distinctive ecosystems will emerge as further research highlights the environments and adaptive responses of populations.

Well-drained savannas are characterized by periods of high rainfall followed by marked droughts during the dry seasons. Agriculture in these areas is constrained by extremely acid, low phosphorus soils that, when combined with excellent drainage and low rainfall during the growing season, make agriculture very uncertain and, in the absence of irrigation,

Table 3.2 Amazonian Terra Firme Ecosystems: Constraints and Opportunities

Black-Water Basins	Terra Firme Forests	Montane Forests	Savannas
Extremely low levels of nutrients or oligotrophy	Very high species diversity	Lower plant and animal biomass than terra firme forests	Acid, low phosphorous soils
Hydrologic stress of flooding/drought cycles	Few individuals of a species per unit area	Variable soils, extremely patchy	Great diversity of ecotones
Poor optical resolution of rivers	High incidence of acid, nutrient-poor soils	High erosion potential due to steep gradient	Lesser importance of fishing
Tendency toward dominance in flora	High incidence of leguminous species	Frost potential in some areas	Greater animal biomass productivity
Low plant and animal biomass productivity	Environmental patchiness		Some soils with impeded drainage drained
Nearly closed nutrient cycle	High incidence of superior soils		
Fish resources concentrated in flooded forest and cataracts	Patches of forest with concentration of plants of economic value		
Low above-bround biomass			
High frequency of plants with toxic secondary compounds			

Source: Moran 1990.

of relatively low productivity in the open savannas. The well-drained savannas, like most parts of Amazonia, are crosscut by rivers. Gallery forests, often growing on outcrops of nutrient-rich basaltic soils, hug the banks of permanent rivers. Indigenous populations practice a diverse and relatively productive horticulture in these forests—in many cases based on corn rather than manioc. They also follow a seasonal pattern of trekking across the dry savannas to take advantage of the ease of visibility that these open areas lend to hunting. Fishing is generally less productive in these areas and less attention is devoted to it, except when a population happens to locate next to some particularly productive section of a river. In addition, they take advantage of the great diversity of ecotones lying within short distances for gathering wild food resources.

Human populations on the savannas are not as dense as they are on the floodplain or in the vine forests. Their social organization is often dualistic, an effective response to the cycles of social fission and fusion (Gross 1979; Zarur 1979) that result from their need to fission for trekking and to fuse for horticulture. Because the savannas lie midway between the rich coastal regions and the rich floodplain, their human societies sometimes developed substantial warfare capabilities in an effort either to defend themselves from the more powerful Tupian chiefdoms of the coast or to overthrow them and take control of those better-endowed regions. They have proven persistent because of their flexible social organization. Today they are among the most numerous populations of native Amazonians and among the most savvy in dealing with outsiders (Anderson and Posey 1985; Gross et al. 1979; Posey 1985; Werner 1979).

Black-water basins have long attracted the attention of limnologists and other scientists (see Sioli 1950; Spruce 1908). These so-called "rivers of hunger" have a distinct vegetation (e.g., *campina*, *caatinga*, or xeromorphic vegetation) that reminds one of the spiny scrub forests of northeast Brazil. From the point of view of constraints, black-water basins are probably the most fragile and constrained ecosystems of Amazonia (Jordan and Herrera 1981). Rainfall is high, with a relatively short dry season—but because of the dominant white sandy soils (spodosols), even this short dry season is enough to cause severe drought stress in the vegetation, which has responded by developing many of the morphological characteristics of arid plants.

This ecosystem has been described by biologists as oligotrophic—as a nutrient-limited habitat that structurally and functionally has become an exemplar of the closed nutrient cycling that many people mistakenly generalize for the entire Amazon region (Jordan 1982; Jordan and Uhl 1978). However, the completeness of the array of nutrient-cycling mechanisms seen in the black-water basins is probably not found anywhere else in the Amazon. Loss of nutrients is minimized by a deep above-ground root mat (ca. 20 cm) that intercepts leaf fall and facilitates its breakdown through the interaction of fungi and mycorrhiza, thereby preventing loss of nutrients (Herrera et al. 1978; Stark and Jordan 1978). Herbivory is reduced by the high phenol content of the leaves and the presence of many toxic secondary compounds. Although total biomass is comparable in this white-sand–black-water ecosystem to that of other areas in Amazonia, in the black-water basins as much as two-thirds of it may be below ground.

The low above-ground biomass and extremely acid and nutrient-poor soils translate into very low biomass productivity of game and fish. Sioli (1950) described the rivers as being of "distilled water purity" from the point of view of dissolved minerals. The inkiness of the rivers, caused by undecomposed organic matter and dissolved phenols, makes fishing with traditional arrows and lances less effective than it is in clearer rivers. The spodosols found over much of this region experience fluctuating drought and flood (Herrera 1979). Because of an impermeable B-horizon in the soils, rainfall does not drain rapidly, causing vegetation to experience stress due to lack of oxygen at the roots (perhaps explaining the above-ground root layer), followed by severe drought stress (explaining the xeromorphic response of plants).

Agriculture in these areas has been practiced primarily along small levees near river banks (Hill and Moran 1983) and in small patches of terra firme forest growing on oxisols (Clark and Uhl 1987). In the levees there is sufficient organic matter due to the slow decomposition resulting from high phenol content, but the underlying soils are extremely acid—sometimes in the 3.5 to 4.0 range—which limits agriculture to a few plants such as manioc that are adapted to such low pH and to otherwise toxic levels of aluminum saturation. Human populations living along black-water rivers tend to be widely scattered and to hold hierarchically structured claims to points along the river in order to control the limited areas of fish concentration in flooded forests and cataracts (Chernela 1982; Goldman 1963; Hill and Moran 1983; Jackson 1983; Moran 1990, 1991; Uhl 1980). Secondary succession is much slower than in other areas of Amazonia, necessitating much longer fallow periods before swidden cultivation can be practiced again (Uhl et al. 1982).

The upland vine forest ecosystems of terra firme are found throughout the Amazon basin, covering nearly 100,000 km^2 in the Brazilian Amazon alone. Recently it has been suggested that these forests are the product of intentional manipulation by prehistoric populations (Balée 1989). This interpretation is based not only on the presence of many species associated with secondary growth and their frequent association with ceramics and other prehistoric archaeological material, but also on their patchy occurrence in areas of high relief in the south and southeast portions of the basin—Rondônia, Roraima, Amapa, and areas between the Xingu and Tocantins rivers (Pires and Prance 1985). These areas have sizable outcroppings of high base-status parent material, resulting in soils of medium to high fertility (alfisols), and rainfall regimes with a distinctive dry season of two to four months. In these forests there are a surprisingly large number of patches of both eutrophic soils (alfisols) and anthropogenic black soils—*terra preta do indio* or *terra preta arqueologica* (Kern 1988; Kern and Kampf 1989; Smith 1980).

The rivers drain watersheds that carry clear water with moderate loads of minerals and have small but productive levees. Fishing is rewarding because of the water's optical clarity. When turbidity reduces the effectiveness of fishing during the rainy season, the surrounding forests are relatively rich in animal biomass because of their relatively high above-ground plant biomass and productivity and because of the creation of "edges" by the human population—areas with greater biotic diversity as a result of their successional quality (Balée and Gely 1989). These are the forests referred to by Herrera (1985) as eutrophic, compared with the oligotrophic rain forests of black-water watersheds. The above-ground root mat noted in black-water basins is almost nowhere visible here, nor are many other nutrient-conservation mechanisms referred to earlier.

The marked dry period and the prevalence of woody vines and trees with modest diameters (ca. 25 to 35 cm dbh) makes the clearing of these forests easier and their drying more effective (Moran 1981). The result is not only richer initial soil fertility through effective burning from year to year, but also longer periods of cultivation per unit of land cleared, owing to higher initial soil fertility and pH values closer to 5.5 to 6.0. Cultivation periods as long as 10 to 15 years are technically possible before yields decline to 50 percent of the first-year yield (Sanchez 1976). Indigenous people in these areas cultivated a great variety of crops, but it should be noted that a surprisingly high incidence of corn-based horticulturalists is found in these areas, in contrast to the more commonly found manioc-based horticulturalists that most anthropologists and geographers have studied (Coimbra 1989; Galvão 1963; Moran 1990). The superior soils found here probably promoted a greater degree of circular settlement relocation to ensure continued access, and perhaps even claims, to these areas and to secure benefits from forest-patch management often associated with these areas. When fields are abandoned, secondary succession is much quicker in these areas—approximating 90 percent of total above-ground biomass within 10 years after the end of cultivation (Sanchez 1976).

Poorly drained savannas are quite distinct from the well-drained savannas. In particular, poorly drained savannas are found in sizable areas of Bolivia's high, flat plateaus with rich soils and moderate climate and in areas like Marajó Island at the mouth of the Amazon. They are believed to be important pre-Columbian sites with intensive agricultural systems. Denevan (1966) studied the Llanos de Mojos and found ridging and mounding, drainage canals, and other forms of intensive management that probably supported relatively high populations. Today, these areas are the objects of mechanized agriculture by Japanese and Mennonite populations who successfully produce for the market as well as for their own subsistence. This type of ecosystem is still poorly understood by cultural anthropologists and geographers, despite its likely importance in pre-Columbian times. This lack of understanding may be due to the decline in intensive systems of production following the loss of population during the first century of contact and the difficulty of finding contemporary populations practicing intensive management. Archaeology remains one important hope for understanding these systems (Zucchi and Denevan 1979).

By the second millenium B.P. there is evidence for prehistoric population in these areas, which seem to have had complex polities, perhaps even chiefdoms. These people made sophisticated polychrome pottery, used funerary urns, and gave greater emphasis to anthropomorphic figures in their art and symbolism (Roosevelt 1987). Some, like the Marajoaras, declined even before the arrival of the Europeans in the sixteenth century, while other populations higher up the river maintained chiefdoms as late as the seventeenth century before they too disappeared through warfare and disease. The Omagua, for example, experienced a loss of population of 70 percent in the first century of contact (Porro 1989:8).

The *montane forest*, or *montaña*, has been the focus of many ecological studies in anthropology (Behrens 1986, 1989; Johnson 1975, 1989; Ross 1978; Vickers 1976, 1984). It is a very distinctive forest from those discussed heretofore. It has lower tree biomass but more epiphytes. It has noticeably lower animal biomass, evident in lower hunting yields (Vickers 1984). Its soils are quite variable in acidity, minerals, and nutrient status. Human populations in these areas are constrained by the lower animal biomass and productivity, but the slightly higher frequency of soils of moderate acidity and fertility makes agriculture somewhat more productive and certain than in the lowland forests. These populations seem to have had long-standing economic relations with the complex chiefdoms

of the high Andes from prehistoric times to the present. This area still has large and well-organized native populations whose expertise in dealing with variability along an altitudinal gradient deserves particular attention.

Native Strategies and Political Ecology

Paying attention to the adaptations of human populations to habitat constraints should not lead us to overlook the variability in the responses of local populations or the impact of local social systems and external political economic forces upon the adaptability of local populations. Contemporary ecological anthropology seeks to move away from a traditional emphasis on local, isolated populations removed from market forces and toward a process-oriented ecological approach that incorporates political economy and historical trajectory in its assessments of adaptive change (Ellen 1982; Lizarralde and Beckerman 1982; Moran 1984; Orlove 1980; Posey 1985).

For each of the ecosystems I have disaggregated above, it is important to delve into local history, to understand the transformations in ecology and society that have been brought about through time. This is a task for the individual investigator and is as detailed in nature as is ecological data collection. Generalizations about local history are not useful even if they are possible. On the other hand, there are significant patterns in regional histories that may serve to explain, at a different level of analysis, patterns of contemporary resource use. In what remains of this chapter, I will offer some indications of the sorts of evidence that serve to give historical grounding to environmental analyses of human adaptive behavior in Amazonian ecosystems.

In the lower floodplain and estuary, one finds the earliest and most notable impact of colonial contact, for the various and numerous populations of the region experienced the brunt of warfare, slave raiding, and epidemic disease (Hemming 1978). Myers (1989) notes that the land of the Omagua in the sixteenth century included 23 to 34 villages strung along 700 km of river front from the mouth of the lower Napo to the mouths of the Javarí and Içá rivers. Some of these villages had up to 8,000 inhabitants (Porro 1989). These large populations, like many others, were reduced by more than 70 percent within the first hundred years of contact, leading to a loss in capacity to sustain complex polities and, no less important to us, the complex systems of resource management that made those large populations possible.

In order to understand the potentials of the lower floodplain and the estuary, it will be increasingly necessary to delve into the colonial archives and to undertake more detailed archaeology than has been attempted so far, in the hope of finding suggestions as to how native people of Amazonia managed to maintain systems of sustainable resource use (Sweet 1974). In addition, greater attention will have to be paid to the caboclos and ribereños who replaced the indigenous populations along the major rivers and floodplains following depopulation. In some areas, these populations today practice sustainable systems of agroforestry and forest extraction that merit attention from contemporary societies in the Amazon. It should be remembered that intensive systems of management will neither occur nor be sustainable unless there is significant *demand* for floodplain products. This is clearly shown by the sustainable systems present in the estuary islands near Belém and by the long-term extraction practiced in the forested portions of Marajó for Belém's market and export markets.

Exploitation of the upper floodplain has been most influenced by the development of fisheries, both in their artisanal form and through modernized systems of aquaculture (Goulding 1980). Paddy rice cultivation has increased in importance in recent years, especially in Peru, due to favorable price supports. Native peoples have shown considerable talent in managing this crop, but it is unclear whether this development is entirely positive (Behrens 1989; Hern 1988). One favorable development is the emergence of regional industries, such as beer production based upon rice, that are likely to be able to absorb production and ensure price levels over time. The paddies, on the other hand, could become serious health hazards unless care is taken to prevent the entry of vectors of schistosomiasis and the further creation of breeding areas for malarial mosquitoes. The economy of this area has the advantage of better articulation with local and regional markets (Padoch and deJong 1989) than Brazil's floodplain areas and a sophisticated understanding of systems of diverse agroforestry among its ribereño and indigenous populations (Padoch and deJong 1989). People in this region seem to have maintained greater contact with their precolonial past, and native communities have greater developed unity, as is evident in groups like the Shuar Federation.

Turning to the black-water basins, it can be said that despite the impacts of disease, the rubber era, and other forms of colonial pressure, the Rio Negro basin has, on the whole, experienced a lesser degree of assimilation and extinction that many others in Amazonia. Perhaps the biggest reason has been the lesser economic interest of Europeans in this area, which is so evidently poor in resources of interest (Galvão 1959:9). Here one finds a remarkably strong sense of ethnic identity, especially along the Vaupés and Içana rivers (Chernela 1983; Jackson 1976, 1983).

This region offers a glimpse into what may have been a much wider pattern of relations between people and land. Clans hold territorial controls over specific areas, controls that are justified by ancient clan myths and are understood *regionally*. Although this does not mean that the clans that currently control given areas of the river always had such control, it does suggest that the process was highly structured and required legitimation in regional mythology. Thus, as the Makú today approach riverine areas currently occupied by Tukanoans, their gradual population movement is preceded by a growing number of marriages between Makús and Tukanoans that may permit, at some future date, the transformation of clan membership and rights to territories currently withheld from the Makú (Reid 1979).

In this region, people manage the environment through an extremely dispersed pattern of settlement, very low population densities, and highly specialized resource exploitation in which some ethnic groups focus upon riverine resources and others upon terrestrial resources. The poverty of this region for any form of intensive resource use provides strong grounds for protecting it. Such protection should include some insurance to its native people against the common tendency to disfranchise them from the land. Their lives might be bettered considerably if greater attention were given to their knowledge of toxic plants with potential for medicine. This knowledge could become an important source of income for local populations if appropriate forms of compensation were found and if sustainable, in situ production of such plants were undertaken.

The terra firme forests together make up nearly 50 percent of the Amazon basin. The diversity of species found in them deserves special attention, and, at least in the short term, they should be protected from deforestation. Many of these areas have soils that can be made productive only with considerable addition of fertilizers and careful selection of cultivars preadapted to conditions of high acidity and aluminum saturation and low levels of essential nutrients. Although nutrient poverty is less extreme than in black-water watersheds, it is enough to limit agricultural production without fertilization to the first year after forest removal.

Until infrastructural development and other economic conditions permit, the terra firme forests are unlikely to be made productive for contemporary urban societies. They can be managed less intensively by local indigenous people whose systems of extensive, low-impact resource use are likely to maintain biodiversity while ensuring human biological and cultural survival. There is discussion now of First World countries' paying for maintaining areas safe from deforestation in compensation for the role forests play in clearing the air of urban pollutants and in stabilizing climate, especially in the hydrologic cycle. Advocates of "debt-for-nature" swaps have suggested that indigenous people might be paid to manage the forests as further insurance against the destruction of vegetation.

What I said above about terra firme forests does not apply to the areas of terra firme covered by upland vine forests. These areas show evidence of previous occupation, often have soils of medium to high quality, and support a greater density of plants of economic interest. These areas, especially those with alfisols, should become the special objects of intensive agricultural management. Under no circumstances should they be put into pasture or into production that is not of high food and commercial value. Patches of alfisols could be managed with annual crops alongside the agroforestry management of patches of oxisols and ultisols in close proximity. Doing so would allow for both diversity of production and a better fit between resources and their use. This is clearly the case in areas of Rondônia managed by the Suruí Indians, who cultivated corn on the alfisols while developing groves of *babaçu* palm on the poorer soils near settlements (Carlos Coimbra, personal communication, 1989).

Additional Trends and Research Priorities

In addition to these dimensions of ecosystem use, one must perforce explore the impact of demography. The demographic changes experienced by native Amazonians are influenced by external ideologies. The ideology of Christian missionaries, for example, often emphasizes the noncontrol of fertility. Such an emphasis may not be entirely negative, considering the high rates of mortality that accompany the first one or two generations of permanent contact between indigenous people and Westerners. A policy emphasizing maximization of births would in all likelihood allow the population to regain its original size faster than a policy aimed at reducing fertility. But in time a policy that encourages reproduction will lead to rates of growth beyond the carrying capacity of native landholdings and, accordingly, to outmigration and merging with the urban poor. The sometimes conflicting relationship between missionaries and anthropologists has limited the controlled study of the impact of particular religious ideologies on the biological survival and adjustment of native Amazonians—and of whether the population, after biological adjustment, begins to modify the ideologies promoted by missionaries.

What all this suggests about research on human adaptability is that understanding demographic change, particularly at the level of households and villages, is a sine qua non for understanding how populations respond to epidemiological changes at the level of the social group—in addition to the already mentioned concern with epidemiology per se, that is, changes in disease prevalence. Disease, depopulation, and missionization affect the entire village population, as well as household units and individuals.

In addition, a number of external forces affect the very existence of social groups as distinct territorial units—especially control over land, monetization, and the incorporation of Amazonia into the world economic system. What has perhaps been missing in anthropological studies has been an effective way of linking these considerations of political economy and political ecology to issues of ecosystem structure, function, and management.

For example, very little research has been done that might help us understand the appropriate size of reservations if they are to provide sufficient land to permit both biological and cultural survival. This lack of research has been a serious deficiency in designing reserves for the Yanomami (e.g., Ramos and Taylor 1979). The oversight is all the more remarkable given that research is currently under way to establish the "minimum critical size of ecosystems" in the Amazon (Lovejoy et al. 1983), but unfortunately, this research, or its equivalent, fails to consider the role of human communities in ecosystems. The knowledge possessed by native peoples could very well inform scientists not only about how to preserve the environment but also about how to exploit it—at a time when the protective functions of the forest in the carbon cycle need to be understood and incorporated into our responses to the dangers of global warming.

The impact of monetization has been noted frequently, but rarely has it been studied as a central focus. The transformation of relatively autonomous societies engaged in long-distance exchange into societies trading on the basis of a common currency is a major readjustment. Monetization has been associated with the demise of work parties, with the individualization of work effort, and with changes in rules of reciprocity and marriage. Such changes are not necessarily negative, but they lead to a transformation of societies sensitive to local environmental change into societies sensitive to terms of trade. Moreover, indigenous people often find themselves in unfavorable positions in exchanges due to their peripheral positions in national economies.

During periods of change there is enormous potential for environmental destruction. The current period of change may take several generations and can be seen throughout most countries of the world today as people pay greater attention to the generation of foreign exchange, to capital accumulation, and to international markets than to the stability and long-term productivity of their renewable resources.

Anthropology needs to engage the problems of contemporary societies and assist in sustainable development. Anthropologists need to join native Amazonians in legalizing their claims to land and alerting the population to the complexities of a money-based economy. A direct intervention in the educational process that is sensitive to the cultural values of native Amazonians and that makes them knowledgeable about the imperfections of the world economic system should provide them with the ability to adjust to monetization in their own reflexive terms, rather than naively join the trend without recognizing the costs that it implies in autonomy and the quality of social relations.

The incorporation of previously autonomous populations into larger systems requires major adjustments. When such incorporation occurs quickly and when states are themselves dependent on world economic forces, the ability of local systems to maintain stable characteristics has proven time and again to be very limited. Herein lies one of the great challenges for research in anthropology and development in contemporary Amazonia. Can systems of social relations be conceived that permit a degree of local autonomy over production, consumption, distribution, and ethnic identity, yet allow local populations to participate in the health, education, and economic gains made possible by "development"? On the whole, it is evident that a vast number of the peoples of the Third World have shared inequitably in the aggregate gains of development. Of these, native Amazonians have been among those benefiting the least. Changing the terms of exchange and the degree of participation in such a way that greater work leads to greater social benefit remains a challenge to the imagination of each and every one of us. It is a challenge that we must meet: in the balance hangs the fate of one of the richest biological regions on earth, the fate of hundreds of distinct societies, and perhaps our own future.

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