Human Ecology, Vol. 12, No. 3, 1984

Rethinking Stone Age Economics: Some Speculations Concerning the Pre-Columbian Yanoama Economy[1]

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The introduction of steel tools and new crops radically transformed the Yanoama Indians' pre-Columbian economy. A consideration of the impact of these innovations allows for the reconstruction of that economy which suggests a higher dependence upon foraging, a lower population density, more mobile settlement pattern, and heavier workload, than today. This reconstruction challenges both current speculations about pre-Columbian Amazonian economic systems which apply Sahlins' concept of "aboriginal affluence" and those concerning the relationship between Amazonian environment and "cultural development." This reconstruction, confirmed in part by fragmentary historical sources, explores some of the dramatic changes which must have taken place since contact. The Yanoama's agricultural subsistence base is a recent innovation, made possible since contact by new tools and new crops.

KEY WORDS: Yanoama; Amazonian Indians; technological change; cultural ecology.

> Before they had any knowledge of the Portugals they used tooles and instruments of stone, bone, wood, Canes and teeth of Beasts &c and with these they hewed downe great woods, with wedges of stone, helping themselves with fire; and they digged also the ground with certaine sharp stakes, and they made their Brooches, Beads of Wilkes, Bowes and Arrowes, as well as now having instruments of Iron, but they spent a long time in making whatsoever thing: wherefore they esteeme the iron very much

[1]This article has benefitted considerably from conversations with Emilio Fuentes to whom I offer my gratitude. I would also like to thank the anonymous reviewer who made detailed comments on a first draft.

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0300-7839/84/0900-0291$03.50/0

> for the facilitie or ease which they find in making their things with it. And this is the reason wherefore they are glad of Commerce with the Portugals or White men.
>
> *Purchas 1905:429-30*

A steadily growing body of information concerning the economies of Amazonian Indians has become the testing ground for new theories in Cultural Ecology and is the home of a heated debate concerning the extent to which environmental parameters dictate, constrain or influence human cultures.

It is the author's view that two extremely important considerations have been largely omitted from these debates and studies—demography and technology—and this article attempts to rectify one of these omissions through the *speculative* (I claim no more) consideration of the impact of metal goods and Old World crops on patterns of Amazonian subsistence, specifically among the Yanoama.[3] Both these omissions may be seen as a result of the reluctance of functionalist ethnology to view societies as dynamic and changing entities in a diachronic perspective viewing them instead as static adaptations adjusted to current environmental conditions.

We are fortunate in possessing a unique body of information concerning the demography of the Yanoama populations.[4] The wealth of this information, coupled with the fact that the Yanoama the largest and least acculturated group of Indians still surviving in Amazonia, has focused the controversy on environmental parameters of these societies. The debate has centered on whether protein availability determines the warfare endemic to the group. Pivotal within this debate is the issue of whether or not the Yanoama are exploiting their environment to carrying capacity or not (Harris, 1974; Chagnon, 1974; Lizot, 1977). The various points of view correspond to several interpretations of the Yanoama's recent history. Thus, where Harris (1974, 1979) has emphasized the changes induced by contact, Lizot (1977, 1980) has played them down, and Chagnon (1968a, b, 1974) has virtually ignored them altogether.

In this paper I suggest that the Yanoama economy has undergone radical transformations during the last 200 years. Far from being a "traditional" Amazonian subsistence economy, I contend that the pre-Columbian Yanoa-

[3]I have previously touched on this issue elsewhere (see Colchester, 1982a, b, c, d).

[4]This thesis work was carried out with funding from the Social Science Research Council, the Emslie-Hornimann Foundation and the Ruggles-Gate Trust. To these organizations I offer thanks.

ma were an essentially-foraging society. This conclusion has important implications for our understanding of the Yanoama in particular (Colchester, 1983) and for the cultural ecology of Amazonia in general.

Yanoama is the general term adopted by a number of early ethnographers (see Wilbert, 1963) to include all four recognized language groups (Sanama, Yanam (Ninam), Yanomam, and Yanoamami) that are clearly related to each other both linguistically and culturally (Migliazza, 1972). There are at present some 21,000 Yanoama in all.

About 200 years ago, virtually all the Yanoama were living near if not on the Parima hills which lie on the watershed between Venezuela and Brazil, just north of the source of the Orinoco (for a summary of the information on Yanoama population movements see Colchester, 1982a). From the end of the eighteenth century and particularly since the beginning of the nineteenth century, these populations began to expand out from the Parima hills at an ever-increasing rate. All the local ethnographers agree that this dynamic territorial expansion corresponded to a rapid population increase (Chagnon, 1968a, b, 1974; Neel and Weiss, 1975; Lizot, 1977).

Two major changes in subsistence practices may have been the basis for this demographic expansion. There are the acquisition by the Yanoama of Old World crops, especially bananas and plantains, but also taro and sugar cane, and the introduction of metal tools.

The Yanoama's trading contacts with neighboring Indian groups were first reported by Humboldt (1851) and Schomburgk (Schomburgk, 1841, p. 161) who describe the raiding and trading relations between the Yanoama and Yekuana. Although the Yanoama probably began acquiring steel goods during this period, we know that the stone axe was not fully replaced until the 1930s (Cardona, personal communication; Lizot, 1980). Continuous trading contacts with non-Indian populations commenced only in the 1950s.

Marvin Harris has proposed a reconstruction of recent Yanoama history. He has advanced the hypothesis that the Yanoama's "ancestors were nomadic hunters and gatherers living away from the larger rivers in small scattered bands that relied on wild forest products for their chief source of subsistence" (Harris, 1974). The Yanoama population increased dramatically with their acquisition of bananas (Harris, 1974) and steel tools (Harris, 1977), but with unfortunate consequences for their environment. According to Harris, it is a "fact that there [were] already too many Yanomamö in relation to their ability to exploit their habitat" and "they [had] already degraded the carrying capacity of their habitat" (Harris, 1974). The population explosion and consequent depletion of hunting resources forced the Yanomamö, i.e., Yanoama, to escalate their levels of warfare as they competed over resources. This, in turn, increased the need for warriors to defend home communities, so that male children were favored at birth and female infanticide was practiced. Consequently, competition over women intensified the warfare causing the villages to fission and relocate, such fissioning leading over time to territorial expansion.

In sum, "the Yanomamö have 'eaten the forest'—not its trees but its animals—and they are suffering the consequences in terms of increased warfare, treachery, infanticide, and a brutal sex-life" (Harris, 1974).

I shall not attempt a detailed evaluation of this hypothesis here (Lizot, 1977). It should be mentioned, however, that the crucial issue of whether carrying capacity has been *reached,* let alone *exceeded,* remains in considerable doubt (see Colchester, 1982a).[5] It may also be pointed out that the exaggerated levels of warfare due to demographic growth might be equally well explained in terms of an aggravation of the delicate sociopolitical system which may have occurred before carrying capacity was exceeded (Colchester, 1983). We are unlikely to resolve this dispute without knowing much more about what the Yanoama were doing *before* their demographic expansion. This paper is an attempt to go part way towards answering this question.

STONE AXES: COMPARATIVE INFORMATION

The Yanoama's transition from stone to steel preceded the arrival of ethnographers in the area. The following reconstruction of their pre-Columbian economy is based in part upon early records. This material is sparse since the Europeans' technology usually preceded them into the interior. On Colon's first voyage to the New World, for example, it was noted that introduced goods actually overtook the exploration (Cohen, 1969).

The Amerindians' transition to a steel-based economy was extremely rapid. By 1554, scarcely half a century after Brazil was first discovered, only the interior tribes were still using a traditional technology (Staden, 1928). The main tools used in Amazonia in the pre-Columbian era were "polished stone" axes (Staden, 1928).

Archaeologists have carried out experiments to evaluate the effectiveness of polished stone tools. Tests show that fine-grained plutonic igneous rocks are more effective than flint tools for chopping wood (Harding and Young, 1979). The axes cannot be boldly swung like steel axes but require shorter chopping strokes (Coles, 1979). The limitations on sharpness and

[5]All the same, there are suggestions that the Parima is a rather resource poor area. Fuentes (personal communication) has remarked on the shortage of game in the Parima Indians' diet and the emphasis on collected animals. Holmes (1983) has found higher levels of malnourishment in the Parima than in a lower lying community. Similarly, the Sanema talk of subsistence in terms of collecting rather than hunting (Colchester, 1982a).

head width mean that the cuts are often messy and result in much splintering and mashing of the wood (Carneiro, 1974; Lyon, 1974; Coles, 1979). Also, because of the width of the heads, much wider slots have to be cut to allow the axe blows to carry to the face of the cuts (Kozak *et al.,* 1979; Carneiro, 1979). These seem to be the reasons why stone axes are less efficient than steel tools. There is, in addition, considerable labor involved in making and maintaining the tools (Kozak *et al.,* 1979).

Measurements of respiration and time-use during controlled comparisons of steel and stone axes, have revealed that the "stone axe takes over six times as long and requires five times as much energy to accomplish the same work as does the steel axe" (Saraydar and Shimada, 1971).[6]

In situ experiments carried out by Carneiro (1979) among the Yanomamö of the Upper Orinoco suggest that metal axes are as much as 1000% more effective than stone axes depending to a large extent upon the size and hardness of the trees involved. The careful use of fire and ringing (debarking) can considerably reduce labor inputs during felling. Coles notes that "some hardwood trees are totally resistant to axes, the axes merely bouncing off the timber, yet by careful fire-setting the huge trees can be felled in 2–3 days" (Coles, 1979). However, even large trees *can* be felled with stone axes (Kozak *et al.,* 1979).

The details of the practice of agriculture by stone-using Indians in Amazonia has been described elsewhere (Harner, 1963; Lyon, 1974; Carneiro, 1974; Colchester and Lister, 1978). One of the most important techniques used to facilitate clearing was that known as the "driving tree fall" or "serial toppling," whereby numerous smaller trees are first partially cut through and then finally brought down by felling a neighboring forest giant.

The information available on the technical aspects of the pre-steel Yanoama economy is sparse. Sanema elders still recall an era when steel tools were scarce.[7] Previously, they used stone axes (*po koshi*) to fell trees and used to gain access to honey by climbing up to the hives and carefully enlarging the openings with agouti tooth chisels. They did not know how to make any tessellate basketry and did not have any bitter manioc. The Sanema ancestors were very hardy and skillful at hunting but were often hungry. Because they had no metal tools, their gardens were small. They could not fell the larger trees, but would instead fire the bark and lop off the upper branches after climbing up into the trees. Some Sanema mention a technique for felling that involved cracking pieces of wood off the trees

[6]I would like to thank Dennis Briton for helping me locate this material.
[7]It is difficult when talking to the elder Sanema to be sure where personal and collective memories begin and end, and both merge gradually into myth (see, for example, Colchester, 1982d).

using palm wood staves, a story mistaken for mere invention until it was discovered than the same practice has been noted in the Yukon area (Leechman, 1950).

Both the Sanema and the Barafiri Yanoama studied by Smole (1976) mention that the optimal areas for making gardens are those dominated by stands of musaceous plants (*Heliconia* and *Phenakospermum* spp.), and similarly Lizot (1980) has suggested that site selection may have been much more important in the pre-contact era.

THE TRANSITION: STONE TO STEEL

There is some comparative evidence of transitions from stone to steel. The era of transition in the Parima included a phase when stone axes were replaced not by steel axes and machetes but by machete fragments hafted as tomahawks much like the old stone heads. In some Sanema areas this technology still persists (Smole, 1976; Lizot, 1974). The transitional phase is less visible than the introduction of actual steel tools, however.

Lizot has briefly discussed the impact of steel tools on the Yanomami. He has suggested that the Yanomami once cultivated secondary vegetation since it was easier to fell (Vayda, 1976), but gave up this practice over 50 years ago (Lizot, 1980, Chagnon, 1968b). At that time, they enlarged their gardens, reduced their dependence on forest fruits, practiced greater sedentarism, and experienced demographic growth (Lizot, 1980). They may also have begun to increase the proportion of manioc as a crop (Lizot, 1980). While the overall impact of steel tools has been played down by Lizot (see Colchester, 1982b for discussion), he notes that "an important part of working time was saved [after which] the Indians found a new equilibrium for themselves. And it was a happy one" (Lizot, 1976a, b). These points are difficult to substantiate. Comparative data (though not extensive or wholly reliable) suggest that the introduction of steel tools may have a more radical effect than that which Lizot attributes to them.[8]

Harner's study of technological change among the Jivaro is rather misleading since evidence that he presents does not correspond to the era of initial transition from stone to steel, but rather to a later period when metal goods became commonly available (Harner, 1963). He asserts that the introduction of metal goods to the Jivaro did not encourage them to increase

[8]According to Fuentes (personal communication) a forthcoming publication concerning Helena Valero's adventures among the Yanoama (Fuentes, forthcoming) furnishes more details on the effects of the arrival of the first steel tools. In particular, Valero notes that villages grew in size specifically in order to share the rare steel tools.

production. Instead, it increased their leisure, trading activities, and conspicuous consumption. Since similar claims have been made for the Yanoama (Lizot, 1976a, b) and have been generalized for lowland South America (Clastres, 1977), this observation requires further evaluation.

It should be noted that Salisbury's (1962) study of the stone-to-steel transition in New Guinea illustrates this sort of change. The Siane's adoption of steel tools led not to an increase in production, but to general reduction of the subsistence effort by about 38% (Salisbury, 1962). Gardening, in particular, became 3-4 times easier to carry out with this new technology. The relative importance of the various tasks changed significantly, but the diet hardly changed at all (Salisbury, 1962).

There are obvious reasons why we cannot transpose such a scene directly onto Amazonia. The Siane have a population density of over 100 times the Yanoama, and their subsistence is derived from pig raising and sweet potato gardening in clearings cut in impoverished secondary vegation. The intensification of agricultural production may simply not have been possible among the Siane, where the crucial limiting factor was probably land availability rather than a more flexible resource such as labor.

Two Yanoama case studies show that the availability of land for agriculture is highly unlikely to have been a limiting factor (Lizot, 1980; Colchester, 1982a). Nevertheless, it may be worth noting that the Siane, according to Salisbury, used to work 80% of each day in the stone tool era.

Holmberg's study of the Siriono (Holmberg, 1954) provides us with a contrasting example. That society greatly increased production with the acquisition of steel goods. Since Holmberg was himself the provider of the steel goods, he was in a most effective position to evaluate the Siriono's progression "overnight from a technology of the Pre-Stone Age to one of the Iron Age" (Holmberg, 1954).

He noted a remarkable increase in efficiency in collecting activities of fruits, grubs, honey, and palm-cabbage (Holmberg, 1954)

> Wood for bows and arrows was more readily extracted; slain animals were more rapidly cut up; mobility through swamp and jungle was greatly increased; wooden utensils and tools were better and more rapidly constructed. In short, the productive capacity of the families receiving tools more than doubled at once. Perhaps the most significant consequence of the introduction of steel tools, however, was that it paved the way for an expansion of agriculture—and hence an ensuring of the food supply.

However, as Isaacs (1977) has pointed out, the Siriono cannot be viewed as representative of Amazonian economies. Their response to the introduction was probably exaggerated; they were really a severely acculturated people who had lost their traditional material culture during an era of previous contacts with Neo-Brazilians. When Holmberg first encountered them they were in the unfortunate state of having been recently deprived of the industrial goods upon which they had come to depend.

Similar examples of apparently Hobbesian societies, the Akuriyo of Surinam (Kloos, 1977a, b), the Kaingang (Henry, 1964), and even the Guayaki (Clastres, 1972), may best be seen as recently acculturated societies in flight before historical circumstances rather than Nature's unyielding rule.

Even the Heta may be another example of a fugitive people who had recently abandoned agriculture and a more sedentary existence and turned to hunting and gathering in the 1930's, a few decades before they were encountered (Kozak *et al.,* 1979). Although ethnographers were able to observe the transition that the Heta made from stone to steel, they disappeared so quickly, destroyed by the suddeness of culture contact, that little can be gleaned concerning the economic impact of the new tools. The rapidity with which the Heta abandoned stone tool use and the amazingly quick loss of interest in traditional tool-making techniques among the younger generation are, however, notable (Laming-Emperaire, 1964).

Harner (1963) has reasonably concluded that "a change to a more efficient technology seems to mean an increase in production only if there is a demand for it. More efficient tools of themselves do not mean greater production."

The value of the steel tools is not in dispute; the question is: what were the effects of these tools on the Yanoama?

PRESENT TRENDS IN THE YANOAMA ECONOMY

Detailed examinations of present Yanoama subsistence patterns have been presented by Lizot (1972, 1977, 1978, 1980), Smole (1976), and Colchester (1982a), and there are numerous other publications presenting information on various aspects of the Yanoma economy.

These economies are rightly considered as "subsistence" economies since they are still minimally inserted into the national market economies. Although a few, peripheral Yanoama communities are now intimately involved in development schemes (Colchester, 1982e), those communities which have been studied in detail have not commercialized any aspect of the food quest. Colchester (1982a) has noted an intensification in the production of material culture for trade even among the interfluvial Sanema, but these details will not affect the reconstruction which follows.

Yanoama economies have the usual mix of economic tactics characteristic of Amazonia, hunting, fishing, collecting, and agriculture are combined in the food quest. Some aspects of the Yanoama's patterns of subsistence require comment here, since the evidence suggests that these economies are still undergoing change. The currect direction of this change gives us an idea of the continuing effects of new tools and crops on the Yanoama's subsistence.

Yanoama hunting is typically characterized by individual bow-and-arrow hunting in the immediate vicinity of the community. The hunter rarely ventures more than 8–10 km from the home settlement and acts opportunistically to shoot game as encountered (Colchester, 1982a; Zacquini, 1982). More organized hunts made up of several individuals who venture longer distances from the settlement are also integral to the hunting economy (Colchester, 1982a, Zacquini, 1982; Hames, 1980; Saffirio and Scaglion, 1982). The groups extend the radius of resource exploitation to about 28–30 km from the settlement. There is good reason to believe that such extended hunts become more important in the economy the more sedentary the villages are. The immediate vicinity of the settlement is, therefore, more depleted (Hames, 1980; Saffirio and Scaglion, 1982). Where shot guns are available, these are used in preference to the bow and arrow (Hames, 1979; Colchester, 1982a). For the reconstruction which follows, however, we shall use data from communities employing a traditional hunting technology.

The place of fishing in the Yanoama economy varies directly as a function of the availability of fish in the rivers. Certain lowland communities appear to acquire the bulk of their protein from fish. Fishing was less significant in the past when the Yanoama were confined to the uplands. Fishing with hook and line was probably not traditional (Taylor, 1974; Colchester and Lister, 1978) and, according to the Sanema, even fish poisoning has been introduced. The fact that the Yanomami use a Carib word to name the *Lonchocarpus* vine suggests that this may indeed be true, though the observation is rather surprising (see Taylor, 1974).

Collecting forms an integral and very important, though very variable, part of the Yanoama economy. Understanding the reasons for this variability, provides an important clue in our search for an understanding of the effects of technological and agricultural change. The Yanomami of the Upper Orinoco have been especially noted for their emphasis on collecting and trekking. Good (1982) has noted that those in his study area may spend up to 40% of their time on trek. Such expeditions may last up to 40 days at a stretch (Fuentes, 1980) and are frequently undertaken during temporary crop failure (Lizot, 1974, 1978). During such treks, wild fruits and other foods replace bananas and plantains in the diet (Lizot, 1976b, 1978; Fuentes, 1980). In contrast, the more peripheral Yanoama practice much less trekking and collecting. In contrast to the Yanomami of the Upper-Ocamo (Fuentes, 1980), those of the missionized settlement of Iyeweitheri, at the mouth of the river (Cocco, 1972), have not gone on extended treks ("wayumi") for the last 10 years (Fuentes, personal cummunication). When

Table I. Yanomami and Sanema Subsistence Efforts

	Yanomami[a]		Sanema[b]	
	Men	Women	Men	Women
Food preparation	22.5	83.5	6.8	111.6
Technology	122.5	176.5	127.5	109.2
Leisure	1117.0	1039.5	1079.7	1122.0
Fishing	37.0	43.0	25.0	4.2
Hunting	74.5	–	139.0	–
Collecting	9.0	80.5	23.3	28.0
Gardening	57.5	17.0	38.7	65.0
Total	323.00	400.5	360.3	318.0

[a]Lizot (1978, p. 77).
[b]Colchester (1982a, p. 209).

he asked them why, they replied that they already *had* enough food. Only during 1983, due to a severe crop failure which caused visible hunger, have some families gone on treks temporarily.

The Sanema spend far less time on collecting expeditions than did the Yanomami who were studied by Good (1982). Table I contrasts the time spent on collecting tasks among the Sanema with that spent by the Yanomami studied by Lizot (1978). The data also reveal that the manner of collecting, as practiced by the Sanema, differs from the Yanomami not only in the time spent on the task, but in its productivity. In terms of calories gained per calorie expended, collecting by the Sanema is far *less* efficient than among the Yanomami (see Table II); but, in terms of grams of *protein* per minute, Sanema collecting is *more* productive than the Yanomami (Colchester, 1982a).

In fact, these differences are not hard to explain. They can be seen to be direct functions of the efficiency and reliability of agriculture. Among the peripheral Yanoama, like the Yanomami of the Padamo and at the mouth of the Ocamo, like the Sanema and the Ninam, bitter manioc cultivation is common, whereas among the central Yanoama it is unknown. Relying on the unreliable and highly fluctuating harvests from their *Musa* plantations,

Table II. Productivity Ratios of Subsistence Tasks

	Yanomami[a]	Sanema[b]
Aggriculture	19.8:1	28.1:1
Hunting	2.8:1	1.8:1
Fishing	0.8:1	0.9:1
Collecting	2.1:1	0.9:1

[a]Lizot (1978, p. 103).
[b]Colchester (1982a, p. 328).

these central Yanoama are obliged to depend on collecting to tide them through scarce periods. Thus, among the "traditional" Yanoama, collecting and trekking form alternative means of acquiring *calories* when agriculture fails them, whereas, among the peripheral Yanoama, collecting and trekking are primarily supplementary means of acquiring *protein*. These differences are even detectable in the virtues that the Indians ascribe to certain forest fruits. For example, the Yanomami on trek make frequent use of the fallen fruits of *Clathrotropis macrocarpa* ("wapu"; Lizot, 1978; Fuentes, 1980), though complex processing is required to make them edible (Fuentes, 1980); among the Sanema, the same fruits (which they call "wapi") are not even considered edible. The Sanema merely observe that the fruits are eaten by agoutis and "waikia" (wild Indians).

Both Chagnon (1968b) and Lizot (1972) have suggested that manioc cultivation was once much more extensive among the Yanoama than it is today.[9] The evidence aginst these suggestions is overwhelming. First, it must be noted that the Yanoama themselves admit that bitter manioc is a recently adopted crop (Colchester, 1982a). Second, the fact that bitter manioc is cultivated only among the peripheral Yanoama and not among the Parima (Smole, 1976) or in the Upper Orinoco area (Lizot, 1978, 1980) is further confirmation. Bitter manioc provides none of the "central" Yanomami's diet (Lizot, 1978), while *Musa* crops furnish 56% of their calories. Among the Sanema, cassava provides 43% of the calories and *Musa* crops only 34%. Settlements closer to the Ye'kuana than those studied depend even more heavily on *Manihot* crops (Colchester, 1982a). The Sanema (and the Yanomami of the Padamo; Hames, 1983) have adopted bitter manioc cultivation from the Ye'kuana. The Sanema have also derived their mythology of the origin of crops from them (Colchester, 1982d). The complex technology for the bulk processing of bitter manioc, i.e., grating boards, seives, tesselate-weave baskets, and telescopic squeeze presses, has also been adopted from the Ye'kuana. There are still villages among the remoter Sanema where the residents are ignorant of these techniques (Colchester and Lister, 1978). In such areas, the tubers, once grated to a pulp, are sometimes pressed by hand to remove the cyanogenic juices. The semiprocessed flour is then merely wrapped in leaves and baked in the fire to render it edible. These villages rely on visitors from downstream communities to make the baskets which they rely on for bulk processing. Across from the Sanema area, towards the Parima, and on the watershed between the Upper Matakuni and the Upper Ocamo, the dependence on manioc steadily declines. Among the "kopali" Sanema, bitter manioc plays only a marginal role in the economy. Finally, the probability of the Yanoama having origi-

[9] Though Lizot (1980) has apparently revised his opinion.

nally been bitter manioc cultivators is very small on energetic grounds. Comparison of the Yanomami *Musa*-based agriculture and the Sanema *Manihot*-based agriculture shows that the Sanema system is much more efficient (about 42% more efficient; see Table II). If the Yanoama are now adopting *Manihot* in preference to *Musa* because it is a more efficient and more reliable crop, is it likely that they *completely* abandoned manioc agriculture in the past?

In sum, certain economic trends are clearly discernible among the present-day Yanoama. They are increasing the sophistication of their agricultural base, so that it is both more efficient and reliable. This is leading to an increasingly sedentary life style, a reduction in the importance of collected foods and trekking and a change in the character of hunting. As villages become more stable, hunting may be becoming more intensive and organized (Safirio and Scaglion, 1982). In certain areas, the practice of hunting zone rotation has been adopted from the Ye'kuana (Hames, 1980; Colchester, 1982a).

Taking all this information into account, it is clear that the Sanema economy is much more different from the aboriginal Yanoama economy than that of the Yanomami. For this reason, we shall use the data collected by Lizot (1978) among the Yanomami for the reconstruction which follows.

RECONSTRUCTING THE PRE-COLUMBIAN YANOAMA ECONOMY

The data presented in Tables I and II, derived from Lizot's extensive studies of the Yanomami of the Manaviche area (presented alongside comparative data collected among the Sanema), form the basis for the speculative reconstruction of the Yanoama economy which follows.[10]

This reconstruction takes place in three stages. First, an attempt is made to correct for the distortion of the data introduced by the destabilization of the demography due to contact. Second, a fictional Yanoama economy is generated by supposing that the Yanoama of the past attempted to maintain their current production mix, with the same crops and foraging practices as today, but using a pre-steel technology. The implausibility of this economy obliges us to imagine ways that the real pre-steel Yanoama would have adjusted their economic strategy to reduce their subsistence effort. Finally, an attempt is made to account for the changes induced by the introduction of *Musa* crops. The possible form of the pre-Columbian Yanoama economy is thus dimly perceived.

[10]Discussion of field methods should be sought in Colchester (1982a, Appendix 1) and in Lizot (1978). My studies were purposefully modeled on Lizot's for comparative purposes.

Table III. Age Cohorts in Yanoama Populations

Years	Sanema[a]	Yanomami[b]	Yanoama[c]	Stable Yanoama[d]
0-14	45.9	35.5	45.4	41.9
15-60	49.6	60.6	53.6	54.5
60+	4.4	4.2	1.0	3.6

[a]Colchester (1982a, p. 118).
[b]Adjusted from Lizot (1978, p. 80).
[c]Neel and Weiss (1975).
[d]Coleman (personal communication).

Table I shows the data collected among the Sanema and Yanomami by Colchester (1982a) and Lizot (1978) concerning the proportions of an average day devoted to subsistence tasks by adult Yanoama between the ages of 15-60 years of age. From detailed studies of Yanomami and Sanema dietary intakes and from careful estimations of the energy expenditure during subsistence tasks, we can calculate the contributions that the various subsistence tasks make to the diets. We can thus estimate the productivity ratios of the various subsistence tasks (see Table II).

These subsistence efforts correspond to populations with structures that have been radically transformed in the past. The populations have been growing for over a century but have recently been seriously affected by introduced epidemic diseases (Neel and Chagnon, 1968; Lizot, 1976a, b; Ramos and Taylor, 1979). These demographic fluctuations have had important effects on the Yanoama's dependency ratios. The number of nonproducers (those between 15-60). Accordingly, we have attempted to simulate a population with a stable structure by manipulating the data of Neel and Weiss (1975) with a computer.[11] The real population could be stabilized by decreasing the total fertility to 7.13. The resulting changed age structure is summarized in Table III and compared to other real Yanoama populations. The same data produce the dependency ratios displayed in Table IV.

These figures reveal that the dependency ratio of Lizot's population is low, corresponding as one would expect to a population which has recently suffered severe mortalities, especially among the young (see, for example, the irregular population profile in Lizot, 1977). We must thus increase the overall subsistence effort proportionally to satisfy the requirements of the simulated, stable population with its higher number of dependents (see Table VI, column 2).

[11]These simulations were carried out by Dr. David Coleman of the University of Oxford. I take this opportunity of thanking him for his generous collaboration. Further details can be found in Colchester (1982a, f). The simulations omit considerations of the radical changes in disease ecology that have occurred in post-Columbian times. However, the simulations are probably the best we can do with the data available.

Table IV. Dependency Ratios of Yanoama Populations[a]

	Dependents
Sanema	101.4
Yanomami	65.5
Yanoama	86.6
Stable Yanoama	83.5

[a]Number of dependents per 100 producers calculated from Table III.

Table V presents us with a tentative conversion table in which production estimates based on data collected among steel-using Yanoama can be converted into corresponding rates for stone-using Indians in the same environment and attempting identical production techniques. The figures in this table are mainly derived from the material discussed above and are only offered as reasonable estimates. These should be adequate for our purposes since, in reality, there are many more variables than we can hope to control exactly.

The conversion ratio for agriculture is derived primarily from the study of Salisbury (1962)[12] according to which agricultural productivity increased three- to fourfold when the Siane switched from stone to steel tools. The ratio for hunting is given as 1:1, since the Yanoama studied by Lizot employ essentially the same technology today as they did in the pre-steel era. The productivity of fishing must have been considerably reduced in the past when hook and line were not available. If poisoning with *Lonchocarpus* vines was practiced, the energy cost of cutting down the vines must have been about 5–10 times greater with stone tools (according to the material cited above), while the rest of the process of poisoning would not have changed greatly. The increase in total effort necessary to secure the same catch can be moderately estimated at 2:1. The conversion ratio for collecting may be the most difficult to estimate. The tasks vary from being extremely dependent on cutting tools, such as collecting honey, felling branches in the leafy crowns to harvest caterpillars, and hacking open trunks to gather palm cabbage or grubs, to being completely technology independent, such as gathering fallen fruits.[13]

[12]We must distinguish between total agricultural effort and forest clearance. Carneiro (1979) estimates that the latter may have been 8–10 times more arduous for the stone-using Yanoama.

[13]In making these estimates we are made aware of the lack of field data which discriminate more exactly between the various activities which make up the different tasks. Future studies aimed at evaluating the impact of technological change should take care to measure the exact proportions of time during which different tools are used so we can more accurately account for their replacement of less efficient alternatives.

Table V. Tentative Tabulation of Relative Efficiency of Technologies in Subsistence Tasks

Task	Steel: stone ratio
Agriculture	3:1
Hunting	1:1
Fishing	2:1
Collecting	2:1
Food preparation	1:1
Technological task	1.5:1

The figure of 2:1 is based on Holberg's observation that steel tools "more than doubled" the Siriono's productivity. Since, unlike the deprived Siriono, the Yanoama possessed stone axes, the impact of steel tools on this aspect of their production would presumably have been somewhat less. Similarly arbitrary conversion figures are offered for food preparation and technological tasks.

By applying these conversion figures to the Yanoama subsistence effort detailed in Table VI (column 2), we can calculate the subsistence effort of a fictional, stabilized Yanoama population of the same size as the present day communities by adopting the same overall strategy. The putative effort is given in column 3. These figures suggest that such Yanoama would have had to work 11½ hr each day to maintain their present dietary standards. Steel tools offer these theoretical Yanoama the possibility of reducing the overall subsistence effort by 4½ hr per day, that is, by 40%.

Eleven and a half hours a day is a lot of work by any standards and we may speculate that the Yanoama would, in fact, have adjusted their

Table VI. Yanoama Subsistence Efforts (in Minutes)

	Yanomami[a]	Stable Yanoama[b]	Pre-steel stable Yanoama[c]
Agriculture	37	43	129
Hunting	37	43	43
Fishing	40	47	94
Collecting	45	53	106
Technology	150	175	262
Food preparation	53	62	62
Total	362	423	696

[a]Adjusted from Lizot (1978, p. 77) allowing for imbalance in sex ratio.
[b]Adjusted from Footnote *a* allowing for higher dependency ratio (see Table IV).
[c]Adjusted from Footnote *b* allowing for lower efficiency of stone age technology, using Table V.

Table VII. Relative Efficiency of Subsistence Tasks

	Actual[a]	Stone Age[b]
Agriculture	19.8:1	6.6:1
Hunting	2.8:1	2.8:1
Fishing	0.8:1	0.4:1
Collecting	2.1:1	1.1:1

[a]Lizot (1978, p. 103).
[b]From Table V.

strategy to reduce this load. They may have for example, reduced settlement sizes, practiced senilicide, or made greater use of child labor. However, the most important adjustments would have been to change the *proportional* investment in the various subsistence tasks. As Table VII demonstrates, the *relative* efficiencies (productivity ratios) of the different tasks change dramatically with the change in technology.

Assuming that the Stone Age Yanoama would have adjusted their subsistence strategy to optimize calorie returns,[14] we can suggest that the Yanoama barely used to fish at all. Even today, with a modern technology, fishing is energy expensive rather than productive and the upland Yanoama only fish to get protein when hunting fails (Colchester, 1982). This may explain the Yanoama's professed absence of an aboriginal fishing technology. Most important, we should note that agriculture is more than seven times as efficient as hunting as a means of acquiring calories (see Table II), but appears to be only 2⅓ times as effective when stone tools are used (see Table VII). These figures require some discussion.

First, we must consider whether the disadvantages of stone tool use in agriculture might not have been mitigated by adjusting the style of plot clearance and weeding. Since the effort of felling trees is the most energy-expensive aspect of the agricultural cycle, the Yanoama would presumably have carefully selected garden sites before feeling. There is evidence that this was indeed the case. As noted above, both the Sanema (Colchester, 1982a) and the Parima Yanomami (Smole, 1976) mention their preference for areas dominated by stands of soft-stemmed musaceous species. Presumably the same logic leads Lizot (1980) to suggest that the Yanomami used to clear gardens in secondary vegetation in the past. We should note, however, that Hames (1983) has affirmed that weeding is much more arduous in plots cleared in secondary vegetation (because the burns are less intense, killing fewer weed species and because of the higher proportion of

[14]The simplification is crude but has been widely used in evaluating Amazonian subsistence practice (Werner *et al.*, 1979; Gross *et al.*, 1979; Flowers *et al.*, 1982) and forms the basic assumption of the newly popular "optimal foraging" studies (Hames and Vickers, 1982).

adventitious species in the secondary vegetation). Thus, any reduction in labor input gained in clearing the relatively soft wood of the secondary vegetation, would be somewhat offset by the increased effort of weeding.

Regardless of how the Yanoama optimized their agricultural practice in the pre-contact era, we must bear in mind the salient feature of such agriculture as recalled by the Yanoama themselves. In the past, plots were *smaller* and not all the trees were fully felled. If the Yanoama of the Stone Age did once practice agriculture less intensively, how did they compensate for it in supplying their diet?

The rather slight advantage that our data give to Stone Age *Musa*-based agriculture over hunting suggests the answer. It is not difficult to see that even quite small modifications of hunting and collecting techniques, or changes in the overall subsistence strategy, could swing the balance in favor of a primarily foraging rather than a primarily agricultural subsistence base. Foraging yields are optimized by increasing mobility. The major factor impeding mobility is agriculture, therefore, the importance of this basic choice in strategy is emphasized. The data collected by Fuentes (1980) are important in this respect. His map (Fuentes, 1980) shows the localized concentrations of the primary wild food species. The seasonal harvests of these fruits can only be taken advantage of by extended trekking and camping in the areas of temporary abundance. Unfortunately, the data he has collected on time use and diet cannot be used to accurately estimate productivity during trekking (Fuentes, 1980), but he emphasizes the facility with which wild foods are encountered. These (steel-using) Yanoama, while on trek, spent a mere 94 min per day foraging to provide 84% of their diet by weight, (the rest being made up with bananas they brought with them). In contrast, in the vicinity of the fixed group, wild food species are often eliminated (Anderson, 1977); and foraging, while absorbing the Yanomami for about 122 min per day, provides only 27% of their food by weight (Lizot, 1978).

These observations, coupled with our knowledge of present day trends in Yanoama subsistence, suggest the answer to our problem. Just as today the Yanoama turn to trekking to make up the shortages in the agriculture, so would they have in the past. Because their agricultural base was even less reliable and extensive than it is today, trekking would have been even more important.

It is now necessary to consider what the Yanoama economy would have been like before *Musa* crops were introduced. That *Musa* crops have an Old World origin is beyond dispute (Simmonds, 1966),[15] and it is gener-

[15]Musa crops are sterile and polyploid, derived from the hybridization of two wild South East Asian species (Simmonds, 1966).

ally agreed that they were introduced in the post-Columbian era.[16] In the pre-*Musa* era, Yanoama crops would have included peach palms (*Bactris gasipaes*), Maize (*Zea mays*), and neotropic tubers, such as cocoyams (*Xanthosoma* sp. aff. *cajacu*), sweet potatoes (*Ipomoea batatas*), and the neotropic yam (*Dioscorea trifida*),[17] as well as sweet manioc (*Manihot utilissima*). They presumably also cultivated other useful plants like arrow cane, gourd fruits (*Lagenaria* spp., not *Crescentia cujete*), cotton, tobacco, "magical" plants (*Cyperus* spp.), certain drugs (Acanthaceae), etc.

Although there is no data available for us to estimate the relative productivity of such an agricultural base in comparison with *Musa* cultivation, we can be fairly sure it was less efficient (why else would the Yanoama have adopted *Musa* as their staple?). If this is so, the dependence of the pre-steel, pre-*Musa* Yanoama on foraging (hunting and collecting) must have been even greater. If the present-day steel-using, *Musa*-cultivating Yanomami still spend up to 40% or more of their time trekking as Good (1982) has indicated, the pre-Columbian Yanoama must have spent much more time away from their gardens.

Maybe there are too many guesses and estimates in this train of thought to make any conclusions worthwhile. If we do accept them as being generally accurate, we might suppose that the Yanoama of the seventeenth century were interfluve foragers, who supplemented their subsistence by the cultivation of small plots, widely dispersed about their foraging territory. In these small, semicleared gardens they would have concentrated on quick maturing crops requiring limited labor inputs, like cocoyams, which the Sanema call "ohinamo" (the "hunger food") and maize which they call "shilimo" (the "hasty food").[18] The slower maturing peach palms would have demanded minimal attention and, as today, would have provided the opportunity for occasional but important supplements to the diet, exploited in almost the same way as the seasonal productions of wild fruits.

Dependent on a mobility and flexibility of population structure (Colchester, 1983) that discouraged the development of large communities or a complex technology, they survived through an intimate knowledge of the local environment. Only with the adoption of new crops, first *Musa* and

[16]Apparently, however, Smole is reluctant to admit that *Musa* were not cultivated in the Americas in the pre-Columbian era (Roosevelt, 1980). Certainly, his theory that the Parima savannahs were caused by overintensive agriculture "over a period that can be measured in centuries" (Smole, 1976) does not accord well with a post-Columbian introduction of *Musa*.

[17]Not to be confused with the much more productive Old World yam (*Dioscorea alata*).

[18]Such an economic base is comparable to that found among the Shavante (Maybury-Lewis, 1974; Flowers *et al.*, 1982), who had an essentially trek-oriented foraging economy supplemented by occasional and seasonal gardening.

later, in some areas, bitter manioc, and subsequently with the acquisition of steel tools have the Yanoama become the numerous people that we know today.

Is there any real evidence that the Yanoama did indeed once have such a subsistence base? In fact there is; nearly all the earlier descriptions of the Yanoama are in accord rather closely with this reconstruction. The very first remarks by the earliest explorers to the Upper Orinoco, concerning Yanoama patterns of subsistence, suggest an emphasis on collecting. Cocco cites the first missionary on the Upper Orinoco in 1767 as noting that the Yanoama used to collect the fruits of cacao (*Theobroma* spp.) and "yuvias" (Brazil nuts—*Bertholletia excelsa*) and "with such fruit the guariba nation maintains itself, making collections during the time of harvest and storing them for when they cannot go into the jungle to collect them" (Cocco, 1972, p. 45, my translation).

Similarly, Humboldt noted this same emphasis of the Upper Orinoco Yanoama on these fruits, especially the Brazil nuts. He noted in 1801:

> Advancing above the Gehette and Chiquire the *juvia* and cacao trees become so common that the wild Indians (the Guaicas and Guaharibos) do not disturb the Indians of the missions when gathering in their harvests. They do not envy them the productions with which nature has enriched their own soil. (1851, p. 450)[19]

Shortly afterwards (1838), the explorer Robert Schomburgk made a traverse of the Parima and has this to report of the Yanoama then living on the middle Uraricoera, where they had been in contact with Uruak (Awaké) groups for some years. He notes:

> The Kirishanas. . .like the Oewaku, except that they are more bellicose and braver, form a wandering tribe that lives in quite a state of nature. They go about without any clothing and live either by hunting in the mountains or, if this does not produce sufficient quarry, on the fish turtle and alligators in the river. Now and again they clear a little piece of forest ground and plant it with capsicums and cassava roots. . .so as to return later when other pursuits permit of it and collect the harvest. (Schomburgk, 1841, p. 153)

Even the record of Helena Valero's sojourn with the Yanoama in the first half of this century suggests that agriculture was not the dominant subsistence base of all the Yanoama but that some groups still depended largely on foraging (Biocca, 1971). However, it is conceivable that this lack of agriculture among some groups has another explanation, being the result of enforced migrations due to warfare (Colchester, 1982a).

Thus, although the historical record is very fragmentary, the fact that it coincides quite closely with our reconstruction seems to confirm their va-

[19] In contrast, the present day Yanoama of the Upper Orinoco, studied by Lizot (1978, p. 101), gain only .07% of their annual calorie intake from this nut.

lidity. The Yanoama have made a transition from a foraging economy supplemented by "incipient" agriculture to an agricultural economy supplemented by foraging. Even today, the process of transition seems far from complete. On the contrary, the Yanoama are still increasing their dependence on agriculture, and it seems highly unlikely that the Yanoama ever achieved that "happy equilibrium," after their acquisition of the produce of the outside world, that Lizot has claimed.

CONCLUSIONS

> The agrarian alternative had a limited—and very diverse—appeal to non-farming groups when cultivation was primitive and leadership not overly demanding. (Wittfogel, 1957, p. 16)

If these reconstructions are valid (and we should recall their provisional nature given the almost complete lack of previous research in this field) they may have important implications for our understanding of Amazonian societies in general.

In the first place, the study suggests that the adoption of agriculture in Amazonia in the pre-Columbian era may not have been an obvious choice for all the Amerindians, even when crops were available. The high labor inputs necessary for clearing plots with stone axes and the disadvantageous way that agriculture limits mobility and thus reduces the effectiveness of foraging, are important discouragements to incorporating agriculture into the economy. This latter disadvantage, we should note, will weigh less heavily against peoples who live near rivers which provide dependable supplies of protein from fishing, since mobility is much less important for such fishers than for hunters. This suggests that Lathrap's (1970) distinction between riverine and forest cultures is once again validated in general terms.[20]

Lizot (1978) and Clastres (1976, 1977) have attempted to relate Sahlins' (1972) proposal of an era of aboriginal affluence among Stone Age foragers to the "neolithic" cultivators of the Amazon (Bergman, 1980; Arcand, 1976). Given the fact that the data on which these suggestions are based relate to steel-using, not to the Stone Age Indians,[21] the argument is

[20] Lizot is quite wrong to think that his studies of the soils and production of the Yanomami communities living near the Orinoco refute Lathrap's model (Lizot, 1977, 1980). his data of Yanomami fishing productivity show that the yields are very low (see the productivity of the Bororo studied by Werner *et al.*, 1979, where fishing is three times as productive, though the Mato Grosso is not a nutrient-rich area). The soils of the Guianas are infamous for their poverty and cannot be compared to the "varzeas," while the Upper Orinoco is quite different from the Lower Orinoco and the Amazon which receive the relatively nutrient-rich waters of the Andes.

[21] Moreover, all the examples cited by Sahlins are of steel-using peoples (Colchester, 1982b).

poor. The subsistence effort required in the pre-Steel Era was probably *much* greater than that required in the present era of steel tools. Researchers who have attempted to draw direct conclusions about pre-Columbian social organization, or "cultural development," from information obtained by studying contemporary Indians (Meggers, 1971; Carneiro, 1970, 1973; Gross, 1975) have made this error in judgment.

Remote groups like the Yanoama, long considered to be the largest unacculturated group of Indians in Amazonia, have, it seems, been experiencing continuous change over several centuries. They cannot, therefore, be treated as if they were *stable* adaptations to their environment. In short, it is time that we started examining Amazonian societies in terms of the recent radical transformations that have occurred and that are occurring in their technological, demographic, and economic bases, and must begin to consider what effects these changes might have had on other aspects of their social organization and systems of thought.[22]

REFERENCES

Anderson, A. D. (1977). Os nomes e usos de palmeiras entre uma tribu de indio Yanomama. *Acta Amazonica* 7(1): 5-13.

Arcand, B. (1976). Cuiva food production. *Canadian Review of Sociology and Anthropology* 13(4): 387-396.

Bergman, R. (1980). *Amazon Economics: The Simplicity of Shipibo Indian Wealth.* University Microfilms International.

Biocca, E. (1971). *Yanoama: The Story of a White Girl Captured by Indians.* Dutton and Co., New York.

Carneiro, R. (1970). *A Theory of the Origin of the State.* Institute of Humane Studies, California.

Carneiro, R. (1973). Slash-and-burn cultivation among the Kuikuru, and its implications for cultural development in the Amazon basin. In Gross, D. (ed.), *Peoples and Cultures of Native South America.* Doubleday Natural History Press, New York, pp. 98-123.

Carneiro, R. (1974). On the use of the stone axe among the Amahuaca of Eastern Peru. *Ethnologische Zeitschrift Zuerich* I(197): 107-122.

Carneiro, R. (1979). Forest clearance among the Yanomamö, observations and implications. *Antropologica* 52: 39-76.

Chagnon, N. (1968a). *Yanomamö: The Fierce People.* Holt, Rinehart and Winston, New York.

Chagnon, N. (1968b). The culture ecology of shifting agriculture among the Yanomamö. *Proceedings of the 8th International Congress of Anthropological and Ethnological Sciences* 3: 249-255.

Chagnon, N. (1974). *Studying the Yanomamö.* Holt, Rinehart and Winston, New York.

Clastres, P. (1972). *Chronique des Indiens Guayaki.* Editions Plon, Paris.

Clastres, P. (1976). *Preface to M. Sahlins' Age de Pierre, Age d'abondance.* Gallimard, Paris, pp. 11-30.

Clastres, P. (1977). *Society against the State.* Basil Blackwell, Oxford.

[22]Elsewhere I have made just such an attempt with the Yanoama material (Colchester, 1983).

Cocco, L. (1972). *Iyeweiteri: Quinee Anõs entre los Yanomamös.* Escuela Tecnica Don Bosco, Caracas.
Cohen, J. (ed.). (1969). *The Four Voyages of Christopher Columbus.* Penguin, Harmondsworth.
Colchester, M. (1982). *The Economy, Ecology and Ethnobiology of the Sanema Indians of South Venezuela.* Doctoral dissertation, University of Oxford.
Colchester, M. (1982b). Les Yanomami, sont-ils libres? Les utopies Amazoniennes, une critique. A look at French anarchist anthropology. *Journal of the Anthropological Society of Oxford* 13(2): 147-164.
Colchester, M. (1982c). Ecological modelling and indigenous systems of resource use. Some examples from the Amazon of Venezuela. *Antropologica.* In press.
Colchester, M. (1982d). Myths and legends of the Sanema. *Antropologica.* In press.
Colchester, M. (1982e). Amerindian development: The search for surplus production in Amazonia. *Survival International Review.* In press.
Colchester, M. (1982f). Health and survival among the Yanoama. Document prepared for publication by the Anthropological Resource Centre and Survival International.
Colchester, M. (1983). The Yanoama at war; Subsistence, sovereignty and social change in an Amazonian society. *Man.* Submitted.
Colchester, M., and Lister, J. (1978). The ethnobotany of the Orinoco-Ventuari region: An introductory survey. Manuscript.
Coles, J. (1979). *Experimental Archaeology.* Academic Press, London.
Cruxent, J. (1961). El alto Ventuari. *Boletin Informativo* II: 38-40.
Flowers, N. *et al.* (1982). Variation in Swidden practice in four central Brazilian Indian societies. *Human Ecology* 10(2): 203-218.
Fuentes, E. (1980). Los Yanomami y Las Plantas Silvestres. *Antropologica* 54: 3-138.
Fuentes, E. (ed.). *Yo Soy Napëyoma.* Fundacion La Salle, Caracas. Forthcoming.
Good, K. (1982). Limiting factors in Amazonian ecology. Paper presented to the 81st Annual Meeting of the American Anthropological Association, Washington, D.C.
Gross, D. (1975). Protein capture and cultural development in the Amazon basin. *American Anthropologist* 77: 526-549.
Gross, D. *et al.* (1979). Ecology and acculturation among native peoples of central Brazil. *Science* 206: 1043-1050.
Hames, R. (1979). A comparison of the efficiencies of the shotgun and the bow in neotropical forest hunting. *Human Ecology* 7(3): 219-252.
Hames, R. (1980). Game depletion and hunting zone rotation among the Yekwana and Yanomamo of Amazonas, Venezuela. *Working Papers in South American Indians* 2: 31-66.
Hames, R. (1983). Monoculture, polyculture and polyvariety in tropical forest Swidden cultivation. *Human Ecology* 11(1): 13-34.
Hames, R., and Vickers, W. (1982). Optimal diet breadth theory as a model to explain variability in Amazonian hunting. *American Ethnologist* 2(2): 358-378.
Harding, A., and Young, R. (1979). Reconstruction of the hafting methods and function of stone implements. In Clough, T., and Cummins, W. (eds.), *Stone Axe Studies.* Council for British Archaeology Research Council, Report No. 23, pp. 102-105.
Harner, M. (1963). *Machetes, shotguns and society: An inquiry into the social impact of technological change among the Jivaro Indians.* University Microfilms, Ann Arbor.
Harris, M. (1974). *Cows, pigs, wars and witches: The riddles of culture.* Fontana, Glasgow.
Harris, M. (1977). *Cannibals and Kings: The Origins of Cultures.* Fontana/Collins, London.
Harris, M. (1979). The Yanomamo and the causes of war in band and village societies. In Margolis, M., and Carter, W. (eds.), *Brazil: Anthropological Perspectives.* Columbia University Press, pp. 121-132.
Henry, J. (1964). *The Jungle People: A Kaingang Tribe of the Highlands of Brazil.* Vintage Books, New York.
Holmberg, A. (1954). *Nomads of the Long Bow; the Siriono of Eastern Bolivia.* Natural History Press, New York.
Holmes, R. (1983). *Adaptación Tradicional Indigena a la Selva Pluviosa Tropical del Territorio Federal Amazonas.* Talk to the Audubon Society of Caracas, February 17, 1983.

Humboldt, A. (1851). *Personal Narrative of Travels to the Equinoctial Regions of America.* George Routledge and Sons, London.
Isaacs, B. (1977). The Siriono of eastern Bolivia: A re-examination. *Human Ecology* 5(2): 137-154.
Kloos, P. (1977a). *The Akuriyo of Surinam. A Case of Emergence from Isolation.* International Work Group on Indigenous Affairs, Document 27, Copenhagen.
Kloos, P. (1977b). The Akuriyo way of death. In Basso, E. (ed.), *Carib-speaking Indians: Culture, Society and Language.* University of Arizona Press, Tucson, pp. 114-122.
Kozak, V. (1972). Stone age revisited. *Natural History* 81: 14-24.
Kozak, V. *et al.* (1979). *The Heta Indians. Fish in a Dry Pond,* Vol. 55. Anthropological Papers of the American Museum of Natural History, New York.
Laming-Emperaire, A. (1964). Les Xeta, survivantes de l'age de la pierre. *Objets et Mondes* 4: 263-276.
Lathrap, D. (1970). *The Upper Amazon.* Praeger, New York.
Leechmen, D. (1950). Aboriginal tree felling. *Bulletin of the National Museum of Canada,* 118: 44-49.
Lizot, J. (1972). Economie ou societe? Quelques themes a propos del' etude d'une communaute d'Amerindiens. *Journal de la Societe des Americainistes* 60: 137-174.
Lizot, J. (1974). El rio de los Periquitos. Breve relato de un viaje entre los Yanomami del Alto Siapa. *Antropologica* 37: 3-23.
Lizot, J. (1976a). *The Yanomami in the Face of Ethnocide.* International Work Group on Indigenous Affairs, Document 22, Copenhagen.
Lizot, J. (1976b). *Le Cercle des Feux.* Editions de Seuil, Paris.
Lizot, J. (1977). Population, warfare and resources among the Yanomami. *Man* 12(3/4): 497-517.
Lizot, J. (1978). L'economie primitive et subsistence. *Libre* 4: 68-113.
Lizot, J. (1980). La agricultura Yanomami. *Antropologica* 54: 3-93.
Lyon, P. (ed.). (1974). *Native South Americans: Ethnology of the Least Known Continent.* Little Brown and Co., Toronto.
Meggers, B. (1971). *Amazonia; Man and Culture in a Counterfeit Paradise.* Aldine/Atherton, Chicago.
Migliazza, E. (1972). *Yanomama Grammar and Intelligibility.* University Microfilms, Ann Arbor.
Neel, J., and Chagnon, N. (1968). The demography of two tribes of primitive relatively unacculturated American Indians. *Proceedings of the National Academy of Science* 59: 680-689.
Neel, J., and Weiss, K. (1975). the genetic structure of a tribal population. *American Journal of Physical Anthropology* 42: 25-52.
Purchas, S. (1905). *Hakluytus Posthumus or Purchas his Pilgrimes Contayning a History of the World.* Hakluyt Society, Glasgow.
Ramos, A., and Taylor, K. (1979). *The Yanoama in Brazil.* The Anthropological Resource Center, International Work Group on Indigenous Affairs, Document 37, Survival International, Copenhagen.
Roosevelt, A. (1980). *Parmana: Prehistoric Manioc and Maize Cultivation on the Amazon and Orinoco. Academic Press, New York.*
Saffirio, G., and Scaglion, R. (1982). Hunting efficiency in acculturated and unacculturated Yanomama villages. Journal of Anthropological Research 38(3): 315-327.
Salisbury, R. (1962). *From Stone to Steel.* Cambridge University Press, London.
Saraydar, S., and Shimada, I. (1971). A quantitative comparison of efficiency between a stone axe and a steel axe. *American Antiquity* 36: 216-217.
Schomburgk, R. (1841). *Travels in the Guianas and on the Orinoco during the Years 1835–1839.* Geographical Society, London.
Simmonds, N. (1966). *Bananas.* Longmans, London.
Smole, W. (1976). *The Yanoama Indians: A Cultural Geography.* University of Texas Press, Austin.
Staden, H. (1928). *Hans Staden: The True Story of His Captivity, 1557.* George Routledge and Sons, London.
Stelcl, J., and Malina, J. (1970). Anwendung der Petrographie in der Archaeologie. *Folia Fac. Sci. Nat. Univ. Purkynianae Brunensis Geologia,* 11(5).

Taylor, K. (1974). *Sanuma Fauna: Prohibitions and Classifications.* Fundación la Salle, Caracas.
Vayda, A. (ed.).-(1976). *War in Ecological Perspective.* Plenum Press, New York.
Werner, D. *et al.* (1979). Subsistence productivity and hunting effort in native South America. *Human Ecology* 7(4): 303-316.
Wilbert, J. (1963). *Indios de la Región Orinoco-Ventuari.* Fundación La Salle, Caracas.
Wittfogel, K. (1957). *Oriental Despotism: A Comparative Study of Total Power.* Vintage Books, Random House, New York.
Zacquini, C. (1982). Occupacao do territorio por seis comunidates Yanomami. In *Relatorio Yanomami, 1982, Situacao de Contato e Saude.* The Comisao pela Criacao do Parque Yanomami, Sao Paulo, pp. 123-132. Manuscript.