

Jonathan Hill

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on
South American
Indians**

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**Studies in Hunting and Fishing
in the Neotropics**

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EDITOR'S PREFACE

The primary purpose of this series, as stated in the first issue, is to provide "rapid dissemination between specialists of new data, theoretical perspectives, symposia, etc., without the normal impedimenta of journal and book publication."

The present issue is a good example of the service we hope to be able to provide. The papers which make up Number 2 of the Working Papers on South American Indians were presented to a symposium of the XLIIIth International Congress of Americanists in Vancouver, British Columbia on August 13, 1979. The series editor received the completed manuscript on February 7, 1980; printed copies will be in the mail to those with standing orders before the first of April. Given the current interest in the debate dealt with in this symposium, we feel that making these data available without great delay best serves the interests of scholars and scholarships.

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Readers' responses to the first issue of WP was most gratifying, particularly the responses from scholars living outside the United States many of whom placed standing orders for the series. We invite all our readers to follow their example. This speeds up the delivery process by allowing us to mail new issues as soon as they come from the bindery. It also saves us the expense of notifying you of the availability of each issue as it is about to appear, thus cutting the price we have to charge to cover the cost of production and postage.

* * * * *

Now that WP Number 2 has gone to press we are making plans for subsequent issues. Work has begun on preparing the papers from the 1977 AAA symposium organized by Jane Safer for late spring publication. Gertrude E. Dole is preparing a selection of essays on the Kuikuru, the Amahuaca, and other groups and problems in the Amazon basin which she presented at various professional meetings but never published. This will be the first of what we hope will be many volumes of collected papers by individual authors, papers full of data, analyses, and speculation which languish unpublished in our files after their initial presentation at annual meetings, symposia, etc.

* * * * *

WP Number 2 is the result of the work and cooperation of many people. Ray Hames organized the symposium and edited the papers. Much of the manuscript reached the editor ready for photo offset reproduction; Wendy Guerra did the retyping needed. Bea Shapiro of the Bennington College duplicating department and Maryellen Staples were responsible for printing. The Pennysaver Press of Bennington printed the cover, collated, and bound the volumes.

Kenneth M. Kensinger
Series Editor

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Working Papers on South American Indians, Kenneth M. Kensinger,
series editor.

1. "Social Correlates of Kin Terminology" edited by David John Thomas. 1979. 85 pp. \$2.00. (Includes papers by K. Adams on Barama River Carib, G. Dole on Amahuaca, R. Hahn on Rikbakca, O. Johnson on Machiguenga, and D. Thomas on Pemon.)
2. "Studies of Hunting and Fishing in the Neotropics" edited by Raymond B. Hames. 1980. 137 pp. \$4.00.

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STUDIES OF HUNTING AND FISHING IN THE NEOTROPICS:

INTRODUCTION

Raymond B. Hames

Beginning roughly in 1946 with the publication of the monumental Handbook of South American Indians (seven volumes, 1946-1959), edited by Julian Steward, one of the founders of cultural ecology, tribal societies in Amazonia have been the subject of a great deal of theorizing by proponents of cultural ecology. This is best exemplified in the early works of Meggers (1954; 1957), Carneiro (1957; 1960; 1961), and Steward and Faron (1959) and more recently by Lathrap (1968), Carneiro (1968), Meggers (1971), Siskind (1973), Gross (1975), Denevan (1966; 1976), Durham (1976), and Ross (1978). These theorists have attempted to explain such wide-spread patterns as low population density, small village size, high settlement mobility, village fissioning, infanticide, and warfare which characterize many native communities as adaptive responses to either nutrient deficient garden soils or scarce fish and game resources, or a combination of the two. But what is striking in nearly all of these adaptive explanations is the lack of high quality quantitative data which is necessary to test propositions about the relation between environment and cultural behavior.

This is not to suggest that all Amazonian researchers have been in general agreement over the nature of environmental determinants of social processes. In 1974 Chagnon suggested that warfare and fissioning among the Yanomamö could not be accounted for by ecological models of resource scarcity. Soon after, Gross (1975), Durham (1976), and Ross (1978) claimed that protein scarcity was a wide-spread problem throughout Amazonia and

no one had presented data to the contrary. Lizot (1978) and Chagnon and Hames (1979) marshalled evidence to show that Yanomamö protein intake was more than adequate, that protein was acquired with little effort, and that warfare over game resources and territory did not occur. In the same vein Beckerman (1979) made a survey of animal and vegetable protein resources available to Amazonian populations and concluded that Gross (1975) had underestimated their diversity, quantity, and quality. Vickers (1975) presented data on the hunting abilities of a group of Siona-Secoya hunters to argue against Siskind's (1973) suggestion that men frequently exchanged meat for sexual favors from women due to protein scarcity. In addition, Johnson (1974) and Vickers (1978) cautioned against the use of simplistic univariate explanations of environmental relations by quantitatively demonstrating that, depending on time and place, a variety of limiting factors could account for adaptive responses.

Although at times the level of debate between proponents of various positions has been acrimonious it has also stimulated new research and publications on a variety of ecological topics which, in a sense, are peripheral to the ongoing debate. This is exemplified in Lizot's work on Yanomamö energetics (1979); Hames's comparison of hunting technology efficiency (1979); Gross et al. on the ecological determinants of acculturation; and Werner et al. (1979) on the determinants of subsistence time allocation.

On August 13, 1979, at the XLIII International Congress of Americanists in Vancouver a symposium entitled "Protein Procurement by Native Amazonia Populations" was held. The papers herewithin derive from that symposium and have been written to supply quantitative data on hunting and fishing variability, to evaluate existing theory as it relates to protein acquisition, and to make suggestions for new areas of research.

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AN ANALYSIS OF AMAZONIAN HUNTING YIELDS
AS A FUNCTION OF SETTLEMENT AGE

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Introduction

The purpose of this paper is to focus on the aggregate hunting yields of a specific Amazonian Indian community through time. The paper relates to a controversial debate among specialists concerning the availability of dietary protein in the Amazon Basin and the significance of the protein factor in the dynamics of tropical forest societies (e.g., Beckerman 1979, Chagnon and Hames 1979, Gross, 1975, Harris 1974, 1977, Ross 1978, Siskind 1973, and Vickers 1975, 1979). Stated briefly, the major argument concerns whether or not protein availability is the major ecological factor in the cultural processes of tropical forest warfare, low population density, migration, male supremacy, and village-level political organization. Proponents of the protein scarcity hypothesis such as Harris, Gross, and Ross argue that the relatively low availability of protein in tropical forest habitats accounts for these features. Opponents of the protein scarcity hypothesis reject this position and offer a variety of competing hypotheses based on ecological, structural-functional, or mentalistic paradigms (reviewed in Vickers 1979).

The research that I have conducted among the Siona-Secoya Indians of northeastern Ecuador has led me to the belief that tropical forest culture can best be understood in terms of the interactions between a human subsistence technology based on shifting horticulture, hunting, fishing, and collecting and environmental resources. Specifically, I have argued (1975, 1976, 1979) that

protein availability is but one of a number of environmental factors which may exert a limiting influence on population density, settlement size and permanence, and political organization in the Amazon, and that a multifactorial ecological model is superior to a single-factor model. The present paper will not resolve this debate; the purpose here is to shed light on the dynamics of hunting at a specific settlement through time via the quantitative analysis of aggregate hunting yields. By design, the scope of this paper is delimited to the relationship between one independent variable (length of settlement) and one dependent variable (hunting yields). Since this paper is not intended as the definitive description of the complexities of Siona-Secoya hunting, dimensions such as hunting zone locations and characteristics, seasonality, and hunting techniques and strategies are not treated fully here. However, my omission of these details should not be taken as an indication that Siona-Secoya hunting lacks sophistication. Even though the present analysis is devoted to the relationship between two variables, it does provide insights into the structures and sizes of game populations, the impact of hunting on these populations, and changes in hunting emphasis through time. Furthermore, the focus on length of settlement and hunting yields provides empirical data which are highly relevant to the debate concerning the significance of animal protein availability in Amazonian cultural dynamics.

Location of the Study and Methods

This study focuses on hunting at the Siona-Secoya Indian village of San Pablo de Shushufindi on the Aguarico River in north-eastern Ecuador. Eighteen months of fieldwork was conducted there from September 1973 through March 1975, and six weeks of subsequent fieldwork was carried out from late June through early August 1979.¹ The Siona and Secoya are related groups of Western Tucanoan speaking peoples who have intermarried and migrated to their present location on the Aguarico River from the Cuyabeno River in 1973 and from the Angusilla River (Peru) in 1974. The observations on hunting activities and yields from 1973-75, therefore, are representative of a new village in its first two years of existence; the observations from 1979 are representative of a village in its sixth year of existence. As of March 1975, a field census indicated that there were 266 Siona and Secoya residing within the borders of Ecuador. However, this population was dispersed and the number of people in specific settlements was subject to fluctuation as emigration and immigration of households occurs with frequency over the period in which a particular location is inhabited. During 1973-75 the mean number of individuals residing at San Pablo was calculated to be 132. The census update made in July 1979 indicates that the present population of Siona-Secoya in Ecuador is 316. It is estimated that the mean population of the San Pablo site in 1979 is about 160, but with considerable variation in the number of individuals present at any given time.

The methods of observation concerning hunting activities and yields included both direct observation and weighing of yields and post-hunt interviews. The observations and interviews were designed to elicit the following information:

1. The name of the hunter
2. The date of the hunt
3. The time of departure from the village
4. The time of return to the village
5. The location of the hunt
6. The species and number of animals killed, or whether no kill was made
7. The weight of each animal killed or captured (either by direct weighing or by estimation using mean weights for specific species)
8. The names of hunting companions, if any (to allow subsequent interviews concerning their yields for the hunt)

The 1973-75 fieldwork resulted in a sample of 283 individual hunts (i.e., the equivalent of one man on an average one-day hunt). On hunts of more than one day, the yield for each day was taken separately for computative purposes. It is estimated that this sample represents approximately 13% of the total number of hunts originating from the settlement during the 18-month research period. The 1979 fieldwork resulted in a sample of 148 hunts (involving 45 hunters), which is estimated to be 59% of the hunts during the six-week research period. The proportionally larger 1979 sample reflects the fact that the observation of hunting activities was the first priority of the fieldwork, whereas the 1973-75 fieldwork focused on a wider range of ecological and ethnological problems.

TABLE 1. MOST COMMON GAME SPECIES IN
SIOMA-BECOYA HUNTING YIELDS, 1973-75

Species	Lumber in Sample ^a	Estimated Annual Kill ^b	Ranking by kcal Contribution
Woolly monkey (<u>Legethrix</u> spp.)	130	662	3
White-lipped peccary (<u>Tayassu pecari</u>)	92	468	1
Collared peccary (<u>T. tajacu</u>)	85	433	2
Curassow (<u>Mitu salvini</u>)	61	310	5
Piping guan (<u>Pipile pipile</u>)	40	204	9
River turtle (<u>Podocnemis</u> spp.)	19	97	12
Trumpeter (<u>Psophia crepitans</u>)	16	81	14
Spix's guan (<u>Penelope jacouacu</u>)	14	71	13
Tapir (<u>Tapirus americanus</u>)	12 ^c	8 ^c	4 ^c
Howler monkey (<u>Alouatta seniculus</u>)	11	56	6
Agouti (<u>Dasyprocta</u> sp.)	10	51	10
Armadillo (<u>Dasybus</u> spp.)	5	25	8
Tortoise (<u>Geochelone</u> sp. or <u>Testudo</u> sp.)	3	15	15
Pardiz (<u>Crypturellus</u> sp. ?)	3	15	-
Toucan (<u>Pteroglossus</u> spp. and <u>Rhamphastos</u> sp.)	3	15	-
Cayman (<u>Caiman</u> spp.)	2	10	11
Capybara (<u>Hydrochoerus</u> <u>hydrochaeris</u>)	2	10	7
Deer (<u>Mazama</u> spp.)	2	10	-

^aThe sample consisted of 283 individual one-day hunts. It is estimated that this sample is equivalent to 19.6% of the hunts originating from San Pablo de Shushufindi in one year.

^bThis column represents the estimated mean annual yield during the first two years following the establishment of San Pablo (for 23 hunters and an estimated 1441 individual one-day hunts per year).

^cSince a tapir kill is a major village event, all of the tapir kills from September 1973 through March 1975 were recorded. The columns for Annual Kill and kcal Contribution have been adjusted so that the disproportionate reporting of tapir kills is taken into account.

Species Representation in Siona-Secoya Hunting Yields

Although the Siona-Secoya classify a large number of animal species as edible game, a comparatively small number of species are killed with frequency. Table 1 indicates the number of animals from significant species included in the 1973-75 hunting sample, as well as the projected mean annual kill during the first two years following the establishment of San Pablo, and the ranking of species by total caloric contribution to the Siona-Secoya diet. The white-lipped peccary (Tayassu pecari), collared peccary (T. tajacu), and woolly monkey (Lagothrix spp.) were by far the most significant game animals in terms of contribution to diet. The tapir (Tapirus americanus) and curassow (Mitu salvini) ranked fourth and fifth in terms of meat contribution, followed by a series of species whose contributions were relatively small.

Mean Weight of Hunting Yields

The 1973-75 sample of 283 one-day hunts produced a total yield of 6042.2 kg (13,317.0 lb) of butchered meat (i.e., gutted, but including bone). The mean yield per hunt, therefore, was 21.35 kg (47.1 lb) of butchered meat. The mean yield for the 148 hunt sample of June-August was 11.9 kg (26.2 lb) or 55.9% of the 1973-75 yield.

Are the Lower 1979 Yields a Consequence of Seasonal Factors?

Since the June-August 1979 yields fall at the end of the rainy season for this part of the Amazon Basin, it might be argued that

seasonal factors alone may account for the lower 1979 yields. For this reason it is useful to make a comparison with the yields for June-August 1974. In 81 hunts recorded for this period the mean yield was 41.4 kg (91.2 lb) of butchered weight per one-day hunt, and indicates that hunting can be very productive during these months. This very high yield, however, reflects the fact that seven tapir were killed during June-August, or 58% of the 12 tapir that were killed during the 18 months of fieldwork. If the tapir kills are omitted from both the 1974 and 1979 June-August yields, the mean butchered weight figures are 20.5 kg (45.2 lb) and 9.9 kg (21.8 lb) respectively.

This comparison indicates that the yields for the rainy season in 1974 were actually better than the mean yield for 18 months in 1973-75, and even when the tapir kills are omitted, the rainy season yields are nearly the same as the average yield for the 18-month period. It seems best, therefore, to interpret the lower June-August 1979 yields in terms of reduced game populations rather than in terms of seasonality. The 1973-75 observations indicate that the Siona-Secoya engage in hunting on a year-round basis, and that the major game animals are also taken year-round. For these reasons, I believe that it is acceptable to utilize the entire 1973-75 sample for comparison with the June-August 1979 sample, and interpret the data as indicating that hunting yields in 1979 are about 56% of what they were in 1973-75.

Distance and Time Factors

The Siona-Secoya utilize a variety of hunting grounds or zones in much the same manner as Hames (1979) has described in his locational analysis of Ye'kwana and Yānomamö hunting. That is to say, these people recognize and identify a series of locations and biotopes which they exploit in their hunting, fishing, and collecting activities. Some of these areas are contiguous with settlements whereas others are as far as 60 km distant and can only be reached by journeys of several days in length. The Siona-Secoya also engage in morning or evening hunts and one-day hunts in addition to the longer "expedition" hunts of two or more days. The hunting data presented in this paper represent mean energy inputs and outputs for a sample which includes both short and long hunts within the various zones and biotopes.

It is evident that in 1979 Siona-Secoya hunters are having to travel farther to find game than in previous years. One indicator of this is that in one-day hunts in 1973-75 they used to travel southwest towards the Shushufindi River (5-10 km) to find game, whereas in 1979 they are crossing the river and travelling into the forests beyond it (individuals have stationed canoes at the river which they use in their crossings). Since it is impossible to accompany hunters on each hunt to estimate the distance covered, I use the time duration of the hunt as an indicator. (I estimate that the hunters cover 2-3 km per hour through the forest.) In 1973-75 the average time of an individual one-day hunt was 7.56 hours. In 1979 it is 8.48 hours,

so the length of the average day hunt has increased by 12%. In terms of distance travelled, the average one-day hunt in 1973-75 is estimated to have covered about 17 km, whereas in 1979 the estimate is about 20 km.

Hunting Efficiency

One method of evaluating hunting yields is to look at the caloric return of hunting by means of the following formula:

$$\text{Hunting Efficiency} = \frac{\text{kcal hunting yield}}{\text{kcal energy expended in hunting}}$$

The advantage of this formula over simple hunting yields is that it takes the factor of relative effort into account.

In order to calculate the caloric return of Siona-Secoya hunting, the mean yield in kilograms of butchered meat is reduced an additional 30% to allow for inedible bone and body parts, which gives the estimated edible portion. The mean caloric value of Siona-Secoya game is estimated to be approximately 170 kcal per 100 g of edible meat, or 1700 kcal per kg of edible meat (based on a survey of meats in Leung 1961).

Since most Siona-Secoya hunting time is spent walking over relatively level terrain, Montgomery's and Johnson's figure (1976) of six kcal/minute (or 360 kcal/hour) for the Machiguenga Indians of the Peruvian montana in this activity is taken as the basis for computing caloric expenditure.²

With these factors it is possible to estimate the 1973-75 and 1979 caloric returns in hunting with the following computations:

$$\text{1973-75 Hunting Efficiency} = \frac{1700 \text{ kcal } (21.35 \text{ kg } \times .7)}{360 \text{ kcal } \times 7.56 \text{ hr}} = 9.33$$

$$\text{1979 Hunting Efficiency} = \frac{1700 \text{ kcal } (11.9 \text{ kg } \times .7)}{360 \text{ kcal } \times 8.5 \text{ hr}} = 4.65$$

These calculations indicate that the caloric return for hunting in 1979 is about 50% of what it was in 1973-75.

Overview of the Hunting Data

There is little new in the idea that the population of a prey species declines as predation increases (all other factors being constant). It follows, therefore, that the longer a hunting people stay at a specific site, the greater will be the depletion of local game populations. Even if we were not aware of the hunting conditions at San Pablo de Shushufindi, we could reasonably predict that hunting yields in the areas adjacent to the settlement would decline with time. As the data presented in this paper have shown, most of the indicators of hunting which have been used show trends in the anticipated direction:

1. The mean hunting yield has declined (from 21.3 to 11.9 kg)
2. The length of hunting trips has increased (from 7.56 to 8.48 hr/one-day hunt)
3. The caloric efficiency of hunting has declined (from 9.3:1 to 4.6:1)
4. Larger species appear to be more vulnerable predation than smaller species (see Table 2)
5. The percentage of trips in which no kill was made increased from 11.3% to 18.6%

In order to balance this information the following characteristics of Siona-Secoya hunting in 1979 must also be recognized:

1. The volume of game taken after six years of hunting continues to be considerable
2. A large majority (81.8%) of hunts are still "successful" (defined here as a hunt with at least one kill)
3. The rate of decline for some large species (e.g., collared peccary and howler monkey) is more gradual than might have been expected (see Table 2)
4. Hunting is still a very viable activity in terms of caloric return
5. Hunting continues to be the major source of dietary protein for the Siona-Secoya (about 60%)

Dietary Implications of the 1979 Hunting Yields

Dietary surveys conducted during the 1973-75 fieldwork indicated that the mean caloric intake for the Siona-Secoya was 2215 kcal/day, or almost precisely the 2223 kcal/day estimated mean requirement (for all age groups, following the FAO method of calorie requirement computation; cf. Vickers 1976: 131-133). With regard to protein consumption, the mean intake in 1973-75 was 65.3 g/day of animal protein and 15.4 g/day of vegetable protein, or a total of 80.7 g/day (for all age groups). The protein intake in 1973-75, therefore, was well in excess of recommended daily allowances. For example, the FAO recommended allowance for an adult male weighing 65 kg (143 lb) is 37-62 g/day of protein, whereas the mean intake for Siona-Secoya males weighing an average of 62.6 kg (138 lb) was 112.6 g/day.

The observed decline in Siona-Secoya hunting yields means that protein consumption is also down. It is estimated that the current mean protein intake for all Siona-Secoya age groups is about 41 g/day of animal protein and about 15 g/day of plant protein, for a total of approximately 56 g/day.² The indications are, therefore, that Siona-Secoya protein intake in 1979 is still better than adequate despite the decline in hunting yields.

For purposes of discussion, it may be useful to consider a "worst case" situation concerning protein intake in which the following hypothetical conditions prevail:

1. All animal protein is derived from hunting (neglecting fish as a source of protein)
2. Hunting yields continue to decline at the rate recorded from 1973-79 (this seems unlikely due to factors discussed in the following section of this paper)
3. Protein intake from vegetable sources is not increased

Under these worst case conditions, animal protein intake would drop to 17.6 g/day by 1985 and to 10 g/day by 1991. If vegetable protein intakes were held constant, the mixed daily intakes of protein would be about 33 g/day and 25 g/day, respectively. It is not certain that protein deficiency diseases would be manifested even at these hypothetically low levels, since recommended daily allowances are quite generous and human populations have been observed with far lower intakes without clinical signs of protein deficiency. As B. Abbott Seagraves writes in a recent analysis of nutritional stress:

Criteria commonly accepted in identifying and measuring nutritional status, and the relationship between actual food intake and health, lack reliability and

specificity....The standards for caloric and general nutrient requirements, such as those proposed by FAO and the U.S. National Research Council, have been increasingly discarded as a tool in the direct assessment of nutritional status, as they make no allowances for the possible environment-specific variations in human needs and adaptations....that a considerable range of nonpathological adjustment to caloric and protein intake is the rule rather than the exception is predicted by certain general characteristics of system structure and operation. For each of the many variables in a living system....there is a range of stability....all living systems possess remarkably effective means of responding to and mitigating stress and hence preventing serious strain (1977:196, 199-200).

Since the Siona-Secoya diet is composed of a large variety of foods from both wild and cultivated sources from a diversity of ecological zones, it appears that they have considerable capacity to compensate for shortages in any given food resource in a specific location at a specific time.

When Does the Game Run Out?

The data presented in this paper are the result of empirical field investigations and provide information on aggregate hunting yields through time at one indigenous settlement in the Amazon. The basic data are impartial and may be subject to varying interpretations by specialists. Proponents of the hypothesis that protein is the major limiting factor in Amazonian cultural dynamics may take the declining yields at San Pablo de Shushufindi as evidence which supports their position. Opponents of this view may prefer to emphasize that hunting at San Pablo de Shushufindi is still a very viable activity despite six years of heavy human predation on faunal resources.

In view of this debate, one might well ask, "When does the game run out?" or "When will the scarcity of game force the people to move?" Unfortunately, there is no simple answer to this question. The data presented in this paper indicate that yields at San Pablo have dropped by approximately 44% over a five- to six-year period. But this does not mean that five years is the half-life of all game species in a linear rate of decline. If this were so we could predict that in ten years the mean yield for Siona-Secoya one-day hunts would be 3.7 kg (8.2 lb) of butchered meat. But a hunting sample from a Siona-Secoya settlement on the Cuyabeno River reveals a mean yield of 5.67 kg (12.5 lb) butchered weight after more than 30 years of continuous habitation (Vickers 1975). So the data from Shushufindi and Cuyabeno suggest that the relationship between length of residence and hunting yields is an asymptotic one in which hunting yields start very high during the initial period of settlement, and then drop sharply for a period of several years after which the rate of decline slows. Figure 1 is a graph of the suggested relationship.

One reason for this relationship is the differential resistance of various species to hunting pressure. As Ross has pointed out (1978) smaller game such as the agouti and squirrel have a higher rate of reproduction due to short gestation periods and multiple births. Because of the availability of such species mean hunting yields are unlikely to decline to the zero point. Table 2 indicates a general tendency in which smaller species are becoming more frequent in hunting yields at San Pablo.

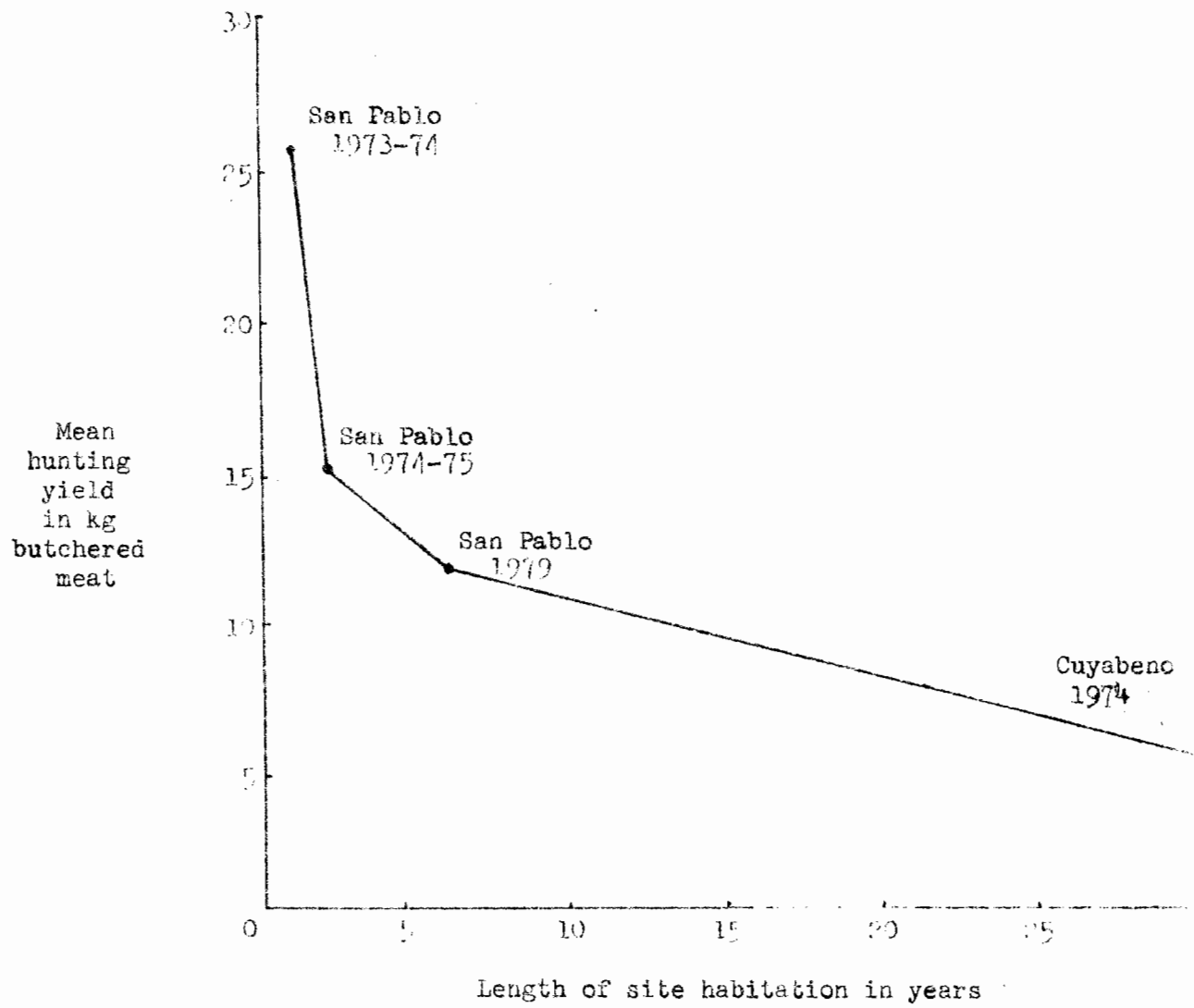


Figure 1. Hunting Yields as a Function of Length of Site Habitation.

Another significant fact is that most indigenous Amazonian settlements fission and/or relocate before game populations are totally decimated. Once again, the concept of hunting "efficiency" is useful; people become dissatisfied when yield relative to effort declines, and not just when yields reach zero. The fission and relocation process has already begun at San Pablo de Shushufindi as seven households have moved upriver towards the Eno River, and 10 of the remaining 15 households at San Pablo have made pioneer gardens downriver in anticipation of a future move. But hunting yields are not the only factor in this process; while it is true that the Indians are having to hunt farther from the settlement, and that their yields have declined, they are also complaining that each dry season they have to travel farther to make their gardens, that the palms they use to thatch their houses are scarce, that they have to carry their firewood over greater distances, that their neighbors cause them misery, and that San Pablo has become "boring" after six years of settlement. These emic perceptions reflect both obvious environmental realities and cultural themes which are nearly universal among the native peoples of the Amazon. It is my view that these statements concerning flora and fauna, interpersonal relations, and attitudes are related components of a cultural-ecological system which has remained viable for at least several thousand years because of cultural practices which limit population growth and promote dispersal and movement (e.g., abortion, infanticide, ritual restrictions on sexual

TABLE 2. COMPARISON OF SPECIES KILL PROBABILITIES AT SAN FABILO DURING FIRST TWO YEARS OF SUPPLEMENT AND AFTER SIX YEARS

Species	Per Cent Chance of Kill During One Day		
	1973-75 ^a	June-August 1974 ^b	June-August 1979 ^c
Primary targets			
Tapir (<u>Tapirus americanus</u>)	4.3	8.6	2.0
White-lipped peccary (<u>Thyassu pecari</u>)	33.1	28.4	17.6
Collared peccary (<u>T. tajacu</u>)	30.6	16.0	21.6
Woolly monkey (<u>Leontothrix</u> spp.)	46.8	40.7	23.6
Howler monkey (<u>Alouatta seniculus</u>)	4.0	3.7	3.4
Curassow (<u>Mitu salvini</u>)	21.9	14.8	15.5
Pining guan (<u>Pipile pipile</u>)	11.4	4.9	6.1
Spix's guan (<u>Penelope jacquacu</u>)	5.0	6.2	2.7
Trumpeter (<u>Pipilo cernitans</u>)	5.8	6.8	0.7
Secondary targets			
Agouti (<u>Dasyprocta</u> sp.)	3.6	4.9	4.7
Paca (<u>Cuniculus paca</u>)	4.0	0.0	0.7
Squirrel (<u>Sciurus</u> sp.)	0.4	0.0	0.7
Armadillo (<u>Dasyurus</u> spp.)	2.2	0.0	0.7
Cayman (<u>Caiman</u> spp.)	0.7	0.0	1.4
Turtle (<u>Geochelone</u> sp. or <u>Tortue</u> sp.)	1.1	1.2	0.7
Toucan (<u>Pteroglossus</u> sp. and <u>Ramphastos</u> sp.)	1.1	1.2	2.0

^aBased on a sample of 283 individual one-day hunts.

^bBased on a sample of 81 individual one-day hunts.

^cBased on a sample of 148 individual one-day hunts.

activity, warfare and witchcraft), thereby allowing for resource renewal following periods of depletion. That is to say, these cultural practices represent an adaptation to a variety of Amazonian environmental resources at a given level of technology (shifting horticulture, hunting, collecting and fishing).

Conclusion

This paper has focused on one resource--hunted game--and has indicated the rate of game depletion at one settlement over a six-year period. The time depth of the sample data provides useful insights into predator-prey relationships between humans and animals in the Amazon. Additional studies on the utilization of other resources are needed, however, before definitive quantitative statements can be made on the relative significance of specific environmental factors as "limiting factors" in Amazonian cultural development. My own position is that the availability of protein resources may be a limiting factor on community size, stability, and political organization in specific locations at specific times, but that other ecological factors such as soil fertility, drainage, floral resources, level of technology, and the presence of other human populations may also play the role of a limiting factor at specific locations and times. It is also likely that there are even more cases where factor interaction is present. San Pablo is a good example of this, for the depletion of flora, fauna, and nearby

arable land are all contributing to the incipient fissioning of the settlement. These data suggest that a systemic (i.e., multi-factorial) model of tropical forest cultural adaptation is likely to prove more useful than any single limiting factor hypothesis.

NOTES

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² The mean animal protein intake estimate of 41 g/day/individual includes 32 g/day from hunted game and 9 g/day from fish.

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GAME DEPLETION AND HUNTING ZONE ROTATION
AMONG THE YE'KWANA AND YANOMAMÖ OF AMAZONAS, VENEZUELA ¹

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Introduction

Locational analyses of land use patterns among lowland Amazonian populations have been attempted infrequently, but when they have, they have proved crucial for deciding debates on the nature of indigenous adaptation to the Amazonian ecosystem. For example, Carneiro (1960, 1961), through a careful analysis of Kuikuru shifting cultivation in relation to productivity, fallowing, and available horticultural land, was able to demonstrate convincingly that shifting cultivation was not an impediment to the establishment of large and permanent villages in Amazonia. Recently, it has been suggested (Harris, 1974; Gross, 1975; Ross, 1978) that low animal biomass in the Amazon is an important adaptive variable for some Amazonian populations and that warfare, territoriality, low population density, and small nomadic village populations are responses to the problems of game depletion. Recent research (Chagnon and Hames, 1979; Lizot, 1978) has indicated that inadequate protein consumption cannot account for patterns of warfare in one Amazonian population, the Yanomamö, and the protein hypothesis is an unlikely explanation in a number of other populations on which we have adequate data. However, this paper will not comment directly on the relationship between warfare and protein capture and consumption but rather how native Amazonian hunters respond to the problem of declining hunting efficiency.

The aim of this paper is to show, through a locational analysis of hunting input and output, and their interrelationship, how the members of two Amazonian populations, the Ye'kwana and the Yanomamö, respond to game depletion in segments or zones of their environment. The research reported here suggests that Amazonian shifting

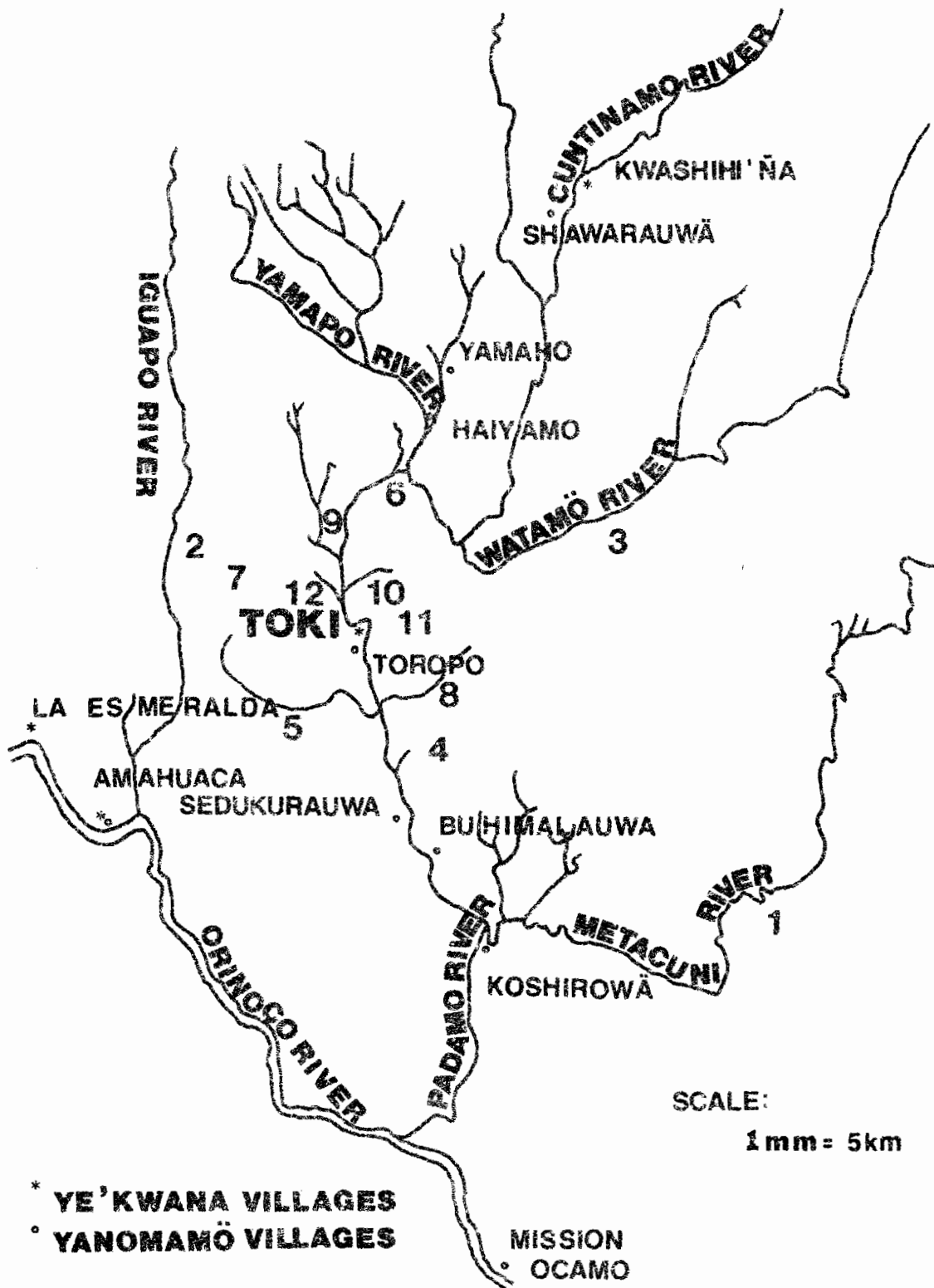
horticulturalists who depend on game for the bulk of their protein consumption deal with local game depletion through the rotation of hunting zones and that game depletion is not an important cause of village movement.

The Setting

The Ye'kwana and Yanomamö Indians are rather typical neotropical shifting horticulturalists inhabiting the Upper Orinoco River Basin of southern Venezuela, with significant segments of the Yanomamö population spilling over into adjacent portions of northern Brazil. Arvelo-Jimenez (1971) estimates that there are some 1,600 Ye'kwana living in villages of from 20 to 120 people each, mainly along large tributaries of the Orinoco such as the Padamo, Cunucunuma, Ventuari, and Caura. Chagnon (1974) estimates that there are approximately 18,000 Yanomamö in 140 villages ranging in size from 40 to 250 people, with most villages located in the deep forest and away from large navigable rivers. Population density for both populations is less than one person per square mile.

While sustained contact with westerners was not attained until 1954 for the Yanomamö, and many villages still remain uncontacted, the Ye'kwana have sustained intermittent contact since the end of the 18th century, largely as a result of their wide-ranging water-borne trading activities. Missionary activities among the more accessible downriver Ye'kwana villages over the last 25 years, coupled with ties to the national economy through limited cash cropping, have culturally transformed some Ye'kwana villages. Nevertheless, most of traditional Ye'kwana culture persists with the exception of shamanism and some

PADAMO RIVER BASIN



MAP I

aboriginal technology. By comparison, the Yānomamö culture is one of the most vigorous aboriginal cultures in lowland South America, and even those villages that have been heavily subject to missionary activities have only superficially changed by their acceptance of some manufactured goods, apart from demographic trends due to introduced diseases.

Both groups depend on shifting cultivation for about 75% to 80% of their total caloric intake (Hames, 1978; Lizot, 1978), with hunting, gathering, and fishing making up the balance. Ye'kwana gardens are dominated by manioc and Yānomamö gardens by plantains, cultigens with only 1%-2% protein content. Both populations depend on hunting and fishing for 75% to 80% of their protein requirements, with hunting and fishing supplying about 80% and 15% of Yānomamö animal protein, respectively, and 68% and 25% for the Ye'kwana (Lizot, 1978; Chagnon and Hames, 1979). The Ye'kwana's greater dependence on fishing is a result of their villages being located on the banks of rivers, while the smaller importance of fishing in Yānomamö protein consumption is due to their settlement in interfluvial areas where fish resources are low.

Area of Study

The general area of study among the Ye'kwana and Yānomamö populations is the Padamo River Basin, a border area delimiting the easternmost extent of the Ye'kwana and the westernmost extent of the Yānomamö population. Intensive research on hunting practices took place in the Ye'kwana village of Toki (Map 1) and the adjoining satellite Yānomamö village of Torope-teri. Toki contains a permanent Ye'kwana population of 76 with 18 Yānomamö adopted into Ye'kwana households. One section

of the village houses 20 Yānomamö who occupy two separate dwellings, while another Yānomamö house, occupied by 15 people, is located 10 minutes away from the main village. In this area Yānomamö are motivated to reside near Ye'kwana primarily to gain access to trade goods. Ye'kwana villages with satellite Yānomamö (including Sanumá) villages occur extensively throughout the Yānomamö/Ye'kwana border area (Arvelo-Jimenez, 1971; Ramos, 1972, 1978).

Environment, Climate, and Plant Formation

Given Toki's 2,280 mm of rain per year, elevation of 250 m, and mean annual temperature of 24 degrees centigrade, the biome around Toki could be classified as moist to wet tropical forest, according to Holdridge's natural life zone typology (Holdridge, 1967). The terrain immediately around Toki is flat to gently undulating with small hills of 50 to 75 m irregularly dotting the vista. Approximately 4 km to the east of Toki is a short range of hills about 10 to 12 km in length and 100 to 200 m in elevation. From 10 to 30 km upstream and inland on the Padamo are the giant inselberg mountains of Duida, Huachumacari, and Marahuaca which attain heights up to 3,000 m, making them the largest mountains in all the Guiana Highlands.

Rainfall was recorded from September 1975 through May 1976. Rainfall exceeded 100 mm in all months except for November, January, and February. These three "dry season" months are important economically because trees felled in the garden-making process must have adequate time to dry to insure a good burn. Peak rainfall occurred in March, April, and May, averaging 350 mm per month.

As Nietschmann (1972, 1973) has shown for the Miskito Indians of coastal Nicaragua, biotopes and their associated forest vegetation types strongly correlate with hunting success and the distribution of important game animals. However, for Amazonia there is very little information as to the distribution and density of game animals across biotopes. Furthermore, there is a great deal of confusion and inconsistency over the classification of biotopes in Amazonia. Below, I will list the major biotopes surrounding Toki according to the schema developed by Prance (1978) and list some of the more important game animals found.

Terra firme forest. This is forest on high ground containing large trees with closed canopies and very sparse ground cover. Although its biomass is among the greatest of any terrestrial ecosystem in the world, very little of it is available to ground-dwelling animals, so 40-70% of the mammalian biomass exploiting this biotope is aboreal (Eisenberg and Thorington, 1973). Although no measurements were made, I estimate that this biotope covers at least 80% of the hunting zones frequented by Ye'kwana and Yanomamö hunters. Important game animals found there appear to be deer, tapir, white-lipped peccaries, monkeys, anteaters, and large game birds.

Seasonal várzea forest. (This biotope is similar to what Meggers [1971] calls Igapó.) This is forest behind natural levees of rivers or large streams which is inundated for 1 to 3 months per year during the period of heaviest rains (March, April, and May). Species diversity and biomass are less than terra firme forest. Letouzey (1978: 106) describes it as having ". . . an abundance of medium sized trees with silt roots, many buttressed trees with pneumatophores, an abundance of

lianas, and a poorly developed understory." This biotope is frequently dominated by water tolerant palms, heliconias, cecropias, cedar, silk floss, and bamboos (Guadua sp.). Animals commonly found are caviomorph rodents (capybara, agouti, acure, and picture), collared peccary, tapir, and water fowl. Caiman, naturally, are present along the margins of rivers and in the várzea when it is inundated.

Swamp forest. Poorly drained areas near the mouths of streams or basins behind river banks are rare in the Padamo but are important in hunting because deer and many of the large semi-aquatic fauna found in the várzea are also found here, but in denser concentrations. The vegetation is similar to that found in seasonal várzea forest but trees tend to be shorter and the canopy less complete.

Anthropogenic formations. This refers to any plant formation which has formed as a result of human activity. The forms are quite variable and range from producing gardens, rastrojos (Sp., Venezuela), or gardens abandoned for five to seven years, and to secondary forest in various stages of succession. Anthropogenic biotopes are dominated by softwoods (especially species of the genus Cecropia in riverine areas), usually less than 35 m in height with very narrow canopies. The small canopy allows a great deal of light to penetrate the forest floor, stimulating growth of dense ground cover, which in some areas is impassable. Anthropogenic biotopes surround the vicinity of Toki and the abandoned village sites of Shanama'ña and Nosamo'ña (see Map I). Deer, caviomorph rodents, and sloths are abundant in these areas.

Hunting Zones

Among the Ye'kwana and the Yqnomamö nearly all hunting occurs in named and explicitly known hunting zones, with each zone characterized by one or more of the plant formations outlined above. A hunting zone can be best described as a drainage basin having a linked series of trails with the largest of these trails paralleling the stream or river which serves as the nexus of the drainage. And all but one of the twelve regularly used zones (see Map I and Table I) are named after the largest stream or river which drains them.

The fact that the main hunting trail in each zone parallels the largest streams is not without ecological significance. The Ye'kwana and the Yqnomamö believe that game animals tend to be more abundant around riparian habitats whether they be large rivers or small streams (especially during the short "dry season"). This native belief of animal abundance in riparian areas is perhaps explicable in terms of the ecological concept of the ecotone. An ecotone is defined as an area of transition between two biotopes or plant formations. Most rivers and streams of the tropical forest tend to have a riverine forest (Port., restinga) on their banks, and, if the bank is low enough to permit flooding during the height of the rainy season, a seasonal várzea forest is located behind the restinga. Invariably, a terra firme forest is found behind the restinga or the várzea. Therefore, main hunting trails tend to run through two to three biotopes more or less continuously with the areas of transition between each biotope serving as ecotones. Ecologists (e.g. Odum, 1959; Lamprey, 1963) have argued that ecotones typically have heavier concentrations and greater diversity of animals than either of the biotopes divided by

the ecotone. This fact is known as the "edge effect" and it is assumed that animals are more plentiful and diverse here because ecotones are able to supply alternate nutritional needs of animals owing to their ecological complexity (cf. Hickerson, 1962).

Thus far I have purposely avoided the term hunting "territory" to refer to specific areas in which hunting is done or the general area a village population exploits. This is because a territory is commonly defined as "an area occupied more or less exclusively by an animal or group of animals by means of repulsion through overt defense or advertisement" (Wilson, 1975:597), and this definition does not entirely fit the Ye'kwana or the Yąnomamö. However, Harris has speculated for the Yąnomamö (1975:103) and Ross has observed for the Jivaro (1978) that these Amazonian populations have rather discrete hunting territories at the village level and, importantly, the edges of such territories serve as buffer zones or no-man's-land between neighboring hostile villages. Lizot (1978) countered Harris' speculation by stating that the Yąnomamö have a limited sense of territoriality which is based on a village's regular use of an area of land for hunting. Unfortunately, Lizot's observation brings up more questions than it answers.²

Locational analysis of Ye'kwana and Yąnomamö hunting patterns indicates that the inhabitants of Toki actively share four of their twelve hunting zones (Cúa, Manguera, Sedukurawä, and Igupo; see Map I and Table I) with the neighboring Yąnomamö villages of Sedukurawä-teri, Buhimalawä-teri, Haiyamo-teri, and the Ye'kwana village of Amahuaca'ña. However, these shared zones are 4-6 km from the neighboring villages and, according to Ye'kwana and Yąnomamö informants.

hunters will not usually hunt any nearer unless they are in hot pursuit of game.

There are a number of political, economic, and ecological considerations which deter Yānomamö hunters from hunting closer than 4 to 6 km from neighboring villages and which permit the partial overlapping of hunting zones. The Yānomamö, due to shifting political alliances, do not fully trust the intentions of neighboring hunting parties when they come in close proximity to their village because these areas are frequently exploited by groups of women in their gathering, fishing, and gardening activities. Yānomamö men and women fear that neighboring hunting parties might be tempted to abduct these women, even at the cost of breaking an alliance. Economically, there is no rational reason to hunt near a neighboring village. This is because game resources are depleted near a village (see Table I and discussion below) and since neighboring villages are usually one-half to one day's walk apart, it would make no economic sense to travel such a great distance to hunt in a game depleted area when superior alternate areas could be reached more easily. And finally, as suggested by ecological studies of animal territoriality, territories are defended when the costs of defense are exceeded by the benefits conferred by being territorial (Brown, 1964; Covich, 1977). Furthermore, ecological theory suggests, as outlined by R. Dyson-Hudson and E. A. Smith (1979) for human societies, that territoriality is most likely to be adaptive (i.e. the benefits will exceed the costs) when resources are densely distributed and predictable in occurrence spatially and temporally. However, neotropical game animals are thinly distributed and spatially unpredictable (i.e. patchily distributed) but temporally

predictable. R. Kiltie, who has studied the behavior of white-lipped peccaries which are the most important game animals for the majority of neotropical hunters, has documented that these animals are unpredictably distributed both spatially and temporally (1979). Therefore, ecological theory and the biobehavioral characteristics of neotropical game suggest that territoriality probably would not be adaptive for Amazonian hunters.

Hunters from the various villages in the lower Padamo realize that they share overlapping hunting zones, but as Lizot (1978) points out, hunting zones are never the source of disputes. Smole (1976) who made a cultural geographic study of the Parima Yanoama, notes the existence of overlapping hunting zones and that land is never a source of disputes. The Ygnomamö do have territories up to approximately 6 km from the village which are vigorously defended, and are maintained to prevent the abduction of women and, to a lesser extent, to safeguard crops (especially, the desired peach palm) in semiabandoned gardens and some gathering areas. Beyond this 6-km limit the disposition to defend areas of forest in which most hunting is done becomes attenuated with increasing distance from the village, until areas of overlapping exploitation are reached. As hunters pass through overlapping areas and near neighboring villages they feel themselves to be in another's hunting domain. However, they rarely transgress these zones of overlap, unless in hot pursuit of game, because they realize the closer they come to a neighboring village, the less likely they are to encounter game. The costs and benefits of hunting in various zones is the major mechanism that patterns hunting behavior and partitions hunting zones between villages.³ For the Ye'kwana and Ygnomamö of the Padamo, it's best to consider most of the land which

hunters exploit as part of their home range and not as a territory (cf. Brown, 1975:61, for a discussion of home range in relation to territory). Patterns of areal exploitation in other portions of the Yanomamö tribal distribution may differ as they are determined by local environmental, demographic, and political conditions.

Methods

The variables of hunting labor input, output of captured game, and hunting zone characteristics are the crucial factors to be interrelated in the argument of this report. Therefore, in this section they will be defined and the methods used to measure them will be described.

Data on hunting input were gathered through an observational technique, known as "instantaneous scan sampling" by primatologists (Altmann, 1974) and "spot checks" by ethnographers (Johnson, 1975), and it has also been widely used in industrial time-motion studies (Mundel, 1978). The method consists of making randomized observations of all individuals in a population and noting what each individual under study is doing at the time of observation. After a sufficient number of observations have been made on individuals in a population, it is possible to make estimates of time allocated to each activity.

Gathering data on hunting activities employing the above method has some limitations. If an individual was out in the forest hunting, then it was always impossible to observe his activity directly. Therefore, sometimes I had to gain such information by relying on verbal statements about an individual's hunting activities from his kin (this also occurred for some gathering, fishing, and gardening activities which took place outside of the village). However, I

devoted a considerable amount of time to testing the reliability of informant's statement concerning the activities of others by comparing them to interviews of hunters after they returned home. With very few exceptions, informant's statements and hunter interviews corresponded in great detail.

Data on hunting time input was gathered over a period of 216 days divided into segments of 76, 62, and 78 days. Of the full-time Ye'kwa and Yānomamö hunters, a total of approximately 8,000 observations were made of which 900 were scored as hunting. When an observation was made the following information was included on a FORTRAN computer coding sheet: (1) name, (2) time, (3) date, (4) location, (5) activity, and (6) interaction (this was only scored when the individual under observation was interacting with someone). Variable #4 is of particular importance in this study because it indicated the hunting zone in which the individual hunted.

Sampling of hunting outputs occurred simultaneously in the same time sample period as hunting input. All hearths in the village were visited several times a day. If a kill had been made, the following information was noted: (1) name of hunter, (2) day, (3) species of animal killed, (4) weight of animal, (5) weapon used, and (6) hunting zone where the kill was made.

All hunting zones were visited at least twice in order to determine their distance from the village, plant formations, travel time, topography, and size. In addition, hunters were interviewed in order to determine how long the zone had been exploited, animals characteristic of the zone, and other factors which influence hunting. Unfortunately, the area was first accurately mapped in 1971 with side-beam

radar at a scale of 1:250,000 and this technique and scale does not permit any interpretations of ecological or topographic characteristics of the area, save the location of major environmental features.

Hunting Input

Table I and Figure I reveal a number of differences and similarities in Ye'kwana and Yānomamö hunting input for each of the hunting zones. In general, these patterns are determined by the distance of a zone from the village, relative game abundance, hunting method, and technology (see Hames, 1979, for a discussion of the effect of modern hunting technology on Ye'kwana and Yānomamö hunting practices).

The most immediately visible differences between Ye'kwana and Yānomamö hunting zone time allocation is the fact that some zones are used exclusively or nearly exclusively by the Ye'kwana or by the Yānomamö. Yānomamö hunters do little or no hunting in the zones of Metacuni, Cúa, Watamo, and Sedukurawä because these areas are too difficult or distant to reach without the aid of outboard motors. The hunting they did in these areas occurred only in the company of a Ye'kwana hunting party using an outboard motor. Ye'kwana hunters, on the other hand, hunted in these areas frequently, owing to their possession of outboards. The Yānomamö could have hunted in the above-named zones during overnight hunting expeditions but instead preferred to devote time to this kind of hunting solely to Iguapo because the Ye'kwana did not hunt there and, as a consequence, game was subject to less hunting pressure. The Ye'kwana spent little or no time hunting

TABLE I. Hunting Input, Output, and Input/Output by Hunting Zone

Zone	Map Location #	Hours Hunted		Game		Input/Output		Distance (km)
		Ye'k.	Yano.	Ye'k.	Yano.	Ye'k.	Yano.	
Metacuni	1	302.0	0.0	1645.0	0.0	5.43	0.0	33.0
Iguapo	2	0.0	1137.0	0.0	900.0	0.0	0.79	14.0
Watamu	3	408.0	50.9	1385.0	73.2	3.39	1.43	13.0
Sedukurawä	4	224.9	0.0	526.6	5.2	2.34	0.0	9.5
Manguera	5	38.9	457.5	0.0	343.7	0.0	0.75	8.0
Cúa	6	398.9	49.2	386.5	0.0	0.96	0.0	7.5
Makanahama	7	140.1	720.0	142.6	340.0	1.01	0.47	7.2
O'doiyenadu	8	325.9	854.5	261.3	358.4	0.80	0.42	6.0
Shanama'na	9	329.8	71.9	685.5	37.8	2.07	0.53	5.5
Wohokuha	10	98.5	52.5	95.5	15.0	0.96	0.28	3.0
Audäha emadi	11	168.3	105.1	20.0	31.5	0.12	0.30	2.5
Gardens	12	272.4	245.6	164.0	74.0	0.62	0.30	1.5
Totals		2708.0	3604.0	5311.0	2179.0	1.96	0.604	

in the zones of Manguera and Iguapo because these zones are deeply inland and cannot be reached by outboard motor.

Due to their possession of the outboard motor, the Ye'kwana could exploit easily any hunting zone utilized by the neighboring Yānomamö villages of Koshirowä-teri, Sedukurawä-teri, Buhimalawä-teri, Haiyamo-teri, and Yamaho-teri (see Map I). However, as Map I indicates, the Ye'kwana do not hunt closer than 4-6 km from these villages. As mentioned previously, this is due to the fact that zones near a village are depleted of game and it not worth the effort to make a long hunting trip only to hunt in game-depleted areas.

The relation between hunting input and distance displayed in Figure I and Table II corresponds to the basic kind of hunts of the Ye'kwana and the Yānomamö. Both distinguish between morning and evening hunts, day hunts, and expedition or overnight hunts. Morning and evening hunts occur within a radius of up to 4 km of the village, last no more than two or three hours, and are for the purpose of adding meat to the morning and evening meals. They occur most frequently during seasons when time must be allocated to more pressing activities (e.g. felling gardens). Also, a large proportion of these hunts are made by youths who are honing their hunting skills and who do not have the ability to hunt in more distant zones. Day hunts occur between 3 and 9 km of the village, last for six to nine hours, and are the most common kind of hunt. Expedition hunting occurs beyond 9 km of the village, lasts for two days or longer, and is done to acquire large quantities of game for local consumption or for Ye'kwana wasai or Yānomamö reahu inter-village feasting.

YE KWANA

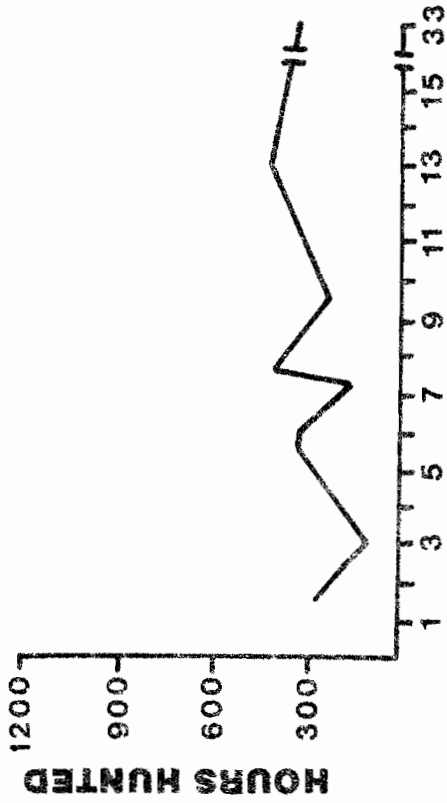


FIGURE I

YANO MAMO

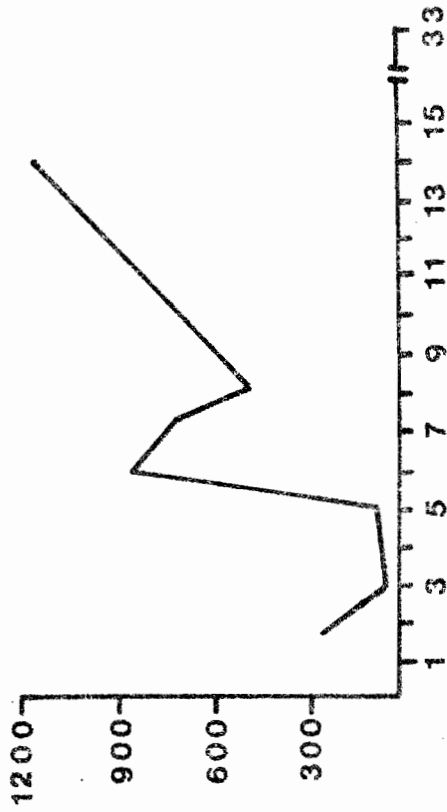
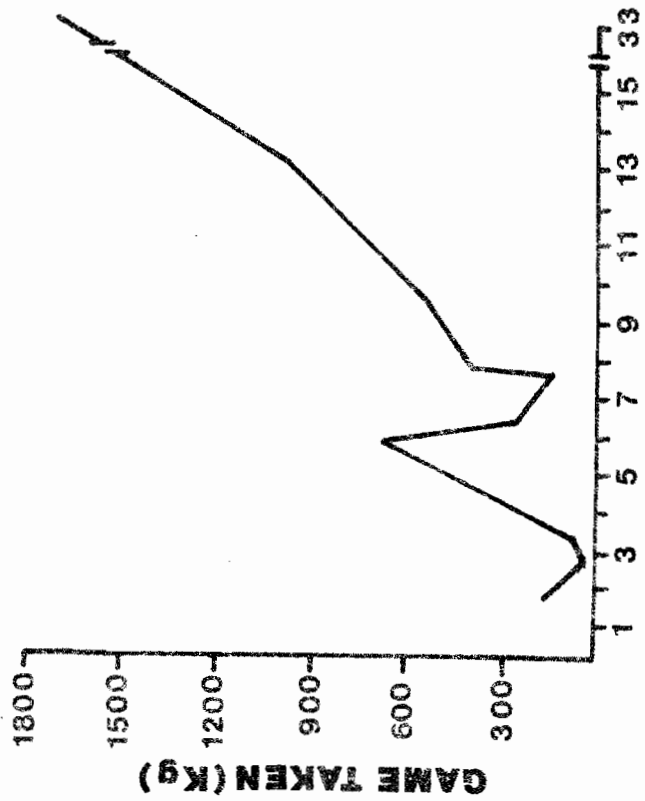


FIGURE II



DISTANCE FROM VILLAGE (Km)

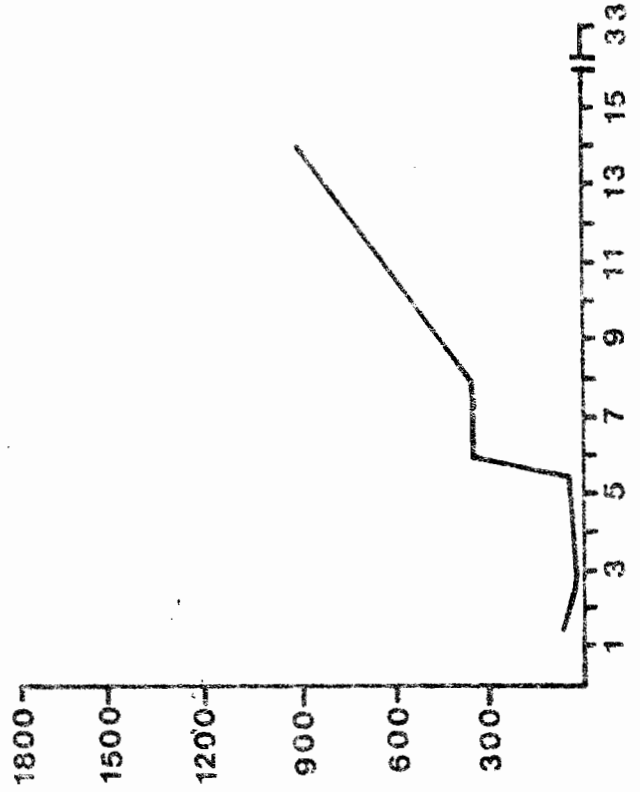


Table II. Hunting Time Allocation (%)*

Hunt Type	Ye'kwana	Yanomamö
Morning/Evening (0-4 km)	20%	11%
Day (5-9 km)	53%	56%
Expedition (9+ km)	26%	33%

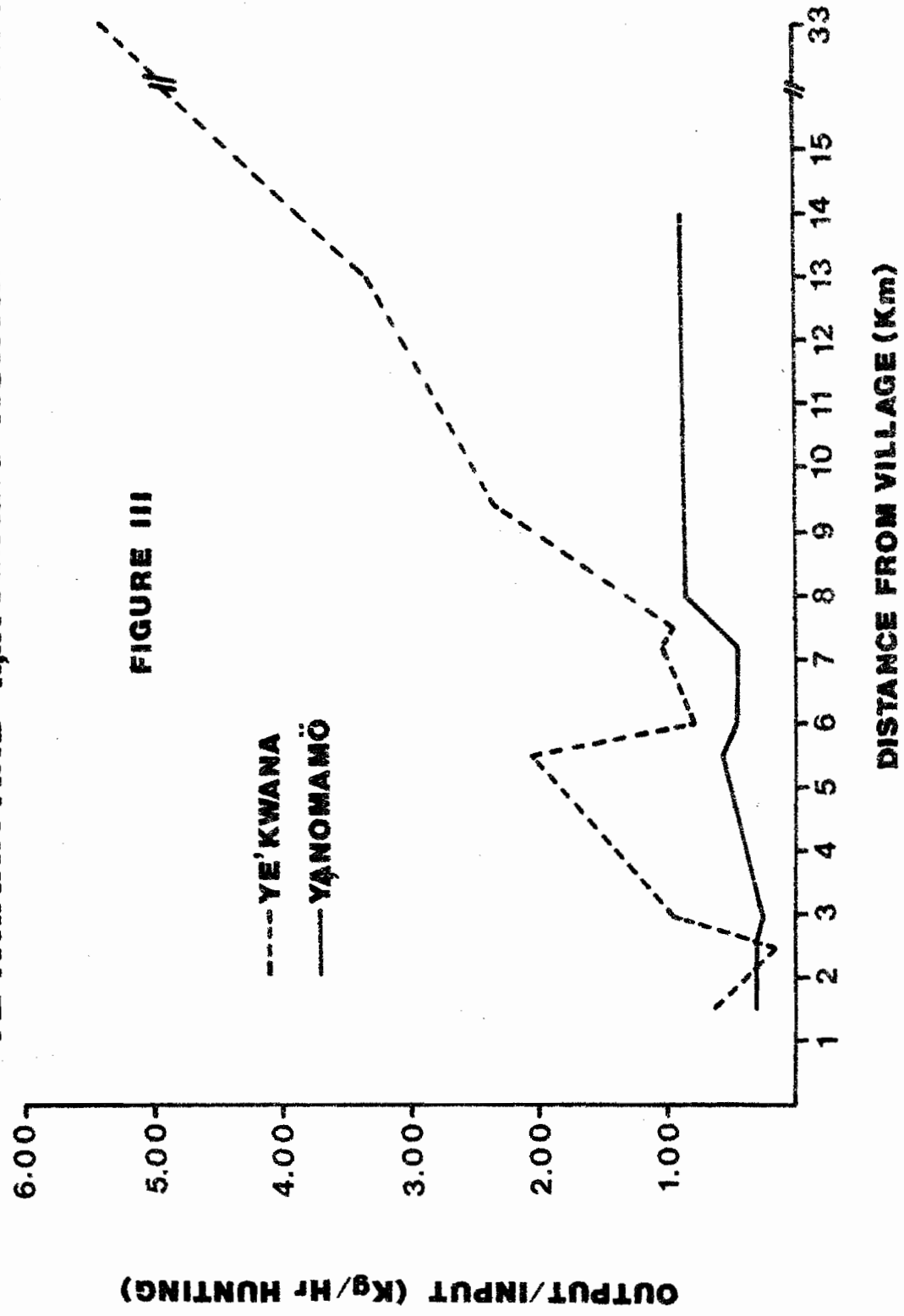
*Derived from Table I.

Hunting Output

The amount of game taken from each hunting zone is obviously a function of the quantity of faunal biomass and amount of time spent hunting in each zone, which in turn is determined by the dominant biotope and the length of time the zone has been exploited. Figure II, which plots the amount of game taken from each zone against the distance of the zone from the village (distance is a fair index of the history and frequency of exploitation and hence the quantity of animal biomass for each zone). It indicates that, if we exclude hunting zones in which the Ye'kwana or the Yanomamö do little hunting, there is a fairly good positive relationship between distance from village and quantity of game. That is, the further the zone from the village, the greater the amount of game taken.⁴ Distant hunting zones are important in the hunting economy of the Ye'kwana and the Yanomamö: 57% and 41% of all game taken by the Ye'kwana and the Yanomamö, respectively, was taken from distant hunting zones (Iguapo, Watamo, and Metacuni) which are the foci of expedition hunting.

YE'KWANA AND YANOMAMÖ HUNTING EFFICIENCY

FIGURE III



The productivity of each hunting zone makes for an interesting comparison with the data published by Nietschmann (1973:173) on the Miskito Indians of Nicaragua. Nietschmann noted that the relationship between distance and hunting yield was not linear but that it was more akin to a normal distribution (i.e., yields were low far and near to the village and peaked over the middle range). Nietschmann implies that variability over distance is largely a function of the variable distribution of biotopes throughout the Miskito hunting area. The difference between the Ye'kwana and Yanomamö data and the Miskito data is probably attributable to the fact that Amazonian habitats are not as complex and diverse as the habitats of coastal Nicaragua.

Hunting Output/Input

The data on hunting input and output, alone, are insufficient measures of the quality of each hunting zone. By combining input and output data for each zone into output/input ratio (kilograms of game per hour of hunting) the quality of each hunting zone and the abundance of animals therein can be evaluated. Table I and Figure III indicate that there is a positive linear correlation between distance of a hunting zone from the village and its output/input ratio. Furthermore, if one were able to delete the added time necessary to travel to distant hunting zones then the relationship would be stronger and perhaps curvilinear.⁵

Actually, the real determinant of hunting success--measured by output/input--is not the distance of a zone from the village but rather the degree to which the zone has been exploited. Distance of a zone from the village is merely a useful index, in most cases, of its

history and intensity of exploitation. In a real sense, output/input ratios in hunting zones behave in much the same way as output/input ratios in horticultural plots which have been cropped for varying lengths of time; and, as will be argued later, Ye'kwana and Yānomamö hunters rotate or shift hunting zones in much the same way and for the same reasons they shift horticultural plots.

Earlier it was suggested that biotope could influence the abundance of game in each hunting zone. However, it was noted that for most zones the effect of biotope type is masked because most zones are about 80% terra firme and in practice it was very difficult to determine the proportion of other biotopes in each zone. Nevertheless, one can make a strong argument that biotope type strongly influences hunting success in the hunting zone of Shanama'ña. Figure III reveals that hunting success for the Ye'kwana is much higher in Shanama'ña than it should be given its proximity to Toki and its long history of exploitation. This zone has been exploited continually for at least 25 years and was once a village site, between 1965 and 1969, for the Ye'kwana and the Yānomamö of Toki. The high continued productivity of Shanama'ña is most probably related to its degree of ecological complexity and numerous ecotones. Instead of being dominated by the terra firme biotope, Shanama'ña contains large areas of swamp forest, seasonal várzea forest, and a variety of anthropogenic formations, as well as some terra firme forest. The juxtaposition of so many biotopes suggests large ecotonal areas.

The higher productivity of garden land and abandoned gardens immediately around Toki in comparison to the two nearby terra firme hunting zones of Audáha emadi and Wohokuha also attests to the role that biotope plays in hunting success. Gardens, abandoned gardens,

and secondary forest provide a large amount of edible biomass for terrestrial, as well as arboreal and volant, animals. Linares (1976) and others have already pointed out that garden hunting is relatively efficient even though such areas are often subject to long-term exploitation.

Since there is an implicit assumption in this study that hunters attempt to maximize the amount of game captured in relation to the amount of time spent hunting, one may legitimately ask why hunters bother to hunt in zones near the village which are least profitable and why they do not allocate more time hunting in distant zones which are most profitable. (This is also a perplexing problem in optimal feeding theory in relation to optimal patch [here, zone] choice, cf. Pyke et al., 1977; Krebs, 1978).⁶ Time constraints for the Ye'kwana and the Yqnomamö and gasoline cost and scarcity for the Ye'kwana are the major factors which may explain this deviance from the expected. As pointed out above, hunting near the village, which is the least efficient type of hunting, most commonly occurs during periods of the year when other necessary economic tasks, such as garden clearance, dominate Ye'kwana and Yqnomamö time budgets. Similarly, long-distance hunting is limited to times when hunters can devote exclusively two to five days to hunting, and this hunting, especially for the Yqnomamö, is best done during the short "dry" season when it is easiest to travel in the forest. The cost and scarcity of gasoline for outboard motors limits the amount of time the Ye'kwana can hunt in the rich zones of Watamu and Metacuni. Finally, the restricted seasonality of night hunting, which is the most profitable of all hunting, partially explains why Ye'kwana hunters did not spend more time hunting in Shanama'ña which is an unusually rich night hunting zone.

Discussion

A locational analysis of Ye'kwana and Yānomamö hunting patterns has a number of implications concerning aboriginal use of faunal resources in the neotropics, as well as the role of hunting and protein procurement in relation to successful adaptation to the Amazon. Briefly, the Ye'kwana and the Yānomamö utilize hunting zones so as to maximize game yield while minimizing hunting effort and this pattern of areal exploitation is suggestive of a semi-sedentary settlement adaptation.

During the first few years of a village's existence the hunting zones immediately around the village are exploited intensively because game is abundant and effort expended is low. As game becomes depleted (in the sense that the output/input ratio declines in nearby hunting zones), more distant zones are opened if the added travel time is repaid by higher rates of rates of return in comparison to nearby zones. Table I reveals that this process has occurred already in Toki because the two nearest hunting zones (aside from the garden zone), Audäha emadi and Wohokuha, are the least frequented hunting zones that the Ye'kwana and the Yānomamö exploit. This is not to suggest that the hunters of Toki are obeying some conservation ethic to preserve animals from local extinction, but rather, as the output/input ratios indicate, these areas give the lowest rates of return of all zones. Relaxation of hunting pressure in low-yielding zones allows game populations to rebuild and this will eventually enhance hunting success in such zones. However, I would not argue that the aim of relaxation of hunting pressure in depleted zones is to permit local game populations to rebound, although it is one of the effects (cf. Williams,

1966, p. 8 ff., for a discussion of adaptation and fortitious effects). The aim of taking pressure off the game-depleted zones is to maximize hunting efficiency by exploiting more profitable zones. This process has been well established for Athabaskan hunter-gatherers (Feit, 1973; Jarvenpa, 1977).

The utilization of hunting zones among the Ye'kwana and the Yānomamö is analogous to their utilization of garden land. Through time intensively cropped hunting and garden lands lose their fertility (as measured by declining output/input ratios). When this occurs to a particular degree, land is abandoned and new land is opened for exploitation. While the new land is exploited, heavily cropped land regains its fertility and later it can again be cropped effectively. Conklin (1957) has devised a well-accepted typology of shifting cultivation based on the length of time cultivated land is allowed to fallow before recultivation. Adopting this typology for neotropical forest hunters, one might classify groups like the Amahauca (Carneiro, 1970) as "pioneering hunters" because they abandon their settlement after one or two years, when game immediately around the village becomes depleted, in order to establish a village where game is more abundant. The Ye'kwana and the Yānomamö might be classified as "integral hunters" because of their practice of rotating hunting zones. The factors which determine the kind of hunting strategy utilized are undoubtedly complex: population density, political environment, settlement size, and the quantity and seasonality of fish and game resources are the most important factors.

The numerous and intensive studies of shifting cultivation in the tropics have provided a great deal of information regarding how long a

plot of garden land may be cultivated, how long it must be fallowed prior to recultivation, and the factors which determine this process. The primary aim of this paper has been to demonstrate that some neotropical hunters utilize their hunting land in much the same way as shifting cultivators. However, as the data presented here indicate, this process of hunting zone rotation is only vaguely understood, and it is not exactly known whether this form of hunting adaptation occurs among other neotropical horticulturalists who depend on hunting for a major portion of their protein intake. Given the rapid encroachment of criollo settlers into Amerind land in the Amazon and the creation of national Indian parks (especially the planned Yānomamö Indian Park near the Brazilian-Venezuelan border, cf. Ramos and Taylor, 1979), it is crucial that ecologically oriented researchers gain some idea of the extent to which Amerinds utilize their hunting land and what their needs are. The remainder of this paper will be devoted to accessing one part of that problem: that is, the rate of recovery of a hunting zone.

In order to assess the rate of recovery for hunting zones, the examples of Cúa, Watamo, and Metacuni will be used (see Map I and Table I). When the Ye'kwana and the Yānomamö arrived in Toki in 1969 none of these hunting zones were used. Initially game was locally abundant in Toki and there was no need to travel to these distant spots to hunt successfully. According to Ye'kwana and Yānomamö informants, Metacuni had been hunted intensively between 1920 and 1955 by the Yānomamö inhabitants of Koshirowä-teri, Buhimalawä-teri, and Sedukurawä-teri; Cúa was hunted intensively between 1945 and 1969 and then lightly from 1970-1974 by the villages of Haiyamo-teri and

Namaho-teri; and Watamo between 1940 and 1955 by the Toropo-teri and the Ye'kwana when they lived at Nosamo'ña. If we assume that all these zones were exploited until their output/input ratios were similar to Audáha emadi and Wohokuha (see Map I and Table I) and if we know that Watamo was reopened in 1973, Cúa in 1975, and Metacuni in 1975, then the following table (Table II) may be constructed:

Table II

Zone	Length of Fallow	Output/Input Ratio (kg/hr)
Cúa	6 years	0.98
Watamo	17 years	3.39
Metacuni	20 years	5.34

The table above suggests quite obviously that the longer a zone is not hunted the greater the hunting success when it is reopened. The findings here are consonant with those of Vickers (1976, 1979) in his study of the Siona-Secoya of the Ecuadorian Amazon. At the start of Vickers' study the Siona-Secoya moved their village into an area which had not been exploited for 20 years and they killed game at a rate of 2.82 kilograms (eviscerated weight) per hour of hunting during their first year of residence. During their second year of occupation, Siona-Secoya hunting yields dropped by 40% to around 2.0 kg/hr hunting. Vickers points out that the adaptive responses were to hunt smaller animals which were overlooked when large animals were abundant during the first year of settlement and to exploit increasingly zones

distant from the village. Partial analysis of animal types by hunting zone for the Ye'kwana and Yānomamö also indicate that small animals were more frequently taken in hunting zones near the village.

Furthermore, studies of optimal diet choice in a variety of animal species (cf. summaries in Schoener, 1971; Pyke et al. 1977; Krebs, 1978) have demonstrated repeatedly that as large prey (or prey which yields the highest net rate of return) becomes scarce, predators switch to small prey which had been ignored when large game was abundant (cf. also Winterhalder, 1979). In other words, predators switch from being specialists to generalists with changes in density of large and small game, by broadening their diet breadth.

Lathrap (1968) and Meggers (1971) suggest that interfluvial populations such as the Yānomamö must shift residence frequently due to local game depletion. While some Amazonian populations such as the Amahuaca of the Peruvian Montaña appear to fit this model, the Yānomamö of the Padamo do not. Although the Padamo Yānomamö are currently a fluvial population, they have become so only in the last 30 years. Ethnohistorical research on this population reveals that in over 30 village moves spanning a period of 90 years none, according to informants, were made because of declining game yields, even after they were pointedly queried about the relationship between game depletion and village movement. Research by Chagnon on the largely interfluvial Namowei-teri and Shamatari population blocs (Chagnon, 1974) with a sample of over 300 residential shifts over a period of more than 100 years also indicates that informants never rationalized such movement in terms of game depletion, although lack of easily accessible garden land was not infrequently cited (Chagnon, personal

communication). This is not to say that game depletion is not, or cannot be, a cause of residential shifts, but merely that we have been unable to document it.

Chagnon (1973) has shown that the Yānomamö shift residences for two general reasons. The first, which he terms a "micro-move," occurs when garden land immediately around the village becomes sufficiently distant productive gardens in order to shorten walking time. Such moves are also precipitated by general village structural decay (e.g. rotted roof thatch) and environmental health problems (e.g. increasing chigger and cockroach populations). These moves range from 100 m to 1 km of the former village site. The second kind of move is termed a "macro-move" and occurs when a village must put a great deal of distance between itself and a more powerful enemy village for reasons of safety.

Conclusion

It appears that there are several major adaptive responses to declining game yields in Amazonia. The first might be called pioneering hunting. This response occurs among interfluvial populations with low population densities, small settlements, and little or no dependence upon fish, such as the Amahuaca (Carneiro, 1970). Such communities exploit the game immediately around the village for a period of one to two years and then abandon the settlement when game becomes difficult to acquire. The second form might be called integral hunting and is manifested by such groups as the Ye'kwana and Yānomamö through the rotation of hunting zones. The widening of diet breadth, which has been documented by Vickers (1976, 1979) for the Siona-Secoia, and which

occurs among the Ye'kwana and Yanomamö also, is another adaptive response for integral hunters and takes place in concert with hunting zone rotation. However, it is still too early to tell whether this simple dichotomy is adequate to cope with the various strategies for dealing with local game depletion. Johnson (1975) has suggested that the Machiguenga of the Peruvian Montaña have responded to game depletion by growing a greater number of protein-rich crops such as maize and beans instead of relying on protein-poor crops such as manioc and plantains, staples of the lowlands where fish and game are more abundant. Indeed, game depletion may provide the key for understanding the distribution of crop complexes in Amazonia. It is clear that further research is needed to determine the range of responses by Amazonian native populations to diminishing game yields and the demographic and ecological processes which underlie them.

Footnotes

1. Field research for this paper was supported by a grant from the National Institute of Mental Health (NIMH 5 ROI MH 26008-SSR), and time to write this paper was supported by a H. F. Guggenheim Fellowship. I would like to thank S. Beckerman, N. Chagnon, R. Kiltie, A. Johnson, T. Melancon, B. Nietschmann, K. Taylor, D. Thomas, W. Vickers, G. Webster, and B. Winterhalder for reading the manuscript and offering useful comments.
2. In regards to hunting territories Lizot asserts, "In fact each Yanomamö community has its own hunting territories. These territories are exclusive and determined by use alone, and they are never the object of disputes. Since neither game nor space is scarce, there is no competition for resources and the community is sovereign" (1978:507). Since the concept of territoriality is defined commonly as a defended area of exclusive use one must assume--implicitly at least--that the Yānomamö in Lizot's area of study are defending their right to monopolize game resources wherever they hunt. It is paradoxical that a settlement would have hunting territories if, in Lizot's words, neither game nor space is scarce. Perhaps Lizot really means to say that they have a home range or an undefended exclusive area (cf. Brown, 1975:58-70, 124-150, for a discussion of these and other concepts of animal spacing systems). However, overlapping or non-exclusive hunting zones between Yānomamö villages have been reported by Smole (1976:78-79) and suggested by A. and N. Lhermillier (1975).
3. Charnov, Orians, and Hyatt (1976:256-257) suggest that a kind of passive territoriality, which appears to be identical to Brown's concept of an undefended exclusive area, may evolve among conspecific predators due either to exploitative or behavioral or microhabitat depression of game animals. For human hunters B. Winterhalder has suggested (personal communication) that this might occur in environments where prey are well concealed, exist at low density, and are relatively sedentary and slow to recover from predation (this is a good typification of neotropical rain forests). In such environments intruders are at a disadvantage because they are ignorant of hunting depression levels caused by predators which regularly use the area. It is conceivable that this is true for Yānomamö and Ye'kwana hunters and it provides a further rationale for hunters spending little time in zones exploited heavily by neighboring villages.
4. Since the founding of the village of Toki in 1969-70 the distant hunting zones of Metacuni, Watamo, and Iguapo have been subject to the least hunting pressure of all zones, although their rate of exploitation, according to informants, has increased in recent years. Therefore, distant zones have a greater amount of total game biomass compared to near zones. But the greater yield of distant hunting zones is not so much a function of greater total biomass but rather the higher proportion of large game (white-lipped peccary, tapir, caiman, etc.) in the total game biomass. A preliminary analysis of the hunting data indicates that the average weight of a kill (kilograms of game divided by number of individuals taken) in distant zones is approximately double of that in near zones. A fuller analysis of this sort is being prepared and will be compared with W. Vickers' data on the Siona-Secoya (Hames and Vickers, in preparation) and related to the issues of optimal diet breadth

5. Charnov's marginal value theorem (Charnov, 1976b) would predict that hunting efficiency (or the net rate of energetic return) should be equalized over all patches (here, zones) of a hunter's habitat because a hunter should leave a patch when its marginal rate of return is equal to or less than the marginal rates of alternate patches. In other words, a hunter should not remain in a patch when his rate of return can be increased by travelling to another patch. The measure of hunting efficiency used here (kilograms of game per hour of hunting) are marginal values since travel, search, and return time are combined for the measure hunting input. To some extent Yanomamö hunting efficiency does confirm Charnov's marginal value theorem because even though hunting efficiency does increase with distance from the village it does so only slightly (cf. figure II). However, the same curve for the Ye'kwana does not bear out Charnov's prediction because hunting efficiency increased dramatically with distance from the village.

It should be noted that humans are central place foragers and Charnov's model applies to non-central place foraging, which, according to Orians and Pearson (1979), is a special case of central place foraging. Nevertheless, in central place foraging equality of net rates of return for each patch may never occur. This is because when a hunter travels to a desired patch he sometimes travels through a number of other patches on his way out and on his way back in which he intends to do no hunting. If suitable game is found en route then it will be taken (cf. Hamilton and Watt, 1970; on trampled zones and refuging). Also, as discussed on page 18, time constraints disallow equality of net rates of return for all hunting zones.

6. Theoreticians of optimal foraging theory frequently attempt to explain deviations from the expected as do to complicating factors such as an organism's desire to minimize variance of intake, to monitor food resources in a rapidly changing environment, and a host of other factors: for a discussion of the role of these factors see Pyke et al. (1976) and Krebs (1979).

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FISHING AND HUNTING BY THE BARÍ OF COLOMBIA

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Although the primary burden of this paper is the presentation of data on the acquisition of animal protein by a group of swidden horticulturalists of the tropical American forests, it is useful at the outset to indicate the theoretical issues on which this data set bears. The first of these issues is the assumption, probably more often spoken than published, that the rainforest is a temporally and spatially uniform habitat for man--that a human group finds more or less the same set of resources at all seasons and in all places in the jungle. Lathrap (1968) has pointed out that there are indeed at least two different major human habitats within the rainforest: the vicinities of major rivers, and the slightly higher "dry forest" lands away from the rivers. The data presented below accord well with this position, although they might be read to suggest that a more useful formulation would see a gradient of resource availabilities stretching from large rivers, across smaller rivers, back into the dry forest, rather than two contrasting habitats. Additionally, these data show unmistakably significant seasonal variation in resource availability and procurement.

A second issue addressed by the data presented below is the hypothesis (Gross 1975) that tropical forest population are limited by the amount of animal protein they can procure. This hypothesis has been both accepted (Ross 1978) and attacked (Beckerman 1979) in the recent literature. The present data do not support the hypothesis.

A third issue on which these data bear is the application of optimal feeding theory (Covich 1976; Emlen 1968; Emlen and Emlen 1975; Pulliam 1974, 1975; Pyke et al. 1977; Rapport 1971; Schoener 1971; Hawkes, personal communication) to the diet of a human population. Although the consideration of that subject will require another paper, I think that the relevance of these data to the theory will be clear.

This paper presents basic data from 1970-2 on the acquisition of animal protein by the Barí, a swidden horticultural people living in the rainforests of the southwestern corner of the Maracaibo basin. The Barí are semi-sedentary manioc cultivators who live in longhouses and demonstrate a number of other broad-brush similarities to the peoples of the Amazon basin. A brief sketch of the basic ethnography can be found in Lizarralde and Beckerman (in press).

Graph 1 shows the rainfall regime of the Barí area; these data are a good indication of the height and clarity of the rivers, with only a few days' lag, due to the proximity of the area to the rim of the basin, and the speed with which the rivers flow. Temperature is nearly constant throughout the year, averaging about 27 C.

Chart 1 shows the dates and locations of all my periods of fieldwork; Chart 2 compresses these data to show how observation distributes over the months of the year for the locations pertinent to this report.

I will consider first fishing, then hunting, an order which reflects the importance of the two activities. For each topic I will make a few introductory remarks about the major species involved, the major techniques

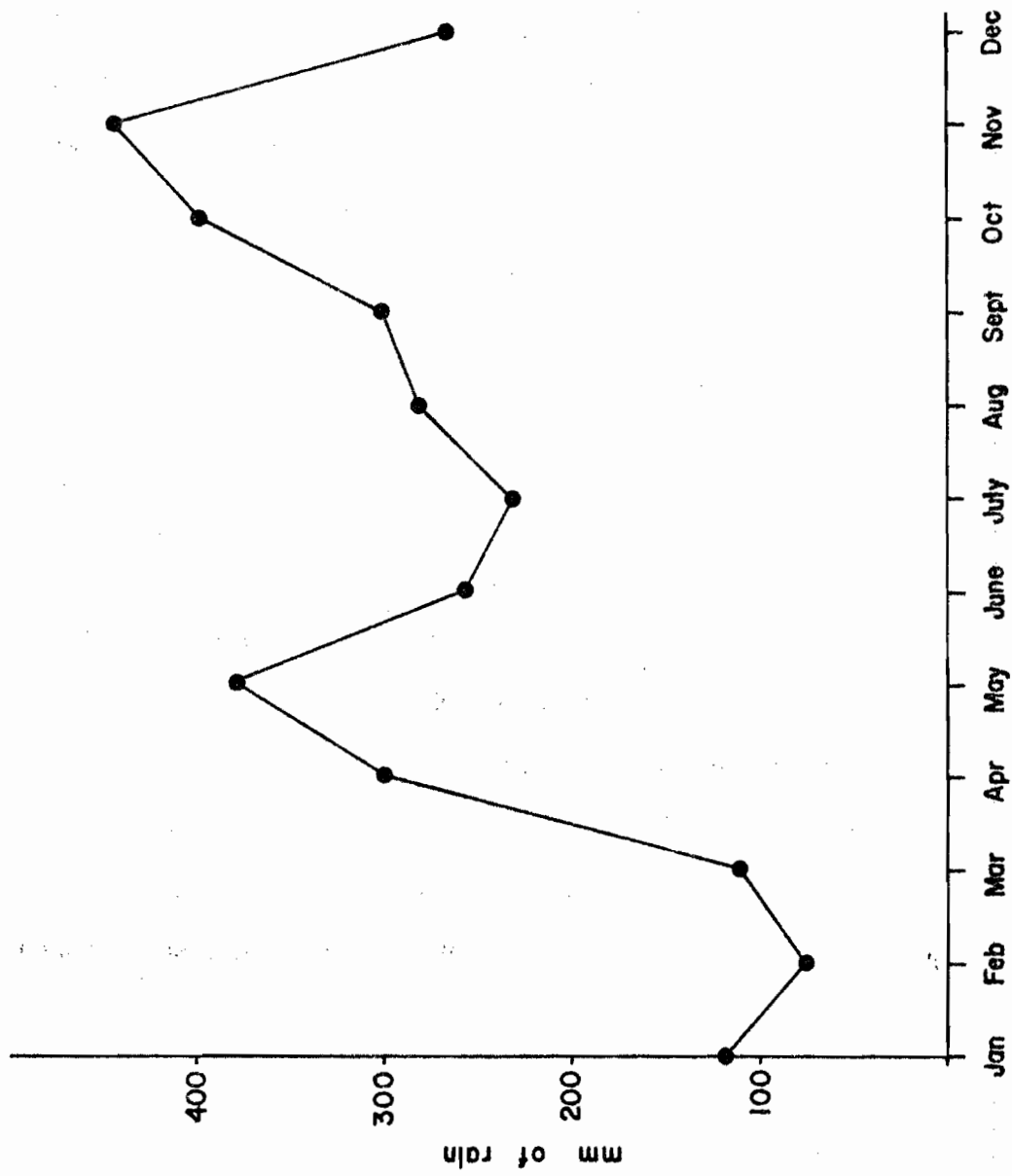


CHART 1: BARI FIELDWORK DATES AND LOCATIONS

TIME AND PLACE OF FIELD WORK
1970

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Catholic Mission on Catatumbo				14- 20									7
Iquiacorora (1)				11- 18				19---4; 11- 26		18- 24		3-4	50
Sapa?dana (2)													
Okbabuda (3)									5; 10				2
Shubacbarino									6-9				4
Antraycayra													
Ashtacacayra										25-----		2	39
Culebritascayra													
"new location" on Rio de Oro													
on trail with Bari													
Totals				7	8			13	26	14	30	4	102

1. A lowland mission station with a traditional style house of the same name immediately across the river; only the days in April, 1972 were spent in the longhouse; the other days were spent at the mission. Longhouse population, 23.

CHART 1: (continued)

1971

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Catholic Mission on Catatumbo													
Iquiacorora		18- 23	26			6		11- 12; 30----	29				16
Sapa?dana								18- 25	25- 28				12
Okbabuda								26- 27	18- 24				9
Shubacbarina (4)								28---	17				20
Antraycayra (5)			28---	23									24
Ashlacacayra (6)		24---	21			7-11		13- 29	4-17				64
Culebritascayra (7)													
"new location" on Rio de Oro (8)													
on trail with Bari			22- 27	24- 25									8
Total		13	28	26		6		21	30	29			153

4. A semitraditional lowland house, population 23.

5. A traditional highland house, population 50.

6. A traditional lowland house, population 9.

7. A traditional highland house, population 55.

8. Several homesteader style lowland individual house, population ab

CHART 1: (Continued)

1972

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Catholic Mission on Catatumbo													
Iquiacorara			30--10							25--- 5	10; 19- 20	27	
Sapa?dana		15- 28	29								11; 17	7	18
Okbabuda		29--- 1; 27- 28									13; 15		6
Shubacbarina			2- 26								14		26
Antraycayra												13- 15	2
Ashtacacayra													
Culebritascayra						19----7							19
"new location" on Rio de Oro										6-10	8-9		7
on trail with Bari						8-14				12; 16	11- 12;	13	16-18
Total		15	31	10	12	14				7	17	12	118

CHART 2: FIELDWORK DAYS PER MONTH

	Iquia- corora	Shubac- barina	Culebri- tascayra	Ashtaca- cayra	Sapak- dana	Antray- cayra	Okba- buda	"New lo- cation"	All hours
JAN	6			8					14
FEB				21	14	1	1		37
MAR	2	25			1	23	3		54
APR	9								9
MAY	8		13						21
JUN			7	5					12
JUL									0
AUG	17		17						34
SEP	23	7		14	8		4		56
OCT	15	18		7	3		7		50
NOV	5	1		30	2		2	5	45
DEC	5			2	1	3		2	13
TOTAL	90	51	20	104	29	27	17	7	345

used to fish or hunt, and the days of fieldwork during which these activities were recorded. Then I will present the quantitative data for each species or larger taxon involved, making comparisons between taxa, between seasons, and between highland and lowland locations when appropriate. A summary conclusion will return the data to the questions of abundance and seasonality.

Fishing

Fish provide over 75% of the animal protein in the Barí diet, with a single species, the bocachico (Characidae, Prochilodus reticulatus) making up about two thirds of the percentage. Another single family, the Loricaridae, represented by a number of different genera, supplies almost another fifth of the fish total. The remainder is comprised of a wide variety of different families, including Pimelodidae, Sternarchidae, Doradidae, Potamotrygonidae, and additional members of the Characidae.

All traditional Barí fishing is done with spears and (much less frequently) arrows, without the use of poison. (Occasionally a kind of "barbasco" from a species of Tephrosia is employed, but it is almost always used only as an irritant, to drive loricarids from tight hiding places in which they have lodged themselves, and not as a stupefactant, to immobilize them. Only very rarely, when people are fishing for small fry in puddles in very small, slow moving streamlets, is the Tephrosia actually used to stun the fish).

By far the most common kind of Bari fishing expedition involves the building of two stone dams from the upstream and downstream ends of an island to adjacent spots on the shore, and the spearing of the fish trapped between. Less common is the use of spears and sometimes arrows in an undammed stretch of water, often one which has a natural constriction of some kind at one end. This kind of expedition almost always works its way upstream. Rarely used techniques include blocking off muddy puddles with large leaves in order to get fry with Tephrosia and arrows, and building a substantial pole and palm frond dam across a small tributary in order to get large catfish that try to return to the main river at night, with spears. Except for puddle fishing for fry, all these techniques require clear water, and are greatly favored by low water as well.

Women as well as men participate actively in most fishing expeditions. When dams are constructed, the women build the downstream member of the pair. They also collect a good many small loricarids and a few crabs, by guzzling under rocks, and they clean and usually scale all the bocachico taken, on the spot. None of these activities is as dramatic as the men's spearing and shooting, and the direct yield is much lower, but they all represent work that would have to be done in any case, and women are therefore counted as full producers on the expeditions they accompany. Some fishing trips are not accompanied by women; and women occasionally make fishing trips of their own, on which they collect whatever aquatic creatures they can grab by hand.

The Barí had begun to use the hook and line at the time of this fieldwork, but the magnitude of this technique's contribution to the diet was not great because the bocachico, by far the most abundant fish, is an algae browser which is uninterested in the bits of manioc and pieces of animal guts they use for bait. The same observation is largely true, as far as I could tell, for all the loricarids, which are bottom detritus feeders. Nets were used only by whites (homesteaders and some mission employees) in the early 1970's. Fish taken with all non-traditional methods are excluded from the catch figures given below.

Chart 3 shows the distribution, over the months of the year, of fieldwork days on which fishing data were recorded. There are fewer days represented here than in Chart 2 for obvious reasons of being able to record only a few things at once, as well as because of gaps existing on days of arrival or departure.

Bocachico: Chart 4 shows the number of fishing expeditions for bocachico made at the various times and places of observation.¹

This chart also provides a projected average figure of number of bocachico fishing trips per 30 day month, based on the ratio of fishing trips to total days of recording.² Chart 5 shows the return per consumer, the return per producer, and the return per producer manhour, in bocachico, for those months for which the data are available. Adult participants of both sexes count as producers for the trips they accompanied, but children are added in only as consumers. Despite the fact that children almost always accompany fishing trips, they are seldom much help.

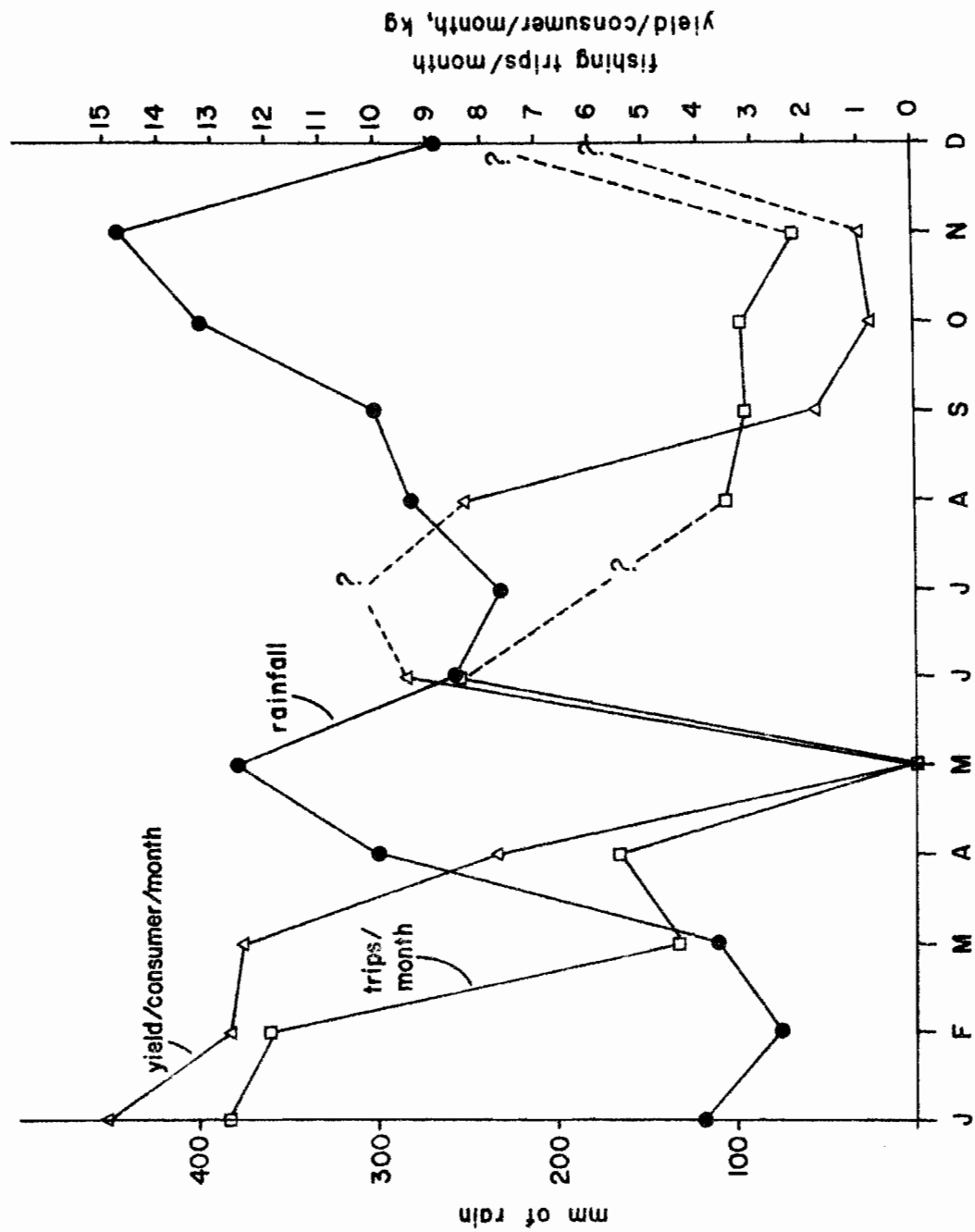
CHART 3: DAYS OF RECORDED FISHING DATA

	Iquia- corora	Shubac- barina	Culebri- tascayra	Ashtaca- cayra	Sapak- dana	Antray- cayra	All houses
JAN				7			7
FEB				21	14		35
MAR		25				23	48
APR	9						9
MAY			12				12
JUN			7				7
JUL							0
AUG				17			17
SEP		7		14	8		29
OCT		18		5			23
NOV				30			30
DEC				2			2

CHART 4: BOCACHICO FISHING PER DAYS RECORDING

	Iquia-corora	Shubac-barina	Culebri-tascayra	Ashtacacayra	Sapak-dana	Antray-cayra	All houses	
JAN				$\frac{3}{7}$ 12.8			$\frac{3}{7}$ 12.8	fishing days recording days projected fishing days for 30 day mont
FEB				$\frac{8}{21}$ 11.4	$\frac{6}{14}$ 12.8		$\frac{14}{35}$ 12.0	
MAR		$\frac{7}{25}$ 8.4				$\frac{0}{23}$	$\frac{7}{48}$ 4.4	
APR	$\frac{2}{9}$ 5.5						$\frac{2}{9}$ 5.5	
MAY			$\frac{0}{12}$ 0.0				$\frac{0}{12}$ 0.0	
JUN			$\frac{2}{7}$ 8.5				$\frac{2}{7}$ 8.5	
JUL								
AUG				$\frac{2}{17}$ 3.5			$\frac{2}{17}$ 3.5	
SEP		$\frac{1}{7}$ 4.3		$\frac{1}{14}$ 2.1	$\frac{1}{8}$ 3.8		$\frac{3}{29}$ 3.1	
OCT		$\frac{3}{18}$ 5.0		$\frac{0}{5}$ 0.0			$\frac{3}{23}$ 3.2	
NOV				$\frac{2}{30}$ 2.0			$\frac{2}{30}$ 2.0	
DEC				$\frac{0}{2}$ 0.0			$\frac{0}{2}$ 0.0	

$\frac{38}{219} = 63.33$ days for a
365 day year



Graph 2 displays some of the bocachico fishing data against the rainfall data to illustrate two points: the number of fishing trips per month, and the catch per consumer per month are both in general inverse functions of rainfall, although there is some variation unaccounted for by precipitation.

Extrapolating the missing points in Chart 5 for fishing expeditions per month and catch per consumer per expedition by the simple method of taking the arithmetic mean of the two adjacent points, we obtain the yearly projection shown in Chart 6. These figures are almost certainly underestimates, as reference to the rainfall data in Graph 2 will suggest.

Graph 3 shows the relation of rainfall to the projected number of manhours per producer per month spent in fishing, and the catch per producer manhour. (Manhours are calculated to include all time spent in an expedition from departure from a longhouse to return to it). As far as these data will carry us, the catch per manhour is almost perfectly inverse to rainfall, and the number of manhours per month somewhat less so. Comparing Graphs 2 and 3 it seems clear that the Barí strategy for bocachico is to fish most when returns are highest. This approach is what would be expected in a situation of abundance, when alternative sources of meat were readily available. If meat in general were scarce, the Barí would have to work hardest when returns were lowest.

Loricarids: Because far fewer loricarids are taken than bocachico, the data for this family are less reliable than those for bocachico. What

CHART 5: BOCACHICO FISHING RETURNS, KG.

	Iquia- corora	Shubac- barina	Culebri- tascayra	Ashtaca- cayra	Sapak- dana	Antray cayra	All houses	manhours consumer per trip
JAN.				1.18;n=3 2.44;n=3 0.49;n=3			1.18;n=3*return per consumer 2.44;n=3 return per producer 0.49;n=3 return per manhour	2.41
FEB				0.98;n=12 3.12;n=12 0.63;n=12	1.30;n=1 3.00;n=1 1.00;n=1		1.06;n=13 3.08;n=13 0.70;n=13	1.51
MAR		2.83;n=3 4.88;n=3 0.52;n=3					2.83;n=3 4.88;n=3 0.52;n=3	5.44
APR								
MAY								
JUN			1.11;n=2 2.18;n=2 0.24;n=2				1.11;n=2 2.18;n=2 0.24;n=2	4.63
JUL								
AUG				2.31;n=2 3.46;n=2 0.38;n=2			2.31;n=2 3.46;n=2 0.38;n=2	6.08
SEP		0.13;n=1 0.36;n=1 0.11;n=1		0.75;n=1 1.13;n=1 0.23;n=1			0.58;n=2 0.94;n=2 0.20;n=2	2.90
OCT		0.24;n=2 0.55;n=2 0.08;n=1					0.24;n=2 0.55;n=2 0.08;n=1	2.58 (n=)
NOV				0.51;n=2 0.77;n=2 0.12;n=2			0.51;n=2 0.77;n=2 0.12;n=2	4.25
DEC								

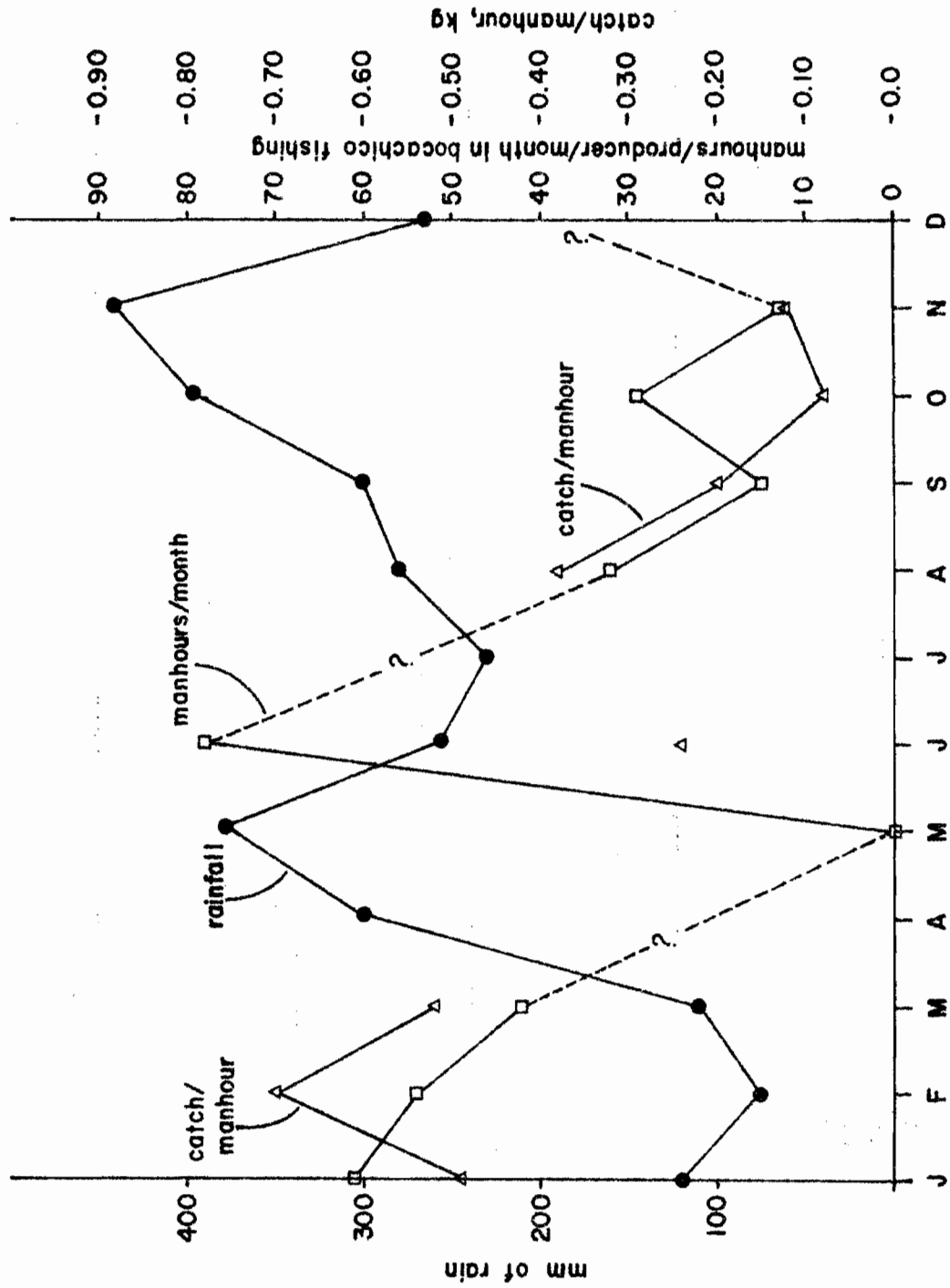
*(n=number of fishing trips from which the returns were calculated)

CHART 6: PROJECTED BOCACHICO FISHING YIELDS

A	B	C	D	E	F	B(E + F)
Month	Projected number of bocachico expeditions	Average catch per consumer per expedition (kg)	Product of B and C = Catch per consumer per Month (kg)	Average catch per producer per expedition	Average catch per manhour per expedition	Average manhours/producer per month
JAN	12.8	1.18	15.1	2.44	.49	61.4
FEB	12.0	1.06	12.7	3.08	.70	52.8
MAR	4.4	2.83	12.5	4.88	.52	41.4
APR	5.5	1.41*	7.8+	2.44*	.26*	20.7*
MAY	0.0	-	0.0	-	-	0.0
JUN	8.5	1.11	9.4	2.18	.24	77.4
JUL	6.0*	1.71*	10.3+	2.82*	.31*	54.6*
AUG	3.5	2.31	8.1	3.46	.38	31.9
SEP	3.1	0.58	1.8	0.94	.20	14.6
OCT	3.2	0.24	.8	0.55	.08	29.0
NOV	2.0	0.51	1.0	0.77	.12	12.8
DEC	7.4*	0.85*	6.3+	1.61*	.31*	38.5*
	68.4+		85.8+			435.1+

* extrapolated

+ calculated from extrapolated figures



information is available is contained in Chart 7, which shows the projected number of days per month on which loricarid fishing occurs, either (as is usually the case) incidentally to bocachico fishing, or (as happens particularly in wet months and at high altitude houses) as the explicit aim of the fishing trip. Rough estimates for the return per trip per consumer, based on a sample of only one trip or on pure extrapolation for all months except January, February, May, June, and November, are also given in that chart.

These data are displayed against rainfall figures in Graph 4, which suggests that loricarid fishing trips and yield per consumer run parallel to rainfall from January through June and inversely to rainfall from July through December. Because of the poor quality of these data, it would be unwise to read too much into this graph. It does however suggest the possibility that loricarid fishing replaces bocachico fishing to some extent during the first half of the year, at times when the rivers are too high and muddy for successful bocachico spearing, but declines with it during the second half of the year, when the rivers are so high that even the loricarids cannot be relied on.

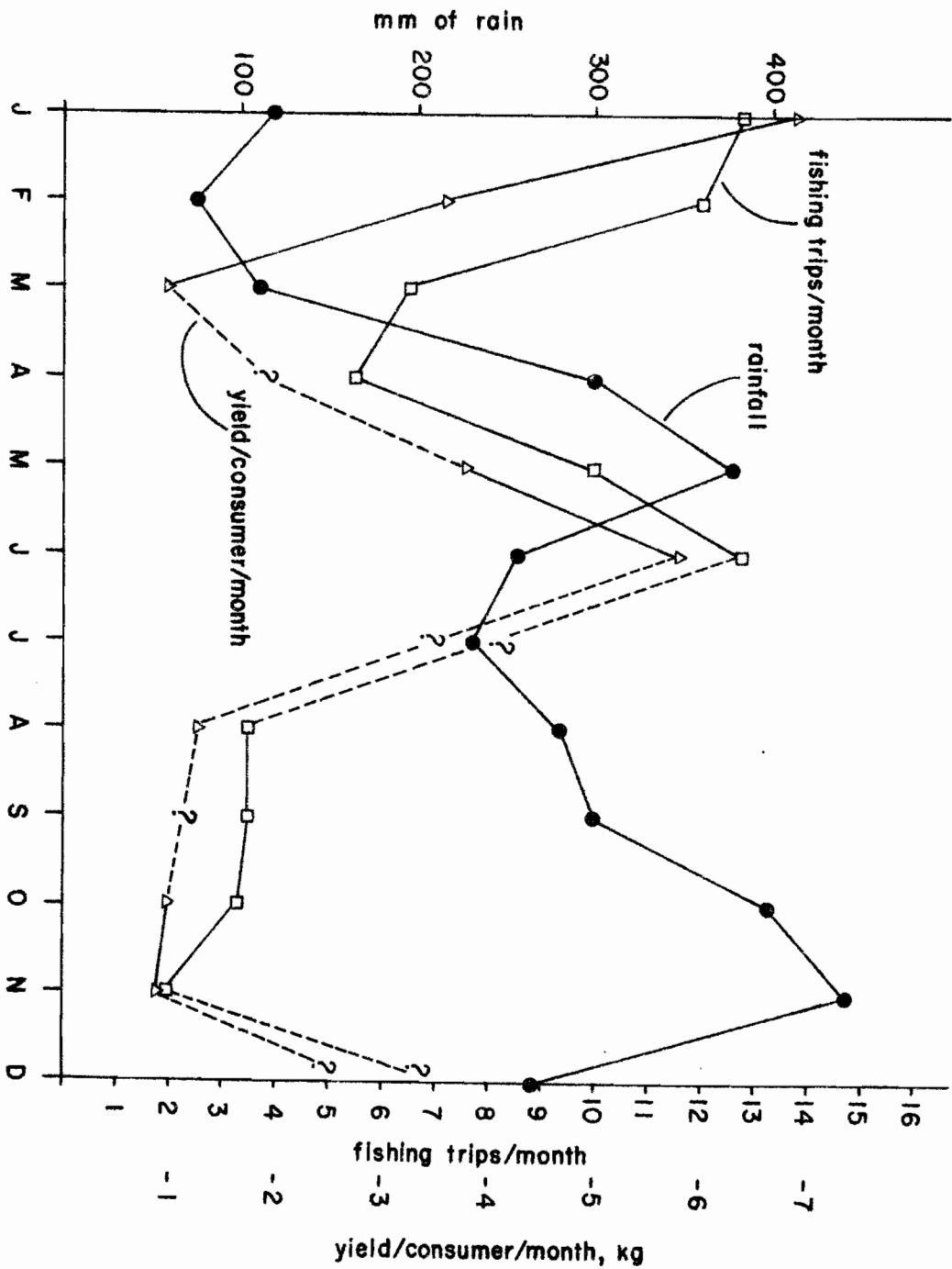
Unfortunately, it is impossible to give meaningful figures on manhours invested in loricarid fishing per month, because for all months except March, May, and June, essentially all the loricarid expeditions recorded were also, and primarily, bocachico expeditions. One comparison for a single month may be helpful, however, because it

CHART 7: LORICARID FISHING, PROJECTED DAYS & YIELDS

	A= Projected # of fishing trips/mo	B= Average catch/consumer/ trip	C=A·B= Average catch/ consumer/mo
JAN	12.8	.54	6.9
FEB	12.0	.30	3.6
MAR	6.5	.15	1.0
APR	5.5	.27*	1.5+
MAY	10.0	.38	3.8
JUN	12.8	.45	5.8
JUL	8.2*	.42	3.4+
AUG	3.5	.38	1.3
SEP	3.5	.35*	1.2+
OCT	3.3	.31	1.0
NOV	2.0	.43	0.9
DEC	7.4*	.47*	3.5+

* extrapolated

+ calculated from extrapolated data



will also illustrate the difference between a highland house, Antraycayra, with no nearby rivers of large size, and a lowland house, Shubacharina, which is close to a number of streams that communicate within a short distance with major rivers, and thus share their ichthyofauna.

In March of 1972 the 23 inhabitants of Shubacharina, over the 25 days of recording, made seven major bocachico fishing expeditions, for a projected 8.4 expeditions per 30 day month. The women alone also made two smaller fishing trips quite close to the house in which they caught some loricarid fry by hand; and there was a "private" fishing trip by one or two men which got a few bocachico. I was able to accompany the entire expedition, count the participants and time their activity, and weigh the catch, on three of the major occasions. In these three trips, a total of 373 adult manhours was spent, and a total catch of about 200 kilograms was obtained. Of this total, at least 175 kilograms was bocachico, and loricarids comprised the bulk of the remaining 25 kilograms, which also contained a few catfish and other species.

Projecting these figures to the full month's 8.4 trips, we obtain a total of 1044 manhours spent in fishing by the 16 adult producers of this house. The projected total catch is 560 kilograms of fish-- 490 bocachico and 70 mostly loricarid. (These are minimal figures, neglecting the women's loricarid fry and the bocachico of the "private" trip). Ratios work out to 23 kilograms of fish per consumer

per month (of which seven eighths is bocachico), obtained at a cost of 1.9 manhours per kilogram. Each producer averaged 65 manhours in fishing.

In contrast, the 50 people of Antraycayra (24 adults) made no bocachico fishing trips during the 23 days I recorded their activities in March of 1971. They did, however, make five fishing trips for other species, a rate which projects to 6.5 fishing trips for a 30 day month. I recorded returns only for my hearth group, and not for the entire residential unit, for this large house, so double projections are used for the following calculations: from a fraction of the house to the whole house, and from a fraction of the month to the whole month. The appropriate calculations suggest that the 24 adult producers of this house spent a total of 939 manhours in fishing in March and obtained about 130 kilograms of fish. This total is quite rough. Consumption works out to only 2.6 kilograms per person. Probably about half of the fish were loricarids, with the rest distributed among the predatory Hoplias malabaricus, various catfish, and a large number of a small fish I have tentatively identified as Piabucina pleurotaenia. It was not possible to separate these small fish from the equally diminutive loricarid fry to weigh each portion. The total cost of all fish was about 7.2 manhours per kilogram. Each producer averaged 39 manhours in fishing.

The difference between the houses is striking. One must work more than three times as hard at fishing, per unit of return, at

Antraycayra as at Shubacbarina, and the total return is only about a tenth as large per consumer. Even though the people of Antraycayra are concentrating on loricarids, they get a smaller quantity of them than the people of Shubacbarina, who are basically looking for other fish. One of the reasons for this disparity is that the loricarids taken along with bocachico are mostly sizeable fish, on the order of a quarter of a kilogram a piece, while the loricarids taken in the small mountain streams are exclusively fry, usually no bigger than the last two joints of one's finger. Be it noted, however, that the people at Antryacayra do not in fact spend nearly as much of their time in fishing as the people at Shubacbarina. They are in that mountain home for game, and fish are merely a fallback resource when hunting is unlucky.

Minor taxa: For all the remaining fish, total catch is too small for monthly fractions to be illuminating. The projected annual catch is calculated by taking the total number of consumer-days (days of observation times the size of the consumption group whose intake was recorded) for the whole period of fieldwork during which the taxon in question was recorded. The total weight of the catch is then divided by the number of consumer-days and the quotient multiplied by 365 to give a projected figure for consumption per person per year.

Annual consumption of catfish (all species of Pimilodidae) by this method works out to be 6.1 kilograms. Next in importance is the small fish which is probably Plabucina pleurotaenia (Characidae), eaten at a

rate of 3.5 kilograms per person per year. The tigerfish (Characidae, Hoplias malabaricus) contributes another 2.3 kilograms. I have not calculated the contributions of the other fish taken with such infrequency by traditional methods that even a yearly average would be of questionable value. However, I doubt that the combined contribution of rays (Potamotrygonidae, Potamotrygon magdalenae?) knifefish (Sternopyginae, Sternopygus macrus?) Doradidae, and many others which I recorded in only a few instances, can total more than five kilograms per person per year, and suspect that their combined contribution is less than half that. (It is, incidentally, the catfish, knifefish, and tigerfish which are most often taken with hook and line. These non-traditional catches have been excluded from the calculations above, but their inclusion would not have had a dramatic effect on the overall results). A rough check of the scanty raw data reveals no striking tendency for any of the minor taxa to be taken at any particular season of the year.

Summary: The figures developed so far indicate that each Bari consumer eats 132 kilograms (fresh, cleaned weight) of fish per year, a total which translates to 362 grams per person, per day. (This calculation omits the rays, knifefish, etc., completely). A rough correction for uneaten bone, armor plates, etc., requires the subtraction of fractions varying between 5% and 25% of the fresh cleaned weight, depending on the species involved. Performing this subtraction, we obtain an actual meat consumption of 112 kilograms per person per year, or 307 grams per person per day. The total number of

manhours spent in fishing (using the bocachico expedition figures for all months except March, May and June, and taking a calculated average figure of 7.2 hours each for the additional loricarid expeditions of those months) is 532 manhours per producer per year, or 44 manhours a month. The overall average cost of fishing is slightly over four manhours of work for each kilogram of fish.

Hunting

Almost 25% of Barí animal protein is supplied by birds and mammals. A little over three quarters of this quantity is derived from mammals alone.³ Of the taxa considered here, four families (Tayassuidae (peccaries), Cebidae (monkeys) Dsayproctdae (agoutis), and Cracidae (guans) supplied over 85% of the meat taken. The first three families supplied close to 90% of all the weight of mammals and two thirds of the weight of birds and mammals together. Guans alone accounted for over three quarters of the weight of all birds counted here.

All traditional Barí hunting is done with bow and arrow. The blowgun is unknown, and arrows are not poisoned. There are two kinds of bows and six kinds of arrows, all of which I hope to describe at a later date. Suffice it to say for the moment that there is a big bow and a little bow, and there is a barbed palmwood pointed arrow, a palmwood tipped bird arrow, a metal pointed arrow with a fixed point, and a metal pointed arrow with a harpoon point. (This last is used for tapir, peccary, and bear--never for fish). There is also

a small arrow made from a splinter of a palm frond and used for small game like doves. A palmwood pointed arrow without barbs, primarily used for fish, is occasionally used for small game as well.

Women do not accompany planned hunting trips, and on the occasions when a collecting trip or a party off on a visit spots game and turns into a hunting expedition, the women usually go to sleep until it is over. Only men are therefore counted as producers for purposes of figuring manhours in hunting.

At the time of my fieldwork, about a dozen Barí had shotguns. These men were usually resident at mission stations, however, and when they did bring their guns to traditional houses, often ran out of ammunition rather quickly. Traditional hunting was thus still thriving, although the shotgun had undoubtedly made greater inroads in hunting than the hook and line had made in fishing.

Chart 8 presents the breakdown of the basic data on hunting returns for each species or higher taxon considered. Data were calculated on the same basis as the figures for the minor fish, except that instead of directly weighed total weights, the amount to be divided by the number of consumer days was the number of individuals taken times the average weight of an individual of the species. "People days" in this chart means what "consumer days" meant for fish; it varies widely because I recorded all the large game acquired by an entire house, but only recorded the small game brought home by the particular hearth group I was living with in the house. The times and places of field recording for game were

Chart 8

1	2	3	4	5	6	7	8	9	10
fish	Spanish	Bari	Family	Genus and species	Dressing technique	Average dressed weight, kilograms	Number of individuals served taken with traditional methods	Extrapolated number of individuals taken per person per year	Extrapolated total weight of species eaten per individual per year
te-lipped cary	marrano	bisora	Tayassuidae	Tayassu pecari	quartered, plus head and spine; most guts kept	16.13	6	.44 people days=4974	6.03 (15%)
buti	picuri	kuvgara	Dasyproctidae	Dasyprocta punctata	whole; head and guts discarded	2.24	15	3.29 people days=1703	5.90 (20%)
blared cary	marrano	shankira	Tayassuidae	Pecari tajacu	quartered, plus head and spine; most guts kept	14.50	4	.29 people days=4974	3.70 (15%)
lder nkey	marimonda	shugshaana	Cebidae	Ateles belzebuth	halved or quartered; some guts discarded	7.60	5	.56 people days=3257	3.62 (15%)
wler nkey	mono allulador	kamashkogdra	Cebidae	Alouatta seniculus	halved or quartered; head and guts discarded	4.63	8	.67 people days=4347	2.48 (20%)
puchin nkey	mono capuchino	barashina	Cebidae	Cebus albifrons?	whole; guts discarded	1.70?	7	1.30 people days=1961	1.77 (20%)
teater	oso horniguero	kangkaina	Myrmecophag- idae	Tamandua tetradsactyla	whole; guts, sometimes head discarded	2.59	4	.74 people days=1961	1.53 (20%)
nksajou	cuchicuchi	bishwira	Procyonidae	Potus flavus	whole; some guts. some- times head discarded	1.29	12	1.14 people days=3835	1.18 (20%)
il monkey	miriquina	baakbora	Cebidae	Aotus trivergatus?	whole; guts discarded	.85?	7	1.44 people days=1779	.98 (20%)
quirrel	ardilla, ardita	karikaara	Sciuridae	Sciurus spp. Sciurus spp.	whole; guts discarded	.16	28	6.00 people days=1703	.77 (20%)
uan	pahuí, pava	batraira chikbarida	Cracidae	Crax spp. Penelop spp.	gutted	1.61	12	4.15 people days=1055	6.01 (10%)
parrot	loro, guacamaya	shiuudara, soira	Psittacidae	Ara spp.? Aratinga spp?	gutted	.35	10	3.46 people days=1055	1.09 (10%)
toucan	tucán	b'ehigdura	Ramphastidae	Ramphastos spp. Pteroglossus spp?	gutted	.27	7	2.42 people days=1055	.59 (10%)
dove	paloma	shibora	Colombidae	Geotrygon sp. Leptotilla sp., etc	gutted	.10?	6	2.14 people days=1055	.19 (10%)
									7.88 total
									27.96 total

35.84

Overall total

essentially the same as those for fish (Chart 3), but some of these days were discarded in working up the data, because someone had perturbed the situation by showing up with a shotgun.

Tayassuidae: The peccaries are barely ahead of the monkeys (9.73 kilograms/person/year to 8.85) in contribution to the diet. Most peccary hunting is done in groups, and if a lone hunter comes upon a band of peccaries he is likely to come home to alert others, rather than attack alone. Peccaries evidently forage slowly enough that they will still be in the neighborhood the next day, so that a proper hunt can be well planned.

Cebidae: Monkeys as a family make a sizeable contribution to the diet, although each of the four species individually is less important than the agouti or either of the two species of peccary. Monkey hunting is often also a group affair, although a lone hunter who comes upon a troupe of monkeys is likely to try his luck immediately if he is far from home. Monkeys, like large birds, can often travel far enough to lose the hunter even when they are apparently mortally wounded.

Dasyproctidae: Agoutis are probably the most reliable kind of game, certainly the most reliable mammal. Their population is comparatively dense, and they seem to be well dispersed throughout the forest. Although they are spooky enough to disappear at the first strange noise, they are attracted to manioc fields (peccaries are, too, but usually have enough sense to avoid the fields of a currently occupied

house) and can even be lured to specially made blinds with baits of manioc tubers or various fruits they like. Agouti hunting is usually a solitary affair--a matter of a long wait and then getting off one or two good shots before the little creatures sprint off.

Cracidae: Guans, South American relatives of the turkey, are the most important family of birds hunted by the Barí. They are hunted either alone or in groups, particularly at dawn or dusk, when they are just waking up or just settling in for the night. Unlike mammals, and many other birds, guans, when disturbed by a near missing arrow or even a shotgun blast, will often fly only to the next tree. They are thus relatively undemanding game to hunt.⁴

It is difficult to figure the number of hours the Barí spend in hunting. There are unambiguous, deliberate hunting trips, but there are also "psuedo-hunts." Usually each morning at dawn several men and older boys from a longhouse go out on the trail for an hour or two. When one asks them what they are doing, they say they are hunting (although the usual Barí word for hunting, "shkírayuna," literally means only "going on a trail") and it is true that from time to time they bring back some game, often a squirrel or a small bird, that they have run across. It is my strong impression, however, that they are not so much hunting as scouting--checking the height and clarity of rivers, the location of fish, the ripeness of wild fruits, the availability of materials for mats, baskets, cordage, etc., the presence of strangers, and the possibility of animal spoor to be followed later in the day. For the calculations which follow, therefore, I

have used for hunting time only those trips which ended in the actual acquisition of game, except in those cases in which it was obvious that serious hunting, and not just scouting, was the intent of a fruitless expedition. Most early morning jaunts are thus eliminated.

Let us now return to the comparison of Shubacbarina and Antraycayra in the month of March. It will be recalled that the producers of Shubacbarina averaged 65 manhours each in fishing that month and were rewarded with about a half a kilogram of fish per manhour; while the producers of Antraycayra spent only 39 manhours each in fishing, and got only a seventh of a kilogram for each manhour. Turning to hunting, we find the story reversed.

The 11 adult males of Antraycayra made a projected 13.75 hunting trips (defined as above) lasting 6.75 hours on the average, in March of 1971. The bag was a projected 239 kilograms of game, or 4.8 kilograms per consumer, at a cost of about 4.0 manhours per kilogram. Not all men accompanied all hunting trips.

The 8 adult male hunters of Shubacbarina, on the other hand, made only a projected 8.75 hunting trips in March of 1972, and these trips lasted only 3.9 hours on the average. The bag was only 33 kilograms, or 1.4 kilograms per consumer, at a cost of 6.1 manhours per kilogram. Again, not all men went along on all trips. The cost per manhour would have been somewhat higher but for the fact that they scared up a couple of kinkajous they weren't looking for while they were clearing some land.

CHART 9

	Cebidae		Dasyproc- tidae		Cracidae		Procyon- idae		Tayas- suidae		Myrmeco- phagidae		Psitta- cidae		Total Weight
JAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEB	0	0	1	2	0	0	1	1	0	0	0	0	0	0	3
MAR	11	37	0	0	9	14	8	10	1	16	0	0	1	0	77
APR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAY	3	10	0	0	1	2	0	0	4	62	0	0	0	0	74
JUN	8	27	2	4	0	0	0	0	0	0	0	0	0	0	31
JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUG	0	0	4	9	0	0	0	0	0	0	1	3	2	1	13
SEP	0	0	2	4	0	0	1	1	3	47	1	3	4	2	57
OCT	4	14	3	7	0	0	1	1	2	31	1	3	3	1	57
NOV	0	0	3	7	2	3	1	1	0	0	1	3	0	0	14
DEC	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3
	<u>28</u>	<u>91</u>	<u>15</u>	<u>33</u>	<u>12</u>	<u>19</u>	<u>12</u>	<u>14</u>	<u>10</u>	<u>156</u>	<u>4</u>	<u>12</u>	<u>10</u>	<u>4</u>	

↑
number of individuals

↑
weight(=individuals times average butchered weight), kg

average wt. 3.4 2.2 1.6 1.3 15.5 2.6 .4

	Weight	people days (rough)	game/person/ day	game/person/ 30 day month
JAN	0	50	0	0
FEB	3	450	.007	.21
MAR	77	1700	.045	1.35
APR	0	0	.080*	2.40*
MAY	74	650	.114	3.42
JUN	31	400	.078	2.34
JUL	0	0	.083*	2.49*
AUG	13	150	.087	2.61
SEP	57	450	.127	3.81
OCT	57	450	.127	3.81
NOV	14	200	.070	2.10
DEC	3	50	.060	1.80

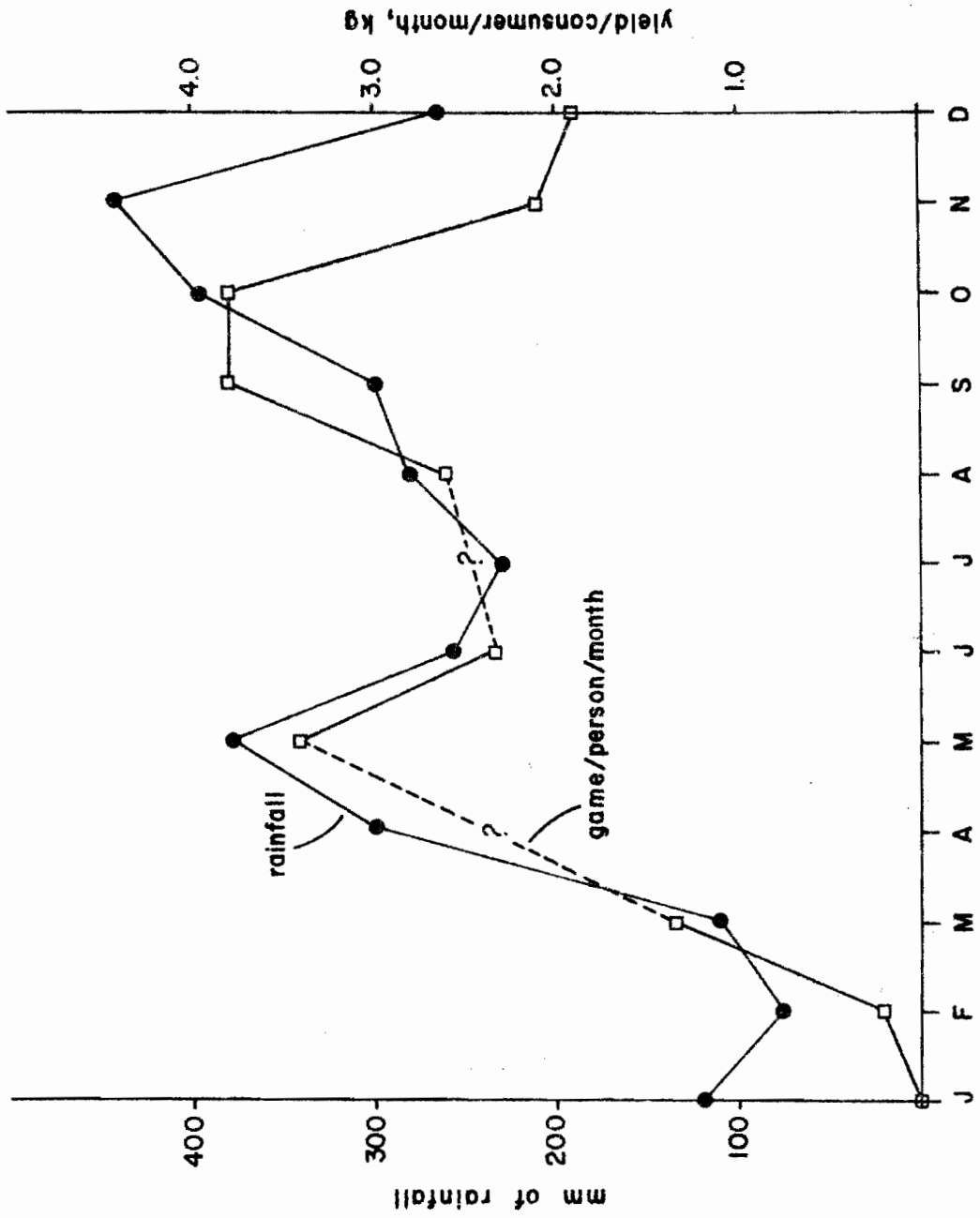
* extrapolated

I am somewhat reluctant to consider the distribution of hunting returns over the months of the year for the following reason: Hunting, unlike fishing, is a distinctly chancy business. Therefore it is not entirely legitimate to project to an entire month from a sample of only a few days, because the presence or absence of a jackpot kill in the sampling period can distort the entire month much more than would be the case for the more reliable and predictable fishing returns. I shall therefore present hunting data which are aggregated as much as possible in an effort to smooth out the random peaks and valleys in the cycle, although I do even this with some misgivings.

Chart 9 presents the yearly distribution of hunting returns, by prey family, for each month. The chart also contains very rough figures for the number of people days to which the returns pertain. These figures are very rough because the size of the group whose return was recorded varies with the species of animal: the whole longhouse for large game, the hearth group only for birds, etc. I have rounded people-days to the nearest 50 to avoid giving an impression of spurious accuracy, and must caution that much more fieldwork needs to be done before hunting returns based on these figures can be used with real confidence.

Also noted in Chart 9, and displayed in Graph 5, are monthly game returns per consumer. When these are platted against rainfall, it can be seen that the two curves are nearly parallel.

A comparison of Graphs 2, 4, and 5 shows that of all the months,



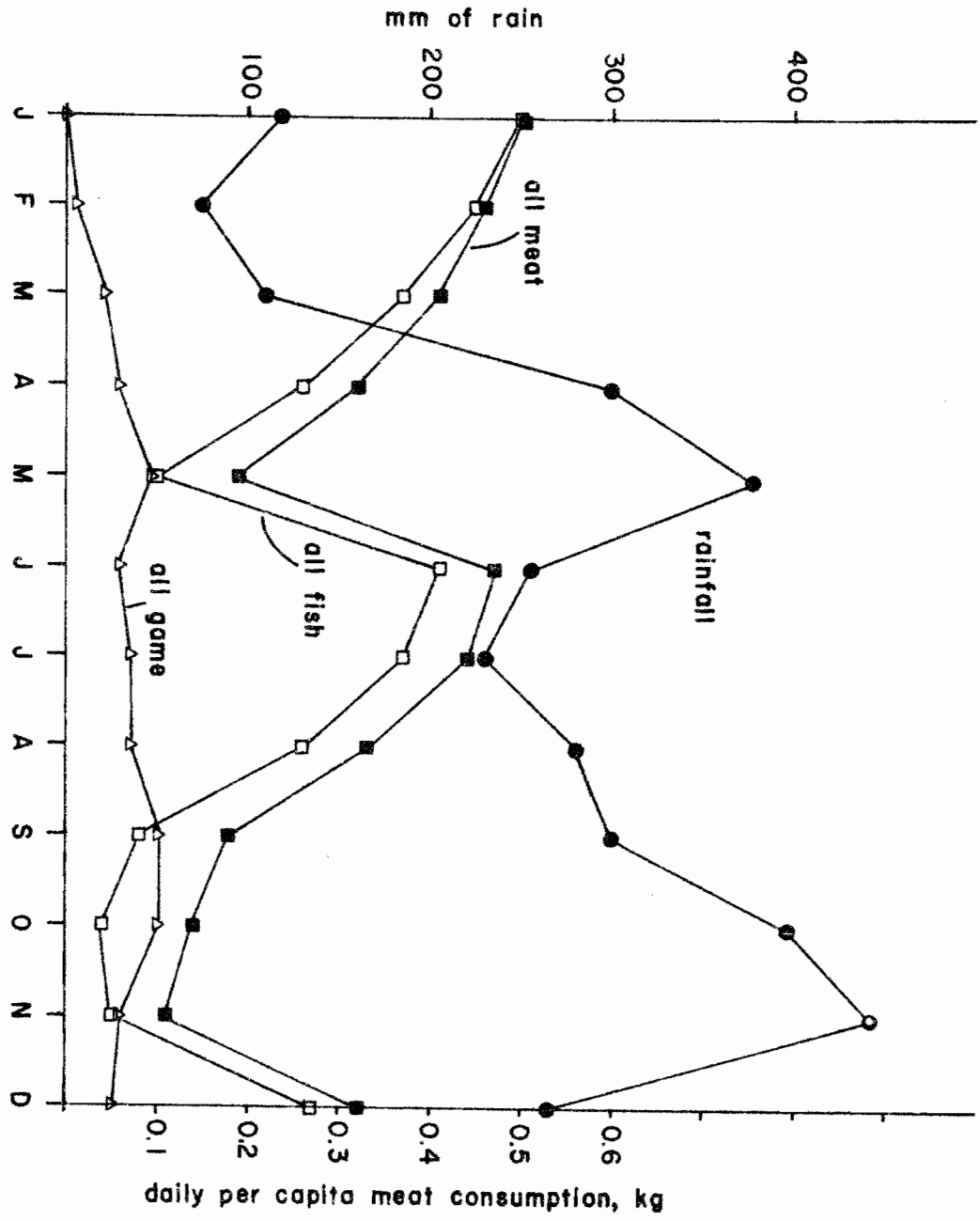
November, the time of greatest rain, is, on the basis of hunting and fishing returns, most likely to be the "hungry month." However, the figures from Ashtacacayra show that even for this month (fishing figures are complete, with no extrapolations, and hunting figures extrapolate only for the last five days, when a visitor came with a shotgun) each Bari consumer averaged over 133 grams of fish and game daily. Subtracting as much as 20% for bone and other waste still leaves the figure at over 100 grams/person/day. (I am not included in these figures, although these people did partially feed me. On the other hand, of the nine Bari residents of this house, one was a girl of about four and another was an infant just being weaned).

Graph 6 shows the average daily consumption of all fish, of game, and of all fish and game together, plotted against rainfall. ("All fish" here includes only bocachico and loricarids. Consumption is computed from acquisition by subtracting 25% of the cleaned catch weight for loricarids, 20% of the butchered weight for all game, and 15% of the cleaned weight for bocachico. Figures are shown in Chart 10). A number of conclusions can be drawn from the examination of this graph.

In the first place, it is difficult to find any support for the position that these people are stressed by the lack of protein. A minimal daily ration of 110 grams of meat (in November) and a yearly average ration of 387 grams/day is more than sufficient. Such is the case particularly when it is recalled that these figures are minimal, that they neglect all the minor taxa of fish and game, and that if we add in the catfish, the Piabucina, the squirrels, the toucans, etc., the yearly average ration of meat climbs to 405 grams per person per day--

CHART 10: MEAT CONSUMPTION PER DAY, KG.

	Bocachico= .85 (monthly catch ÷ 30)	Loricarids= .75 (monthly catch ÷ 30)	Game= .80 (monthly bag ÷ 30)	All fish= Bocachico + Loricarids	Game + All Fish
JAN	.43	.17	0.00	.50	.50
FEB	.36	.09	.01	.45	.46
MAR	.35	.02	.04	.37	.41
APR	.22	.04	.06	.26	.32
MAY	0.00	.10	.09	.10	.19
JUN	.27	.14	.06	.41	.47
JUL	.29	.08	.07	.37	.44
AUG	.23	.03	.07	.26	.33
SEP	.05	.03	.10	.08	.18
OCT	.02	.02	.10	.04	.14
NOV	.03	.02	.06	.05	.11
DEC	.18	.09	.05	.27	.32



21 grams of birds, 77 grams of mammals, and 307 grams of fish.

In addition, in looking over my notes for that November in Ashtacacayra, when, if at any time, there should have been evidence of a shortage of protein and a struggle to overcome it, I find that during that month we often ate the fruits of the Oenocarpus palm, whose custard-like mesocarp probably contains about 8% protein (Beckerman 1977). Further, we ate a good number of hook-and-line caught fish, which are of course excluded from all the figures above. The major activity during this month was the clearing of land in order to put in a banana patch, I believe with the hope of selling the produce. No one seemed at all anxious over any lack of meat. When, in the last week of the month, a visitor arrived with a shotgun, we feasted on guans for the rest of my stay there. I believe that, had there been a felt shortage of meat, the men of Ashtacacayra would simply have increased their hunting time and relieved the shortage, since there was game in the vicinity. However, in the absence of firearms, it was too much trouble to hunt intensively, since no one was particularly hungry, and they were occupied with another project.

In looking over the figures on return per manhour in fish and game, it seems that the cost of animal flesh varies (roughly) between two and twelve manhours per kilogram, and that the mean (depending on the fish or game in question) is between four and eight manhours per kilogram. I would like to suggest that whenever the return drops below 10 or 12 manhours/kilogram, the Barí simply abandon the activity

and turn to some other way of getting protein--be it palm fruits, grubs, snails, or what-have-you. Further, if several activities fall within the acceptable return range at the same time, the strategy seems to be to exploit the most productive activity first, but to pursue the less productive one(s) also, keeping one's hand in in both activities.

Finally, these data make it quite clear that even in the stable, evergreen rainforest, seasonality is an important factor, determining not only absolute total quantity of animal protein available at particular times of the year, but also the various quantities of particular kinds of protein resources, and the relative ease of procurement of these different kinds of resources. We should not accept yearly averages as necessarily indicating the situation of any particular month with any accuracy. Further, even for a people as culturally uniform as the Barí, the resource options of a particular location (highland vs. lowland, in this case) may have a very significant effect on the protein acquisition activities of the people inhabiting that location. Even in a single month, these activities may vary dramatically in response to only a few hundred meters difference in altitude.

If the data presented above demonstrate nothing else, they show that time and place introduce unavoidable variability in tropical forest subsistence practices. The jungle is not nearly as uniform as the conventional wisdom would have it.

Footnotes

- ¹ Although bocachico fishing trips usually turn up with at least a few loricarids, the two fish spend most of their time in different microenvironments, the former preferring sunny, cobble bottomed stretches of water with lots of algae encrusting the cobbles, and the latter liking shady waters which flow either over silt or over a slippery shale bedrock which has a lot of crevasses for catching detritus and for hiding in. I have therefore classified all expeditions which brought back any bocachico as bocachico expeditions, a classification which accords well with Bari's intentions. This procedure leads to a great deal of overlap with loricarid expeditions, which were similarly classified. Figures for returns, no matter how expressed (per consumer, per manhour, etc.) remain accurate, but figures for simple total manhours cannot be added between the two types of expeditions, because most are counted twice. A figure for total manhours spent in traditional fishing is given at the end of this section.
- ² An omission in an earlier work-up of this chart led to an error of 6% to 8% in figures I have published previously on total fish catch and total animal protein intake (Beckerman 1978:18). The much more detailed figures given here replace those erroneous totals.
- ³ The discussion which follows, like the examination of fishing, omits individuals taken with non-traditional methods (shotguns) and species of which only a few individuals were taken. The rule applied is that

for a species to be counted, at least four individuals must have been observed killed with traditional weapons. The data therefore omit tapir (two or three killed while I was in the field, but always with shotguns), brocket deer (two taken, one with a shotgun), spectacled bear (one taken with a bow), several other small mammals (only one or two ever taken) and a great many birds, mostly guans (taken with shotguns).

- ⁴ Shotguns increase the bag of guans immensely. I recorded 12 individuals taken with traditional methods; an additional 81 were taken with shotguns during the few periods--much shorter than the periods of traditional hunting--when someone had a working shotgun. I noted a single shotgun expedition that got 11 guans within two or three miles of an occupied house. Once on the trail between two houses, in a day and a half, just in casual hunting as we hiked, we took 27 guans and then gave up because we couldn't carry any more.

Acknowledgements

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HIGHLAND NEW GUINEA MODELS IN THE SOUTH AMERICAN LOWLANDS

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In 1962, the distinguished British Social Anthropologist, John Barnes, published a seminal paper on the validity of comparing ethnological models from Africa to data collected in the New Guinea Highlands, concluding that African models did not adequately fit the New Guinea data¹. That paper was entitled "African Models in the New Guinea Highlands" and had two important theoretical lessons. First, Barnes showed that the ethnological models purporting to explain the African data they were constructed from did so only with considerable distortion of the African data itself, for African ethnographic reality was far more complex than the models implied. In short, the original models were grossly oversimplified. Second, the empirical data collected by field researchers in New Guinea revealed an even higher degree of variation and complexity for the basic variables on which the African models were themselves constructed, variables such as descent from common ancestors, kinship ties and patterns of reciprocity and variations in post-marital residence. Thus, not only were the models deficient in what they explained, but the critically important notions of agnation, the fixity of

¹ I am grateful to the Harry Frank Guggenheim Foundation for support that enabled me to write this paper. Field research on which this paper is based was also provided by the Harry Frank Guggenheim Foundation, as well as by the National Science Foundation and the National Institute of Mental Health.

membership in descent groups and the seeming enthusiasm of New Guinea natives to make calculated choices that violated basic principles of anthropological wisdom were themselves challenged.

There is an important message for South Americanists in Barnes' essay, for some of the ethnological approaches that were then developed by New Guinea experts to resolve the discrepancies between African Models and New Guinea data yielded models of cultural ecology that were then extended to and applied to lowland South American societies---with parallel misfortunes. Those misfortunes have to do with what Cook (1973:45-6) described as "...nutritional reductionism..." and what Brookfield (1972:46) characterized as "...calorific obsession," and what I would call protein infatuation. This is not to say that all studies of New Guinea Highland societies were ecological in scope, nor that all ecological studies were obstinately and monolithically preoccupied with explaining cultural systems in terms of alleged or suspected shortages of nutritional resources. I do not, on the other hand, mean to imply that studies of native Amazonian societies did not enjoy an independent fluorescence of ecologically-inspired field research. Rather, I wish to draw attention to the theoretical changes that have taken place as a consequence of empirical research in New Guinea, to emphasize that some New Guinea anthropological experience significantly affected South American studies by emphasizing the nutritional

dimensions of human adaptation and, more importantly, to make some suggestions regarding the directions that I think future Amazonian research should take in the light of recent changes in the theory of adaptation and natural selection. I suggest, with regard to the last point, that the paradigm of calorific and protein determinism has failed as an explanatory device and that some basic re-thinking of cultural ecology must now emerge and replace the contemporary emphasis on mono-determinism. [By 'mono' I mean 'single', not as in Spanish, 'monkey' and therefore 'protein'--although that misinterpretation would likewise be acceptable.]

Let me add one final comment on the New Guinea experience before moving more specifically to the Amazonian material and evolutionary theory. It is now clear that highly-informed students of the Highland New Guinea data, such as A.P. Vayda and Bonnie McKay, who earlier championed a calorific approach are themselves moving away from the narrowness of that approach and broadening their theoretical views in full awareness of the inadequacy of the 'nutritional reductionist' view. While they now suggest that greater attention be paid to environmental perturbations and hazards, the important fact is that they acknowledge the inadequacy of the previous theory. Their new perspective, I might also add, is prompted by their own reconsideration of evolutionary theory and their admission for example that effectiveness in converting environmental factors into

adaptations is at least as significant as efficiency, the quality of human cultural systems on which their own earlier work focused. Nor has this only to do with availability of resources, such as calories or proteins: they are prepared to ask at the outset if energy and nutrients are in fact the exclusive limiting or governing factors lying behind human adaptations:

The implication of this for research is that studying the efficiency of energy capture and use by an individual organism or population can be valuable for understanding the strategies employed by that unit if, as Slobodkin says, energy is limiting. If it is not, and if other problems such as floods or water shortages or predation are threats to the survival of an organism, then the effectiveness of the organism's response to those problems and not the energy expended in making the responses is the important subject matter (1977:413).

While I can enthusiastically endorse the position defined by Vayda and McKay regarding the necessity and utility of expanding our view of human cultural adaptation by admitting that variables other than energy affect human adaptation, I believe they are still imprisoned within the confines of the earlier view of human ecology because of their seeming overemphasis on survival of organisms and populations (I applaud their willingness to see a difference between individual and group survival, however) at the expense of viewing survival as only one of the components in adaptation. Another component, one that has been traditionally ignored in the field of cultural ecology, is reproduction and how this relates to both survival and

Evolutionary Theory and Human/Cultural Ecology

Recent and far-reaching changes have taken place in the area of theoretical biology that must now be seriously considered in studies of Amazonian---or any---populations whose cultural forms and behavioral dimensions are examined from the vantage of 'adaptation.' Adaptation, of course, is a central tenet in the theory of evolution by natural selection (Williams, 1966). Thus, studies of cultural ecology, with their focus on adaptive functions of cultural institutions and human behavior, fall squarely into the theory of natural selection. Studies of cultural ecology within anthropology deal broadly with the issues of how a cultured animal copes with and operates within the limitations, restrictions, and material conditions of a particular kind of environment. The objective of most cultural ecological studies is to explain how cultural institutions yield optimal and predictable configurations of community size, population distribution, economic exploitative patterns, political relationships, and social structuring. Adaptation is often vaguely, if ever, defined, but in general it is taken to be a "desirable" response to environmental conditions by a whole 'cultural system' or 'population'-- a response that enhances, optimizes or maximizes that group's survival opportunities. I will return, in a moment, to a more thorough discussion of the "group" versus the "individual" perspective in adaptation, but let me first comment briefly on the specific trends that

recent anthropological research have taken in ecological studies of Amazonian societies by focusing on some extreme (and therefore not necessarily representative) examples and statements.

A conspicuous element punctuating the history of Amazonian studies is the naive ecological stance, yet to be effectively demonstrated with acceptable data, that Amazonas is a 'counterfeit paradise,' and characterized by a paucity of resources that would permit human exploiters, from making a desirable standard of living (see Chagnon & Hames, 1979). While I do not argue the contrary---that Amazonia is a resource paradise---I am still waiting for the data that demonstrates that it is hardly more than a dismal swamp for its human inhabitants. Whereas the pre-1960 view argued that soil poverty and soil nutrients accounted for the attenuated nature of cultural developments there, or the devolution of formerly more advanced societies that penetrated the Amazon basin, the post-1960 arguments have shifted focus to an equally undemonstrated scarcity: high-quality protein. This shift, I suspect, is in part due to the sophistication of New Guinea Highland models of the kind developed by Roy Rappaport (1968) to discuss the possible relationships between protein consumption, stress, warfare, nutrition, population distribution and ritual cycles among the Tsembaga Maring. But Rappaport's arguments were more tentative and cautious than what their translations into Amazonian applications and Eco-Truths yielded (see M.

McArthur, 1977:91-128 for a critical assessment of Rappaport's work). Thus, in 1974, in considering some of my work on the Yanomamö Indians, Harris asked rhetorically:

"...how do you explain warfare among the Yanomamö?" and answered, unflinchingly, "I think there may be a shortage of protein there (1974:vi)."

Further in the same book, this suspicion turns to a firmer conclusion:

Amazonian specialists Jane and Eric Ross suggest that the protein scarcities and not libidinal surpluses account for the constant fissioning and feuding among Yanomamo villages. I agree. The Yanomamo have 'eaten the forest'---not its trees, but its animals---and they are suffering the consequences in terms of increased warfare, treachery, and infanticide, and a brutal sex life (p. 102).

The necessities of the theoretical propositions required empirical truths, and where such empirical support was lacking, its existence was argued by sheer advocacy and simply invented. And where reliable evidence existed that did not support the protein scarcity theory, it was either dismissed or described as 'vacuous empiricism.'

Thomas Kuhn, in his Structure of Scientific Revolutions (1970, 2nd ed.) pointed out that new paradigms often emerge simply because old ones have failed. It is clear to me that the narrow 'protein deficiency' paradigm has failed; indeed there is good reason to believe that it developed from the onset with only the meagrest of scientific justification.

That material resources are necessary and crucial components to understanding and explaining adaptation is

beyond dispute. The important issue is where and how strategic resources fit in the theoretical scheme of things. Let me now suggest what I think we must do in order to understand adaptation and the culture ecology of Amazonian (or any other) societies, as we move from a homeostatic view of populations towards a more dynamic view, and new variables command our attention.

First, we must take cognizance of the fact that the notion of adaptation derives from the general theory of natural selection as originally proposed by Darwin in 1858, and that natural selection, by definition, entails the differential representation of individuals in succeeding generations. This can, of course, come about through differential survival of individuals, as emphasized by previous cultural-ecological approaches, but it can also come about through the differential reproduction of individuals by specific pairs of parents...a component rarely considered by most cultural ecological studies. There are many reasons why sexuality and reproductive variables are not considered by most anthropologists, part of them deriving from the general tradition of cultural anthropology that vigorously rejects any biological variable, and part of them deriving from the Durkheimian and Whitean tenet that individual organisms are irrelevant in understanding human sociality and culture. Why considerations of food and food resources are admissible in our anthropological approaches to human ecology and

reproduction is not has always been a puzzle to me, for ultimately these variables depend on a consideration of the organic, i.e., biological, properties of humans. We apparently can admit the stomach because that can obviously be related to a materialist-determinist perspective that focuses on resources, including food. But we are reluctant to admit the gonads on the assumption that they are too biological and too removed from the material conditions of adaptation (Chiselin, 1974). The fact of the matter is that students of adaptation in other species focus, with no embarrassment, on both resources and reproduction and attempt to show how these relate to each other. In brief, we must now refrain from our parochial anthropological invectives that dismiss the features of reproduction as, simply and ad hominem, 'libinal urges' or 'biological determinism.' If we fail to include reproduction and variations in reproduction in our studies of adaptation, we will simply continue with only half of the toolkit of evolutionary theory.

Second, we will have to seriously consider the differences between 'group selection' and 'individual selection' vantages. Recent theoretical and empirical developments in the field of biology, whence comes our general theory of adaptation, have shown that selection operates most potently at the level of individual organisms---or even smaller units, such as genes--- and that any time that individual level selection is in opposition to selection at the level of the group, the result will be that

the individual adaptations will prevail in the population. Moreover, it has been shown by biologists that in order for group selection to operate, impossibly high extinction rates of micro-populations must occur, rates that are not known to exist in nature. The distinguished biologist, George C. Williams, summarized the theory and the data succinctly by concluding that the characteristics of populations must be considered as fortuitous effects of the evolved functions that occur at the level of individual adaptation, not as evolved functions of the population as a whole (1966). The implications of this for studies of cultural ecology and adaptation are profound, for it calls into question any and all statements that human organisms behave in such a way as to forego their own reproductive and survival interests in order to save their population, or, even more dramatically, their eco-system and the protein therein.

Let me point out, however, that the high degree of cooperation characterizing human groups, coupled with their high intelligence and resulting ability to contemplate future contingencies, makes it theoretically possible that a group selection argument could be demonstrated for humans, but thus far no such demonstration has been made. The point I want to underscore is that we can no longer simply assume that humans and their social, reproductive, exploitative, and other behavioral characteristics are the result of group selection, and we have to explore the greater probability that these characteristics are the result of selection

acting at the level of individuals, i.e., that characteristics of the group are fortuitous effects of individual adaptation and not evolved group functions.

Third, we will have to begin exploring in detail the relationship between resource availability, defensibility and consumption by individuals of both sexes and all ages and how this relates to variations in reproduction and patterns of parental investment. Let me explore this last, and most important, point by putting it into a more comprehensible form---an example---and conclude my comments with this discussion, a discussion that, I hope, will more indelibly reveal the significance of reproductive variables in human adaptation and cultural ecology.

We know from the theory of natural selection and biology that the male of most species is theoretically capable of siring many times more offspring than the females are. This fact of life derives ultimately from the costs of reproduction and the investments made in offspring by males and females: males are less parental than females in most species, and usually invest less, on average, than females do in their offspring. In human populations the degree to which males invest in their offspring varies from culture to culture according to learned conventions, the material conditions of the immediate environment, and the technical capabilities of that group to exploit that environment. In general, the reproductive success of males is a function of the degree to which they as parents are expected or required

to invest in the offspring of their mates in order to rear them to adulthood when they begin their own reproductive careers. The investments entail a wide range of items, including socialization, affection, protection, feeding, caring for them and helping them find mates. Environmental resources are, quite obviously, significant components in the total investment effort by male parents. Where it is relatively easy for males to assemble the material wherewithal required for such investments, we would predict that males would attempt to have polygynous households and that variation in reproductive success by males would be high, and that competition for mates rather than competition for resources would be significant. On the other hand, where resources are relatively scarce and/or costly, energetically, to assemble, polygynous households are less likely to occur at high frequencies, for the requirements of paternal investment in that situation entail greater costs to males, and this sets limitations on their reproductive success. The contrast between Highland New Guinea and Amazonas should be obvious in this regard, especially the relationship between population densities and resources on the one hand and what the individuals seem to be fighting over on the other.

If it takes one unit of environmental wherewithal---strategic resources for example---to successfully rear a single offspring to the point in life where that offspring begins to reproduce, then it follows

logically that a man with ten offspring will require ten such units. There are, of course, two logically different means through which he can assemble his paternal investment. One way of assembling the necessary resources is to work ten times harder than the man with one offspring. My own field research experience leads me to believe that this is not the course followed by highly fertile males, although I suspect that they do work somewhat harder than their reproductively less-successful peers. Pather, they depend on kin of various categories for economic and other support, relying on the productive efforts of often-dependent younger males... they exploit and finesse a wide nexus of kin, the very existence of which is itself a function of the reproductive accomplishments of the previous generation. A simple 'per capita' summary of production and consumption would conceal the immensely important variations that exist, variations that derive from differential reproductive success. The important issues now are not so much 'average' production and consumption or demonstrations that everyone has equal access to the strategic resources, but what the variations are and what the patterns of differential consumption are...and these will be a function of reproductive success. Moreover, it is essential to attempt to understand why some females will marry polygynously, and we must attempt to relate these facts to variations in the quality of paternal investment, a quality that is likely to vary in proportion to the potential husband's capability to

draw on the widest possible nexus of supporters. It should be clear from these considerations that we must now document in meticulous detail the distribution of each individual's kin, their relative numbers and their likelihood of cooperatively supporting households other than their own, or being supported by households other than their own.

In practical terms, the propositions I am suggesting about future field research in Amazonas and interpretations of human behavior that pertain to adaptation and ecology will not require much additional effort for those who already pursue a quantitative approach which, by tradition, is the procedure of choice of most cultural ecologists. But the additional effort will have to be spent collecting other kinds of data that will give new meaning and significance to economic and ecological data already collected and, as far as I am concerned, is the major justification for collecting such data in the first place. I have in mind biodemographic and behavioral data of the sort that reveals something about reproduction. This includes:

- (1) Meticulous genealogies, with an attempt to trace out all connections between members of particular local groups and neighboring local groups with whom they may or may not have immediate social and political relationships, but whence they may have derived or with whom they may interact in the future.

- (2) Demographic data on marriage, fertility and mortality of an order of precision not normally associated with traditional anthropological field research, data that can be used to estimate and/or define life tables.
- (3) Precise measurements on human behavioral events that reveal the costs and benefits of investment patterns. These would be time-motion studies of an appropriately-selected sample of villagers by age, sex and status, keeping track of the individuals by name or identification in order to correlate these data with data on kinship. The purpose of precise measurements is to estimate or define the nature of risks and investments that are costly in terms of favoritism (nepotism) or reproductive jeopardy, and how this affects reproduction.
- (4) Attention to and consideration of extra-local affects that stem from acculturation, such as hunting patterns modified by the introduction of firearms, flashlights, nets, motorized canoes, and, of course, non-aboriginal competitors such as mission-post hunters and cultivators, wage labor, or selling local resources in a market situation. This would also include epidemiological considerations: what impact---in terms of mortality and fertility patterns, distribution of

types of relatives, marriage practices, etc.---has contact with the outside produced?

- (5) Finally, it is important to assess the impact that social pressures from missionaries and government agencies have had on patterns of polygyny, and the critical affects these have on household size and reproductive variations. Some missionaries are more tolerant than others---Padre Cocco, on asking a Ye'kwana whether he were Catholic or Protestant, was told "I'm a Catholic, Padre---I smoke, I drink and I have three wives."

SUMMARY

Much of contemporary ecology, to the extent that it addresses the issue of adaptation, proceeds with a basis in biological theory that is now badly outmoded. Adaptation by definition deals with reproductive success as well as survival... not simply staying in the game, but prevailing in it. We have ignored the reproductive aspects of adaptation by focusing too heavily and exclusively on issues of simple survival, unwittingly equating adaptation with calorific obsessions. The major justification, in terms of the modern evolutionary biology---of which human adaptation is a component---for measuring production and consumption patterns and quanta, is the knowledge and understanding they will provide us about the relationship of individual strategies and cultural institutions, and which has analytical precedence. Modern biological theory indicates

that it is essential for us to document individual variations in productivity, consumption and reproduction to advisedly discuss the whole issue of adaptation in an evolutionary framework. Current evidence and theory shows that the group selection vantage is untenable as an explanatory paradigm for all species thus far studied, suggesting the wisdom, at least, of exploring the implications of these findings for human behavior and adaptation as well. There is, as George C. Williams once mused, a significant difference between a herd of fleet deer and a fleet herd of deer.

I, for one, should like to see the enterprise develop without the punctuation of ad hominem invective that has thus far marked some of the recent history of 'cultural ecological' studies of Amazonian social organization. Invective and polemics are not substitutes for science and understanding: they are merely special pleas to dupe the observer into confusing reason with rhetoric. No amount of meretricious effort can conceal the fact that a failed paradigm has failed, because it cannot adequately account for the known facts. When the theory appears to be faulty, that is what we must consider changing, for facts forever remain the same (cf. Chagnon and Hames, in press, parts I and II).

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THE LIMITS TO PROTEIN

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The papers by Vickers, Hames, Beckerman, and Chagnon are significant because they overwhelmingly refute the Protein Scarcity Hypothesis and because they offer an abundance of good data and fresh views on Amerindian hunting and adaptation.

Marvin Harris and others (Harris 1974, 1977, 1979; Ross 1978) have argued that animal protein scarcity in Amazonia has been a causal factor behind all sorts of Amerindian behavior and cultural patterns, such as warfare, village movement and fissioning, some taboos, female infanticide, male supremacy, and so on. Their simple cause, complexly worked out, would suggest that lack of meat is the major reason behind why people do what they do out there in the tropical forest. In other words, the phrase popularized by Adelle Davis, "you are what you eat," should now be proteimized to "you are what you don't eat enough of!"

The single-limiting-factor theories, such as Harris and protein and Meggers (1954) and Amazonian soils, serve more as a research catalyst than they do as explanations for cultural patterns. Often eloquently argued but minimally supported with facts and examples, the hypothesis that people curbed and channeled behavior in order to maintain tropical forest animals rests precariously on the assumption that Amerindians really didn't have enough meat.

The preceding papers aptly demonstrate that protein from hunting and fishing activities is still abundant in the Amerindian villages studied. Rather than seeking simplistic answers to simplistic questions, Vickers, Hames, and Beckerman present the

results of long-term field research that portray situations of protein abundance resulting from complex patterns of hunting and fishing. Chagnon suggests that whether or not protein or some other thing is limiting or not is too limiting a view in itself. There is more to adaptation than energy and nutrient capture.

In his paper, "An Analysis of Amazonian Hunting Yields As a Function of Settlement Age," Vickers presents hunting return data obtained from samples taken in the same village after the second and sixth year of its establishment. Although many investigators infer change in subsistence yields, Vickers is one of the few who has actually measured production at two points in time. He interprets his findings to mean that hunting efficiency has been reduced some 50% after a four-year interval. Lower yields are to be expected in any hunting area used over a several year period. However, the magnitude of the change may not be as clear-cut as Vickers concludes. When a group of hunters, such as the Siona Secoya of eastern Ecuador, first moves into an area, game animals may be easy to take because they are abundant and they are not used to being hunted. A reduction in hunting yields after a few years may be due either to: 1) hunters are killing animals faster than they are replaced in local populations; 2) animal populations that normally move throughout a large area are not going into specific areas because of human interference; 3) animals have moved out of hunted areas because of human interference; and 4) the animals become more skittish and thus harder to hunt. Furthermore, the way something is measured may determine the

measure of the something. Yield per hunting trip may be very different than yields per area, hour, or person. Nevertheless, these are valuable data and support the idea that hunters will exploit animals to the maximum until reduction creates need to diversify hunting pattern by species, season and site to maintain satisfactory long-term yields.

Ray Hames ("Hunting Zone Rotation: A Locational Analysis of Ye'kwana and Yanomamö Hunting") presents an interesting thesis that hunters follow hunting zones by rotating exploitation just as is done in traditional swidden agriculture. By rotating hunting zones the Y'kwana and Yanomamo of southern Venezuela spatially spread hunting pressure and temporally spread faunal recovery. This is a useful conceptual insight into the dynamics of Amerindian hunting strategies; the pattern is probably of fairly widespread occurrence.

All species of tropical forest animals are not of equal numbers or densities, or of similar desirability or attainability. Hunters may shift hunting focus in terms of cultural preferences for specific species and because of the relative overall numbers and densities of certain animals.

The scan sampling method used by Hames is an effective means to extrapolate long period from short period data. However, as with most sampling techniques, it masks variation. Oftentimes, finding out about the variation in the total range, amounts, and occurrence of something is as important as establishing the average patterns. Variation in seasonal and locational

yields, and short- and long-term differences between hunters, households, and villages might be important information to collect for a discussion of hunting strategies.

The case for ecological homogeneity in the "terra firma" biotope may reflect more the limits of terminology than of the environment.

Hames' paper is exemplary in the productive use of field data to generate theory.

Stephen Beckerman's paper, "Fishing and Hunting by the Bari of Colombia," contains the clearest, most straightforward explanation yet available on the collection and limitation of information on Amerindian hunting and fishing. Beckerman presents detailed data on hunting and fishing returns by species, place, time period, and carefully notes the sample size and gaps in coverage. His discussion of variation in hunting and fishing returns by individuals, households and groups is extremely valuable and all too rarely done. This paper contains some rich data veins for mining.

Although variation in protein consumption is probably as important as average consumption, for comparative purposes it might be useful to note that according to Beckerman the Bari consume an average of .405 kg of protein per day, the Ye'kwana and Yānomamö (Hames) .307 kg/day, and the Siona-Secoya (Vickers) .041 kg/day. Despite the obvious possibility that some groups may simply be better hunters than others, even the Siona-Secoya obtain satisfactory amounts of protein per day and the Bari and Ye'kwana and Yānomamö obtain considerable amounts.

Data collected by Vickers, Hames, and Beckerman indicate that protein is still reasonably abundant and is not a limiting factor. This should put to rest the protein scarcity idea advocated by others who base their arguments on much more limited and incomplete data. If anything is limiting about protein it has been the single factor deterministic research. It is time to get on to other things beyond the in's and out's of calorific cultures.

In "Highland New Guinea Models in the South American Lowlands," Napoleon Chagnon points out that "nutritional reductionism" and "protein infatuation" have produced an overly simplified picture of cultural adaptations, one that is both vague and deterministic. Chagnon suggests that consideration of reproduction must be included into ecological studies; differential reproduction, individual selection rather than group selection, variations rather than aggregates, biological theory rather than cultural energetics. In this paper and elsewhere, Chagnon argues persuasively for a needed new direction in cultural ecological research, a direction that would consider human biological potential and individual variation in reproduction. This is an area that promises to be intriguing and potentially rewarding, but it is a research area in which--as with the protein scarcity theorists--some individuals have advanced explanation beyond the data.

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