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FISH, WILDLIFE, AND HUMAN NUTRITION IN TROPICAL FORESTS: A FAT GAP?

ANDERS SIRÉN and JOSÉ MACHOA

SUMMARY

Conservation biologists often mention human needs for dietary protein as being a main driving force behind unsustainable hunting and fishing that deplete resource bases and threaten biodiversity in tropical forest regions around the world. However, the empirical basis for assuming that the nutritional importance of wild meat and fish in the diets of tropical forest peoples is limited to that of being a protein source is weak. The nutrient content of foodstuffs procured by households in an indigenous community in the Ecuadorian Amazon was calculated and the nutritional status of the people based on anthropometric measurements was assessed. The results suggest that fat is in more scarce supply than protein. Accordingly, it is suggested that the most important role of wildlife and fish in the nutrition of the people in the area is that of being sources of fat, although their role as protein sources also is important.

or local people in tropical forest areas around the world, wild game and fish are important sources of food, and in many cases also of cash income. Unfortunately, however, unsustainable rates of extraction are leading to depletion of the stocks of wild game (Milner-Gulland and Bennett, 2003; Peres and Lake, 2003) as well as fish (Goulding, 1980; Coomes, 1995; De Jesús and Kohler, 2004). In particular, the catastrophic decline of apes and other wildlife in central Africa has lately come into the spotlight (Walsh et al., 2003). Tradition-All the problem of overhunting in tropical forests has been studied mostly from an ecological perspective, but some scientists have lately suggested that there is a need to put more emphasis on the socio-economic aspects of the problem, putting local people’s needs in the focus, and trying to find alternatives so that they can cover their nutritional and economic needs without harming biodiversity (Fa et al., 2000; Robinson, 2006). Conservation biologists tend to take for granted that the main nutritional role of wild game and fish is that of being sources of protein (Robinson and Bodmer, 1999; Fa et al., 2003; Brashares et al., 2004; Pearce, 2005). The empirical basis for this assumption is, however, weak. For sure, wild game and fish have high protein content, but this does not necessarily mean that this always is their most important contribution to human nutrition. In fact, during the last few decades, it has been discovered that malnutrition is a consequence of insufficient protein intake, but more commonly to insufficient energy intake which obliges the body to use protein as an energy source, reducing the amount of protein available for growth, maintenance and replacement of body tissue, as well as other physiological functions (WHO, 1985; FAO, 1994; Anttonsson-Ogle, 1996). Thus, to better appreciate the nutritional importance of wild game and fish, it may help to widen the focus to include also their role as energy sources. In particular, the fat content may be important, as fat has a considerably higher energy content per unit of mass than protein and carbohydrates.

Anthropometric measurements are commonly used as indicators of nutritional and general socio-economic status. Chronic nutritional stress in combination with disease tends to decrease growth rates in children, leading to short stature in adulthood, a process termed ‘stunting’. Acute malnutrition, on the other hand, leads to loss of fat and muscle tissue, also called ‘wasting’. Anthropometric measurements of indigenous Amazonian peoples generally indicate that adults have a quite good nutritional status. However, they also show slow rates of growth of children, and consequently short stature of adults. In a few groups, a high prevalence of thinness has also been found among children, indicating acute malnutrition.

KEYWORDS / Anthropometric Measurements / Dietary Protein / Fat Sources / Nutrient Content /

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leading to loss of fat and muscle tissue (Dufour, 1992, 1994). Some authors, however, have pointed out that short stature may be a genetic adaptation to the tropical rainforest environment, and that high food intake leading to tall stature is not necessarily always healthy (Stinson, 1990; Holmes, 1995). Although it may be debatable whether any particular size and shape of the body can be considered as optimal, there is no doubt that these often change in response to changes in socio-economic conditions (Cole et al., 2000). For South American indigenous peoples, in particular, an example is how the establishment of a large permanent settlement among the Machiguenga of the Peruvian Amazon led to depletion of wild food resources, and consequently, a drastic decrease in body weight and a slight decrease in stature, at community level, were observed over an eight-year period (Baksh, 1995). On the other hand, children of Maya emigrants to the US grew 12cm taller than Maya children in Guatemala with the same genetic constituency but living in poorer socio-economic conditions (Bogin et al., 2002).

The present study combines an assessment of nutritional intake with anthropometric measurements, for the particular context of an Amazonian subsistence-based indigenous community, in order to assess the nutritional importance of wild game and fish in this locality.

**Study Area and Methods**

**Study area: The Sarayaku community**

The study was carried out in the Kichwa community of Sarayaku (1°44'S, 77°29'W) in Eastern Ecuador (Figure 1). The community is situated on the banks of the Bobonaza River, about 65km southeast of the town of Puyo. The principal way of access from Puyo to Sarayaku is by road half way, and the rest by canoe. There is also a small airstrip in the community. Sarayaku has ~1000 inhabitants, distributed in five hamlets that are within a few km reach from each other. During school vacations, most people live in secondary homes dispersed along the main rivers traversing the area. Old-growth tropical rainforest covers ~97% of the area and the population density is about 1/km². Shifting cultivation (Sirén, 2007), hunting (Sirén et al., 2004) and fishing form the basis for what is largely a subsistence economy. Poultry is a minor complementary food source. Food aid for primary school children has been provided from various sources every now and then since the 1970’s. After a break lasting for several years, such food aid was resumed in 2001, providing one daily meal to the school children during approximately half of the year. Governmental salaries, cattle, fibers of the Aphandria natalia palm, handicrafts, tourism, and migratory work provide some cash income, much of which is used to buy hunting and fishing equipment, agricultural tools, clothes, boots and the like.

The residents have become concerned about increasing scarcity of wild game during the last couple of decades. Empirical research has confirmed that overall catch per unit of hunting effort is severely reduced near the village, in comparison with more remote areas, and several species are practically extinct within a several km radius around the village, e.g. wooly monkey (Lagothrix lagotricha), tapir (Tapirus terrestris), and Salvin’s curassow (Mitu salvini; Sirén et al., 2004). Many of the people also claim that fish resources are declining, particularly large migratory fish. This study formed part of a research project that included three years (1998-2001) of fieldwork, dealing with the larger question of natural resource depletion in the community and the potentials for sustainable resource management (Sirén, 2004).

**Food procurement**

Being inquisitive about what and how much other people eat is considered very impolite in the local culture. Therefore, not only could data collection on food procurement and consumption potentially have caused unease and conflict, even just asking for permission to collect such data in a household could have stirred up hard feelings. Because of this, this particular study was not conducted until near the end of the fieldwork period, and the households were approached through secondary school students, with whom a great deal of confidence had been established during various training events related to the research, carried out in the school. The students were informed about the purpose and methodology of the study and asked whether they would be interested in collaborating. In exchange, theoretical and practical training in nutrition was offered, based on the data to be collected. All students expressed their interest, and then proceeded to ask their parents for permission to collect data, together with us, regarding their own respective households. The parents of all thirteen students gave their consent. The main bias resulting from the non-randomness of the household sample was probably that the students come from, on average, somewhat more wealthy households than the community average. Whereas only ~18% of the households in the community have a member who earns a regular salary, mostly teachers, the corresponding figure for the sample was ~38%.

The fluxes of food into and out from these thirteen households were recorded during one full week each, from April to June 2001, except for one household for which data were recorded in August. With minor variations, one or both of the authors visited each household in the afternoon every day except Sunday, during one week, beginning and ending on Monday. At each visit, all food items that had entered or exited the home since the last visit were recorded. Usually the parents of the student provided most of the information. The researcher and the student took notes on separate data sheets, and the student retained his/her sheet for later use in school, where nutrition classes were given, teaching them how to calculate nutrient content and intake. For food items the origin or destination was recorded (own production, sold, bought, gift). If still available, food items were weighed with a simple spring balance. Otherwise their weight was estimated by either recording their quantity in known units such as “bunches” of plantains or “baskets” of cassava, or, particularly for fish, by letting the respondents indicate the volume using a 10 liter plastic bucket. By weighing fish in the same bucket a conversion factor was obtained and volume measurements were converted into weight measurements. In order to avoid omissions or double accounting, the limits of the “home” were defined, and for this purpose it was found best to define the “home” as the houses and the surrounding open area and home gardens. One drawback of defining the limits of the home in this way is that the figures recorded do include the foodstuffs that are brought home but end up getting...
thrown away or given as feed for dogs or poultry. It was difficult to quantify these losses with any accuracy, and those data are therefore not included in the analysis. Also, food that was consumed without having crossed the border of the “home”, as defined this way, was not recorded. This includes food consumed away from home, such as in the forest or in schools, and also food from home gardens or domestic poultry. Recording these types of food consumption with reasonable accuracy would have been difficult, and based on years of experience from the community (JM was himself born and raised there) it was judged that the total amounts would be small anyway. The school meals without doubt provided a significant contribution to the nutrition, but only to the school children and only during part of the year.

In any case, given these biases inherent in the method, the original intention was to also, independently, record actual food intake, in order to cross-check the results from two different methods. Collecting such data with any reasonable accuracy proved, however, to be unfeasible. For example, a major part of food intake was in liquid form, as a brew made of chewed cassava, locally known as asusa. Attempting to record not only the number of bowls consumed, but also the size of the bowls, and the concentration of the asusa, was difficult, to put it mildly. Moreover, given the local cultural norms, the whole procedure was too intrusive and thus very embarrassing for all parties involved. For these reasons, this component of the study was discontinued after only three days of trial. The number of domestic animals possessed by each household was recorded and data on the production and consumption of poultry and eggs was later also collected. To do this, twelve families were followed for one week each in Dec 2005 and Jan 2006. In addition to recording the production, consumption, sales, purchases, and losses of poultry and eggs, poultry that was about ready to slaughter was also weighed and the owners were asked to indicate the age of such individuals, as well as the estimated time left until slaughter. Based on these data the production of poultry and eggs was calculated.

Nutrient content and intake

After applying a factor to calculate the edible portion of each food category, the amount of nutrients in the food was calculated based on available data on nutrient content in the different types of food recorded. For wild game, data on nutrient content were available in Aguiar (1996) for the five species that top the list of annually harvested weight and make up about half of the total annual game harvest in Sarayaku (Agouti paca, Tayassu tajacu, Tapirus terrestris, Mazama americana, and Dasypus fuliginosus; Sirén et al., 2004). Based on these five species, an average nutrient composition for wild game meat was calculated, in order to apply to all game meat recorded. The protein content was quite similar between species, whereas fat content ranged from 1.2 to 3.8%. Calculating average nutrient content of fish was based on Junk (1985), Franco (1987), Dufour (1988) and Aguiar (1996), but was complicated because of the diversity of species consumed, absence of literature data on nutrient content for several important food species in the study area, and the fact that the most extensive source (Franco, 1987) listed fish species only by vernacular name. Therefore, in order to make an estimate of average nutrient composition of fish, some Amazonian species that are not present themselves, but are closely related to common food fishes in the study area, had to be included. Finally, the fat content for fish was calculated as an average of 24 values taken from Castro (1994), Salinas-Coy and Agudelo-Córdoba (2000), and the internet-based database FishBase (Froese and Pauly, 2003), corresponding to at least 21 different species. Whereas the data on protein content was quite similar between species, fat content ranged from 0.5 to 24.9%, although 50% of the species had a fat content of 6-11%. Finally, the average consumption of each type of food was multiplied with the estimated nutrient content, and this was summed up to get the total average nutrient intake per person.

Anthropometric measurements

Anthropometric measurements were made on 444 individuals of all ages. This included almost all inhabitants of the four peripheral hamlets and, in the central hamlet, the pupils of the two primary schools as well as the members of a few households. 381 of the subjects were measured in August 2000, and 63 of them in December the same year. The data for the study population were compared with data from Frisancho (1990), a standard reference population which commonly is used for this purpose in anthropometric studies. These reference data were collected in the US in the 1970’s, and thus represent a population with nearly unlimited access to food. School pupils were measured in school, and the rest of the measurements were made in the homes of the subjects. The measurements were made by either one or both of the authors, together with the male nurse of the local health station and a female local assistant, all of which practiced beforehand, calibrating our measurements between each other. In addition to assisting with the measurements, the nurse also provided medical attention when needed. Standardized procedures according to Frisancho (1990) were slightly modified for practical reasons. Thus, weight was measured with a bathroom type scale, which was checked against a platform-beam scale at the health centre near the central plaza of Sarayaku, in order to ensure that it measured weights accurately and that it did not deteriorate over time due to humidity and dirt. Height was measured with a homemade portable stadiometer. As floors often were uneven, the bathroom scale, as well as the stadiometer, were placed on a wooden platform carefully placed in horizontal position with the help of a water level. Upper arm circumference was measured with measuring-tape, and triceps skinfold thickness with a skinfold caliper.

Height-For-Age (HFA) was used as an indicator of linear growth, as chronic malnutrition inhibits growth and leads to low HFA, also called stunting. The most commonly used index for relative fatness/thinness, on the other hand, is Weight-For-Height (WFH). Acute malnutrition leads to loss of fat and muscle tissue and therefore low WFH, also called wasting. WFH was, however, not an appropriate indicator to use for this study. In the first place, some individuals were so short that there was no corresponding weight data in the reference population. Moreover, WFH is very age-dependent, particularly during adolescence, but the reference data in Frisancho (1990) is provided only for broad age categories. Thus, for example, when a 17-year old classified as well nourished becomes 18 years old, he/she may suddenly get classified as wasted, only because of the change of age category. For studies at community level, this is not a problem if the study population is large, with an even distribution of ages. However, in the present case the study population was small, and had an uneven age distribution. Therefore, the Body Mass Index (weight/height²; BMI) was used instead as an index of relative fatness/thinness. Also, Upper arm Muscle Area (UMA) was used as an index of protein reserves, and thus as an alternative indicator of wasting. The formula for calculating UMA assumes that the upper arm and its constituents are cylindrical. The UMA is obtained by first calculating the total area of the cross-section of the
upper arm, then subtracting the fat area, and finally subtracting a standard value in order to correct for the bone area (Frisancho, 1990). As an index of fat reserves was used the Arm Fat Index (AFI), which is the fat area as a percentage of the total cross section area of the upper arm. In order to facilitate comparison and interpretation, all measures were transformed into z-scores, based on the age- and sex-specific means and standard deviations provided by Frisancho (1990), using the formula

\[
\text{z-score} = \frac{\text{mean of reference population} - \text{subject value}}{\text{standard deviation of reference population}}
\]

Accordingly, a z-score = 0 means that the measurement is equal to the average of the reference population; whereas a z-score = -1 means that the measurement is one standard deviation below the average of the reference population. In accordance with several other authors (Gorstein et al., 1994), a z-score < -2 is used as an indication of wasting or stunting at the individual level, although such cut-off points by necessity are arbitrary. Normally, pregnant women should be excluded from the calculations of average body mass index. However, very few women answered affirmatively to our questions regarding pregnancy, and only when this was obvious at sight. A comparison with the expected frequency of pregnancies based on demographic data revealed that pregnancy recording must have failed in many cases. Thus, to be consequent, all pregnant women were included in the calculations, and the BMI values for women in reproductive age are somewhat biased towards higher values than the correct ones.

**Results**

**Food procurement and nutrient content**

By weight, cassava and plantains are the dominating food items (Table I, Figure 2). Other crops constitute a minor proportion of the total local production. Some domestic fruits were procured, but wild fruits were absent in the sample. The amount of fish brought home equaled 2.49g/capita/day, whereas the amount of wild game was 95g/capita/day. Most households possessed one or a few dogs, and some poultry (Table II). Only one of the households possessed cattle, and none possessed pigs. Cattle and pigs are raised almost exclusively in order to sell to traders in town, and are very rarely consumed within the community. The separate study of poultry indicated that the production of poultry was 2.5g/capita/day, and the production of eggs was 3.8g/capita/day. As these amounts are small in comparison with the amounts of fish and wild game, the methodological fallacy discussed above, implying that the consumption of poultry and eggs is not included in the data set, does not introduce a major error in the calculations. Almost all food was locally produced, and imported food items such as rice, sugar, canned tuna fish, oil, and lard, represented a minuscule portion of the total weight of food. The estimate of wild game was cross-checked with a previous estimate (Sirén et al., 2004) based on hunters reporting their hunting kills over a two-year period, and found to be almost equal (698 and 725g/household/day for the previous and present estimates, respectively). Most of the locally produced food items were consumed within the household, but there was also some exchange between households, particularly of wild meat and plantains (Figure 3). Much of the exchange was in the form of gifts, but some, particularly plantains, was sold for money.

The foodstuffs brought into the homes provide about 3120kcal, 68g protein and 25g fat per person and day, calculated for all household members, regardless of age. In terms of the contribution of energy from different classes of nutrients, carbohydrates provide 84%, proteins 9%, and lipids 7%. The staple crops cassava and plantains have a high content of carbohydrates, vide 84%, proteins 9%, and lipids 7%.

![Figure 2. Crude weight of different types of food products brought into the home per person and day.](image-url)

**Figure 2.** Crude weight of different types of food products brought into the home per person and day. Error bars indicate one standard deviation based on the per capita values for each household.

**TABLE I**

| NUMBER OF DOMESTIC ANIMALS HELD BY THE HOUSEHOLDS IN THE STUDY |
|--------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Household size            | A  | B  | C  | D  | E  | F  | G  | H  | I  | J  | K  | L  | M  | Average% households possessing |
| Dogs                      | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  | 1  | 0  | 3  | 1  | 1  | 0  | 0.9  | 69  |
| Poultry                   | 5  | 0  | 2  | 8  | 12 | 15 | 12 | 32 | 64 | 7  | 13 | 16 | 14.3 | 85 |
| Cattle                    | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0.2  | 8   |
| Pigs                      | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0.0  | 0   |
| Other pets                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 3  | 0  | 0.5  | 15  |

**TABLE II**

<table>
<thead>
<tr>
<th>AMOUNT* OF FOOD PROCURED PER PERSON PER DAY IN EACH HOUSEHOLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
</tr>
<tr>
<td>Cassava</td>
</tr>
<tr>
<td>Plantains, bananas</td>
</tr>
<tr>
<td>Fish</td>
</tr>
<tr>
<td>Wild meat</td>
</tr>
<tr>
<td>Fruits</td>
</tr>
<tr>
<td>Other root crops</td>
</tr>
<tr>
<td>Other non-root crops</td>
</tr>
<tr>
<td>Imported vegetal food</td>
</tr>
<tr>
<td>Imported animal food</td>
</tr>
</tbody>
</table>

* g/person/day

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Population. For young children it was slightly above the mean, and then decreased with age. Also, the upper arm muscle area (UAM) of the Sarayaku population was similar to the US reference population, particularly for females, whereas for males it was slightly lower, particularly for the older age categories. Wasting (z-score <-2), on the other hand, was almost non-existing if BMI was used as an indicator, and uncommon if UAM was used. Arm Fat Index (AFI) showed low fat reserves as compared with the reference population, particularly for females. The z-score for AFI for females decreased with age, and the vast majority of the women >30 years of age had an AFI z-score <-2.

Discussion

The energy content of the procured food of 3120kcal/day/person is approximately the required intake for physically active adult men. Three fourths of the population is made up of women and children whose energy requirements are considerably smaller (WHO, 1985). Thus, the energy content in the foodstuffs brought into the household contains a surplus of energy. The estimated 68g protein per person and day is significantly above the required intake for all age categories and sexes, including adolescents and lactating women (WHO, 1985; Antonsson-Ogle, 1996). However, 25g of lipids from store-bought foods. It may be noted that whereas the contribution of imported foods in terms of protein and total energy is negligible, they actually provided 8% of the total amount of lipids. The small amount of money that is used for buying imported food thus appears to make a quite significant contribution to improving the nutritional balance of the diet.

Anthropometrical study

The results of the anthropometrical study are shown in Figures 6 and 7. Height-For-Age data indicate that the people were very short in comparison with the reference population. The average stature was 147cm for adult women and 160cm for adult men. The prevalence of stunting (z-score <-2), increased during childhood and adolescence, and the majority of adults were stunted according to this definition. Body Mass Index (BMI) was near the mean of the US reference population. For young children it was slightly above the mean, and then decreased with age. Also, the upper arm muscle area (UAM) of the Sarayaku population was similar to the US reference population, particularly for females, whereas for males it was slightly lower, particularly for the older age categories. Wasting (z-score <-2), was, on the other hand, almost non-existing if BMI was used as an indicator, and uncommon if UAM was used. Arm Fat Index (AFI) showed low fat reserves as compared with the reference population, particularly for females. The z-score for AFI for females decreased with age, and the vast majority of the women >30 years of age had an AFI z-score <-2.
The figures presented are based on Dufour (1983), (b) Descola (1994), (c) Berlin and Markell (1977).

When interpreting the results of this study, it must be borne in mind that there were various methodological problems that affected the results. In particular, the study suffered from the scarcity of data on nutrient content of fish in the area. This is further complicated by the fact that Amazonian fish show high seasonal variation in fat content (Junk, 1985).

Reportedly, migratory fish caught in Sarayaku is lean in comparison to the same species when caught downriver around Iquitos on the Marañon River (Linder Isuiza, personal communication). Most of the data on nutrient content of fish came from such downriver locations, although the exact location of the catches were not indicated, and neither were the dates of catch. The Sarayaku people also tell that game animals get fatter during the rainy season, but the literature data on nutrient content provided no indication of the season the analyzed animals have been hunted. Further empirical research on the nutrient content of Amazonian wildlife and fish, including its variation in space and time, is highly needed in order to facilitate further studies of the relations between hunting, fishing and human nutrition.

The sample was small and non-random, and may be affected by seasonal bias. The reliance on store-bought food may have been somewhat greater in the sample than in the community as a whole, given the larger percentage of households earning a steady salary in the sample. One important source of seasonal variation is the difference between school terms and vacations. During vacations, most people disperse out to their secondary homes and eat more wild meat and fish (Figure 8). Consequently, anthropometric measurements may also show seasonal variation. Most anthropometric measurements made at the end of the school term in December, revealed no such seasonal effect. Half of the recorded amount of fish came from one single event of fishing with the icotoxic plant called barbasco (Lonchocarpus nicou). This single event represents a 1/4 of the protein and 1/3 of the fat indicated in Figure 5. However, such large catches of fish are in no way exceptional. In fact, they are quite common during the fish season, which lasts approximately from August to January, but most data for this study were collected outside the fish season. Thus, average fish consumption may be even larger than what these data indicate. The data for imported food represent only four recorded purchases, of vegetable oil, lard, sugar, and canned tuna, plus some rice which was the leftover from school meals. This is insufficient to estimate with precision the nutritional contribution of store-bought food. However, the fact that these few purchases contributed with a significant percentage of the total fat intake recorded is an interesting indication that purchases of store-bought food may serve to increase fat intake more than protein intake, which is logical given that diets based exclusively on local produce are poor in fat but rich in protein.

The results of the study were presented as averages between several households and over time. It cannot be ruled out that the individual consumption of nutrients may sometimes be substantially lower. Data on hunting suggest that game harvest per capita varies by a factor of three between hamlets (Siren, 2004). This does not necessarily mean that some hamlets are worse off than others, as they may compensate this difference by relying more on fish or cash income, but the data available do not permit any firm conclusions regarding this matter.

The results also suggest that exchange of food by gifts, particularly of wild meat, is significant. As hunting luck is variable and unpredictable, and as wild meat is perishable, sharing may be important in smoothing out temporal variations in the availability of wild meat. Some of the foodstuffs recorded as brought into the “home” actually do not get consumed. Some may be thrown away, some is fed to domestic animals, and some cassava is lost in the process of making the fermented brew called asua. The figures presented are based on the amount of foodstuffs brought into the home, and for the food actually ingested the percentage of energy derived from carbohydrates must be somewhat lower, and the percentages of energy derived from proteins and lipids somewhat higher. Nevertheless, even when taking these errors into account,

**TABLE III**

**COMPARISON OF DAILY PER CAPITA ENERGY AND PROTEIN IN THE DIET OF DIFFERENT AMAZONIAN INDIGENOUS PEOPLES**

<table>
<thead>
<tr>
<th></th>
<th>Sarayaku</th>
<th>Tukano (a)</th>
<th>Achuar (b)</th>
<th>Aguaruna (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>3120</td>
<td>2542</td>
<td>3408</td>
<td>3356</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>68</td>
<td>50</td>
<td>105</td>
<td>109</td>
</tr>
</tbody>
</table>

The figures for the Sarayaku and the Achuar represent food brought to the home, whereas the figures for the Tukano and the Aguaruna represent actual food intake. Sources: (a) Dufour (1983), (b) Descola (1994), (c) Berlin and Markell (1977).
the level of protein calories is quite normal, whereas the level of fat calories is very low. In comparison with studies of other indigenous people, the data from Sarayaku indicate an energy intake higher than for the Tukanó, but lower than the Aguaruna and the Achuar. Protein intake seems to be higher than for the Tukanó, but is somewhat lower than for the Aguaruna and the Achuar (Table III). In comparison with other Amazonian peoples (Dufour, 1992) the stature of the Sarayaku people is near average. Thus, the only signs of potential malnutrition revealed by the anthropometric measurements are that stature is short and fat reserves low when compared with the US reference population. One may rightfully question whether the US reference population should be considered as “normal”, given that excessive eating currently is one of the main causes of disease and death in the US (Solomon and Manson, 1997). That the z-scores for several of the anthropometric indices used decrease with age may largely reflect increasing obesity in the reference population as much as decreasing nutritional status among the Sarayaku people. In addition, as mentioned above, short stature may be caused by a wide variety of factors other than lack of food. Nevertheless, the short stature in combination with the data indicating a very low fat intake, probably indicates some nutritional stress, particularly during childhood. This study also highlights how the Sarayaku people are highly dependent on fish for their nutrition, as fish provides a large part of the dietary fat as well as protein. This also implies high vulnerability in case that the fish resources get depleted by overfishing or damaged by pollution (Jochnick et al., 1994; MEM, 1998; SanSebastian and Hurtig, 2004; Webb et al., 2004). Researchers and policy-makers should pay more attention to the importance of sustainable management of fish resources so as to protect the food security of fish-dependent communities in the Amazon. Conservation biologists tend to consider the main nutritional role of wild game and fish as that of being sources of protein (Robinson and Bodmer, 1999; Fa et al., 2003; Brashares et al., 2004; Pearce, 2005). In the absence of empirical data confirming that protein is in short supply for the populations in question, care should be taken in making such statements. To understand the role of wild game and fish in human nutrition, empirical research is needed. This study highlights several difficulties involved in estimating food intake (or in this case, food procurement) in tropical forest communities. The inherent insecurity about the accuracy of such estimates makes it highly recommendable to combine them with anthropometric measurements. In the case of this study, it would indeed have been difficult to reach any conclusions based on estimates of food procurement alone or on anthropometric measurements alone. When combining both methods, however, it can be seen that both point in the same direction. The results suggest that fat deficiency may be more prominent than protein deficiency in at least some human populations that hunt for food in tropical forests. Although a “protein gap” has been mentioned as an important cause and effect of wildlife depletion in tropical forests (Pereira, 2008), it may sometimes be more appropriate to talk about a “fat gap”. Indeed, fish and wild meat are important sources of protein as well as of fat, and if the Sarayaku people would be totally deprived of fish and wild meat, without there being suitable substitutes, they would undoubtedly suffer deficiency of protein as well as of fat. A sudden and total disappearance of fish and wild meat from their diets is, however, not a likely scenario. More likely is a gradual reduction of the catches of wild meat and fish, and the immediate effect of this would be to further exacerbate already existing fat deficiency, whereas overall protein intake would continue to be quite satisfactory for a long time. This is far from unimportant. In order to improve the nutrition and food security of peoples living in tropical forest regions while also conserving the fauna of forests and rivers, one may want to find nutritional complements or alternatives to wild game and fish. To do this efficiently, it helps to know whether one should look primarily for protein-rich or fat-rich foods.

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REFERENCES

PESCA, CAZA Y NUTRICIÓN HUMANA EN BOSQUES TROPICALES: ¿FALTA DE GRASA?
Anders Sirén y José Machoa

RESUMEN

Los biólogos conservacionistas a menudo mencionan a las necesidades humanas de proteínas como la principal fuerza que lleva a prácticas no sustentables de caza y pesca que agotan los recursos y amenazan la biodiversidad en zonas de bosque tropical en todo el mundo. Sin embargo, la base empírica para asumir que la importancia nutricional de la carne y peixes salvajes en las dietas de los habitantes de bosques tropicales se limita a ser la fuente de proteínas es débil. El contenido de nutrientes de los alimentos obtenidos en hogares de una comunidad indígena de la Amazonía ecuatoriana fue calculado, al tiempo que se determinó el estado nutricional de la gente en base a mediciones antropométricas. Los resultados sugieren que el suministro de grasa es más escaso que el de proteína. En concordancia, se sugiere que el papel más importante de la caza y la pesca en la nutrición de la gente del área es el de ser fuentes de grasa, aunque su papel como fuentes de proteína es también importante.

PESCA, CAZA E NUTRIÇÃO HUMANA EM BOSQUES TROPICAIS: FALTA DE GORDURA?
Anders Sirén e José Machoa

RESUMO

Os biólogos conservacionistas com frequência mencionam as necessidades humanas de proteínas como a principal força que leva a práticas não sustentáveis de caça e pesca que agotam os recursos e ameaçam a biodiversidade em zonas de bosque tropical em todo o mundo. No entanto, a base empírica para assumir que a importância nutricional da carne e peixes selvagens nas dietas dos habitantes de bosques tropicais se limita a ser a fonte de proteínas é fraca. O conteúdo de nutrientes dos alimentos obtidos em lares de uma comunidade indígena da Amazônia ecuatoriana foi calculado, ao tempo que se determinou o estado nutricional das pessoas com base em medições antropométricas. Os resultados sugerem que o subministro de gordura é mais escasso que o conteúdo de proteína. Em concordância, se sugere que o papel mais importante da caça e da pesca na nutrição das pessoas da área é o de ser fontes de gordura ainda que seu papel, como fontes de proteína, seja também importante.