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Net Hunters vs. Archers: Variation in Women's Subsistence Strategies in the Ituri Forest

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BaMbuti of the Ituri Forest, Zaire, employ two primary hunting techniques: net hunting, in which women routinely participate, and bow hunting, in which women rarely participate. We hypothesize that the value of women's labor devoted to different subsistence activities, combined with the exchange value of meat, will determine whether women participate in hunts. Field observations were conducted in four different areas: two exploited by archers and two by net hunters. Results indicate that women in net-hunting areas earn more calories per unit time by hunting than by working in agriculturalists' gardens; whereas women in archer areas earn more calories by working for agriculturalists than by hunting. We found no significant difference in the composition or diversity of the forests exploited by net hunters and archers. The results are discussed in light of the long-standing debate concerning the factors that account for distribution of net hunting and archery in the Ituri Forest.

KEY WORDS: hunter-gatherers; BaMbuti; pygmies; archers; net hunters; subsistence strategies; women's subsistence; diffusion.

INTRODUCTION

Net hunting and bow hunting are the two primary hunting techniques used by pygmies living in the Ituri Forest in Zaire. Among net hunters, women participate in hunts; among archers, women rarely hunt. The factors that account for the geographic distribution of these two hunting techniques in the

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Ituri have been the subject of much debate among anthropologists. This issue has attracted so much attention because the adoption of one hunting technique by some BaMbuti[2] but not by others goes to the core of anthropological interest in the processes of cultural diffusion. Also it has served as a focus in the debate concerning the relative significance of ecological variables in shaping technology. Most researchers working in the Ituri have expressed the opinion that the technique employed by a band of hunters determines their social organization: net hunters live in large residential groups and archers in small groups (Turnbull, 1968, p. 135; Harako, 1976; Tanno, 1976; Abruzzi, 1979). Furthermore, it is the prevailing assumption that the burdens of reproduction prevent women from full participation in the hunting of large mammals (Watanabe, 1968; Campbell, 1985), yet among net hunters, as well as among other hunting and gathering groups (Goodman, Bion Griffin, Estioko-Griffin, and Grove, 1985), women contribute significantly to the hunt. In this paper, the explanations that have been offered thus far to explain the distribution of net hunters and archers in the Ituri are reviewed, hypotheses are formulated and tested to explain why women in some areas of the Ituri hunt and why in others their primary subsistence activity is working in villagers' gardens, and further lines of inquiry are suggested into the issue of the distribution of net hunting and archery in the Ituri Forest.

The BaMbuti living in the Ituri Forest can be divided into four populations: the Efe, the Aka, the Tswa, and the Mbuti. These are not discrete demographic populations; their geographic distribution is continuous and they intermarry. However, the four populations are differentiated by language and, in many respects, by custom and technology. Each population is engaged in long-term and complex exchange relationships, often hereditary, with a group of Sudanic or Bantu-speaking horticulturalists. Some BaMbuti earn their living as cash laborers, but most live by hunting and gathering forest resources which they consume themselves and trade to villagers in exchange for cultivated food crops and material goods such as cloth and iron implements. BaMbuti also contribute their labor to villagers and receive cultivated food in return. Most villagers living in the Ituri earn their living through slash-and-burn subsistence farming supplemented by the cultivation of a few cash crops, including peanuts, upland rice, and coffee. Close economic and social relationships between BaMbuti and villagers have probably been in existence for at least 2000 years (Ehret, 1982; Saxon, 1982).

The BaMbuti living in the northern and eastern Ituri with the Sudanic-speaking Lese and Mamvu villagers refer to themselves as Efe. The Efe are archers; they hunt duikers, birds, and monkeys using bows and arrows. They

[2]In this paper, the word "BaMbuti" is used as the generic term to refer to all pygmies living in the Ituri Forest.

also employ spears to hunt larger mammals including buffalo, okapi, pig, and especially elephant (Bailey, 1985; Harako, 1976; Terashima, 1983). BaMbuti living in the northwestern Ituri in association with the Mangbetu and Azande are called Aka. The Aka have been little studied. Many are now living as subsistence farmers and cash laborers, and we know little about their hunting technology. No Aka were included as subjects in this study. Also in the northwest, but to the south of the Aka and in association with the Bantu-speaking Budu and Ndaka are the Tswa (also known as Sua). The Tswa hunt almost exclusively with nets, catching primarily duiker, but also genet, mongoose, and other small and middle-sized mammals. The Mbuti live in the central and southern parts of the Ituri primarily in association with the Bila. The Mbuti, like the Tswa, are net hunters, and have been well studied by Hart (1978, 1979), Harako (1976, 1981), Putnam (1948), Tanno (1976), and Turnbull (1961, 1965a, b, 1968, 1972, 1983).

Turnbull (1968) hypothesized that the humid tropical forest environment of the Ituri was so rich in resources that groups of BaMbuti could adopt any one of several hunting techniques. Net hunting and bow hunting arose from fortuitous forces that were allowed to operate in the generous and permissive environment of the Ituri. This explanation for the adoption of the two BaMbuti hunting techniques now appears improbable, given what has come to be known about the difficulties of subsisting by hunting and gathering in tropical rain forests generally (Headland, 1987; Bailey, Head, Jenike, Owen, Rechtman, and Zechenter, 1989) and in the Ituri specifically (Hart and Hart, 1986; Bailey and Peacock, 1988).

Harako (1976) argued that archery was the hunting technique that prevailed in the Ituri until the relatively recent introduction of nets by Bantu-speaking horticulturalists. Conclusive evidence supporting archery as the original hunting technique and net hunting as a later introduction is lacking. There need not have been a change from one technique to another, but rather a change in emphasis from one to the other is possible. Harako assumed that net hunting is more efficient than archery and so it spread rapidly to those BaMbuti who associated with Bantu speakers. Those BaMbuti who have retained the bow and arrow hunting mode have done so because they associate not with Bantu, but with the Sudanic-speaking Lese and Mamvu, who do not use nets (Harako, 1981, p. 542). While Harako's diffusion model may account for how net hunting spread to the Mbuti and Tswa, it does not explain why it has not since been adopted by Efe, who have long been in frequent contact with both Mbuti and their villagers, the Budu and Bila. Moreover, as Abruzzi (1979) has pointed out, Harako's explanation for the diffusion of net hunting operates in an ecological vacuum and does not explain how net hunting has advantages over archery in some areas, but may not in others.

Abruzzi's (1979) own explanation was more ecological. He attributed the diffusion of net hunting to population pressure exerted by horticulturalists moving into the Ituri. The pressure led to a reduction in the area available to BaMbuti, and this, in turn, led to demand for greater hunting yields and to the concomitant increases in intensification, cooperation, and organization characteristic of net-hunting bands. BaMbuti in the northeast have not adopted net hunting, Abruzzi explained, because they rely less on the natural resources of the forest and receive considerable produce from the gardens of horticulturalists in return for their energetically cheap labor protecting villager gardens from predators.

More recently, Milton (1985) has proposed an even more directly ecological explanation for the distribution of archery and net hunting in the Ituri. She has argued that the two hunting techniques have arisen in response to differences in wild food availability in different areas of the Ituri. Milton, like Abruzzi, believes the distribution of net hunting is confined largely to the southwest Ituri. She predicts the southwest Ituri to be less diverse and thus a more difficult area in which to gain subsistence by hunting and gathering alone, and reasons that BaMbuti in the southwest should be particularly motivated to adopt net hunting because it secures a more dependable subsistence through a reciprocal trade relationship with villagers based on agricultural products in return for meat. Therefore, the southwest Mbuti are more dependent upon the garden foods of the villagers, whereas the archers live in a more abundant and dependable habitat and "become strongly dependent on crop foods from agriculturalists only during the mid- to late rainy season when wild food production in the forest is likely to be most depressed" (Milton, 1985, p. 77).

There are numerous problems with the explanations that have been offered thus far for the distribution of net hunting and archery in the Ituri Forest. Many of the arguments contain factual errors concerning the ecology of the Ituri and the nature of relations between different village-living horticulturalist and BaMbuti groups. Abruzzi and Milton's explanations are based on selective readings of the available literature and not on direct observations. An example of the consequences of their approach comes from a comparison of Abruzzi and Milton's views on the relationships between villagers and BaMbuti in the Ituri. Citing the same source (Harako, 1976), Abruzzi and Milton come to exactly opposite conclusions: Abruzzi believes archers are much more dependent upon village gardens for their food (Abruzzi, 1979, p. 188), whereas Milton insists the net hunters depend more than archers on produce from the villagers (Milton, 1985, pp. 76-77).

BACKGROUND

Research accomplished in recent years concerning the ecology of the Ituri Forest and the social and economic relations between BaMbuti and villagers now makes it possible to clarify this issue and to propose and test a hypothesis for why BaMbuti women should participate in hunts regularly among net hunters but only occasionally among archers. First, certain facts should be known.

The vegetation of the Ituri Forest has been divided into two types, each characterized by dominant species of the subfamily Caesalpiniaceae (Harako, 1976; Hart, 1985). In the southwest, *Gilbertiodendron dewerei* dominates to such an extent that it can constitute 90% of standing vegetation (Hart, 1985). In the north and east, mixed-species stands of *Cynometra alexandrii* and *Brachystegia laurentii* dominate with a number of other tall species interspersed, e.g., *Albizia zygia, Celtis mildibraedii,* and *Ficus spp.* Harako (1976, 1981) wrote and Milton (1985) believed that each of these two different forest types is associated with a different kind of soil. Recent, very thorough studies have shown Harako to have been mistaken: there is no difference between *Gilbertiodendron* and mixed *Cynometra-Brachystegia* forest with respect to soil type (Hart, 1985, p. 43; Hart, Hart, and Murphy, 1989, pp. 623-626). Harako (1976, p. 82) also stated that "archers confine themselves to *Cynometra* forest, while net hunters live chiefly in *Gilbertiodendron* forest and to some extent in *Cynometra* forest." We now know that net hunting is not restricted to one geographical region nor one forest vegetation type within the Ituri (see Fig. 2). Net hunters are distributed throughout the southern, central, and northwestern areas of the Ituri, while archers are in the southeast and north. *Gilbertiodendron* forest, which Milton (1985) correctly identifies as a less-productive habitat (Hart, 1985; Hart and Hart, 1986), is restricted to the southwest, an area that constitutes only a portion of any net-hunting band's hunting range. While some net-hunting bands do hunt primarily in *Gilbertiodendron* forest, none do so exclusively, and some net hunters, such as the Tswa in the northwest, never hunt in this type of forest at all, but rather exploit the mixed *Cynometra-Brachystegia* forests, which are more diverse and productive (Hart, 1985; Hart and Hart, 1986).

Underlying the hypotheses proposed by Harako (1976), Abruzzi (1979), and Milton (1985) is the implicit or stated assumption that net hunting is a more efficient hunting technique than archery. There are now data from large samples of hunts of each type to confirm that there is no substantial difference between the efficiencies of the two methods. Ichikawa (1983, p.

62) has summarized the results from five different studies of net hunters in the central and southern Ituri. The returns of meat per person hour over the five studies ranged from .12–.39 kg. The largest sample was from 27 hunts, which returned .28 kg per person hour of hunting. This is comparable to Bailey's study, conducted in 1980–1981, of 71 Efe archer hunts which returned .27 kg of meat per person hour (Bailey, 1985), and similar to the results of 12 Efe archer hunts observed by Terashima (1983) when .33 kg were returned per person hour of hunting. Harako observed hunts by both net hunters and archers in the same area of forest around Lolwa and found net hunting and archery to have almost identical efficiencies: .12 kilos per person hour for net hunting and .11 kilos per person hour for archery (Terashima, 1983, p. 62). Both Terashima (1983) and Ichikawa (1983) compare the efficiency of large samples of net hunts with bow hunts and come to the same conclusion: "we should alter the idea that bow-and-arrow hunting is less effective than the net hunting" (Terashima, 1983, p. 81). It is now apparent that net hunting is no more efficient in terms of weight of meat procured per person hour hunting than archery. In fact, if we consider the labor necessary to make and maintain the implements necessary for the two techniques, net hunting may well be significantly *less* efficient than archery. For example, during 376 hours of observations, Bailey found that Efe men spent an average of 51 minutes per day making and repairing their bows and arrows (Bailey, 1985), while during 174 spot observations during a 6-day period, he found Mbuti spent an average of 79 minutes per day making and maintaining their nets (Bailey, unpublished data).

A very important difference with respect to the labor that goes into net hunting vs. archery is that, among archers, hunts are almost exclusively conducted by men (for exceptions see Terashima, 1983), whereas, among net hunters, women routinely participate in hunts; they act as beaters to drive the game into the nets (for detailed accounts of net hunting, see Harako, 1976; for archery, see Harako, 1976; Terashima, 1983). This means that per hour of hunting, approximately twice as much labor goes into each hour of net hunting than each hour of bow hunting, and, since the returns per person hour are the same by each method, twice as much meat is captured per net-hunting hour. The major difference between net hunters and archers, then, is not in the efficiency of the hunting methods, but in the subsistence activities of women. Peacock (1985) found that during 387 hours of observation, Efe archer women spent no time hunting. Terashima (1983) observed Efe women participating in a limited number of special hunts. Bailey (unpublished observations) has observed Efe women participating in a limited number of hunts that occur only during one season. In short, hunting by archer women is a rare event. Among net hunters, on the other hand, hunting is a common female subsistence activity. There are no quantitative data available on the amount of time women devote to hunting among net hun-

ters. But Harako (1976, p. 60) found that, on average, slightly more women participate in hunts than men. Tanno (1976, p. 114) found that "the number of (women) beaters was always somewhat less than the number of men." In either case, it is clear that women contribute substantially to hunting in net-hunting areas. Consequently, because archer and net hunts are equal in efficiency, women do not appear to increase the efficiency of hunts, but by contributing their labor, net-hunting women do increase the total yield of each hunt. On a per hunt basis, net hunters get more meat than archers. The additional meat is then traded to local villagers or outside traders for agricultural foods (Harako, 1976; Hart, 1979; Bailey, 1982; Ichikawa, 1983). Most of the carbohydrates eaten by net hunters are acquired by bartering surplus meat acquired on the net hunts for villager-grown crops (Ichikawa, 1983). In contrast, archer women, instead of hunting, spend most of their subsistence time working for villagers for which they receive agricultural foods in return (Peacock, 1985). The great majority of the carbohydrates consumed by archers are not acquired through bartering meat, but by women exchanging their labor for crop foods (Bailey and Peacock, 1988).

There is little difference between the archers and net hunters with respect to their dependence upon villagers for agricultural foods. Both archers and net hunters depend upon agricultural foods for more than 60% of their calories (Hart, 1979; Ichikawa, 1983; Hart and Hart, 1986; Bailey and Peacock, 1988). However, they have different means of acquiring the villagers' foods, the differences being primarily in women's subsistence activities. Whereas women in archer bands work primarily in villager gardens to obtain garden foods, women in net-hunting bands work primarily on forest hunts, and then the meat they procure is traded for garden foods.

In view of the high dependence of all BaMbuti on villager garden foods, it is apparent that the returns to women for their labor become crucial for determining whether they should participate in hunts. Assuming individuals are acting in economically rational ways, in areas where archery prevails, we should expect the returns to women to be greater per hour they work in the villager gardens than per hour they hunt. In contrast, the returns to women among the net hunters should be greater per hour they hunt than per hour they work for villagers. Since we know that the weight of meat acquired per person per hour of hunting by each of the two methods is equal, it should follow that the value of the meat is different in the two different areas. Net-hunting women can achieve a greater return per unit time they devote to subsistence because the meat they acquire while hunting is more valuable to villagers in their area than meat is to villagers in areas where archery prevails. We propose that among archers, the reason women do not hunt is because the exchange value of meat is lower than in net-hunting areas and archer women can do better by working for villagers to acquire garden foods.

HYPOTHESES

In light of the previous information, we went to the field to test the following predictions: (1) there are no significant differences in the composition or diversity of the forest areas exploited by net hunters vs. those exploited by archers, (2) the value of meat to villagers is higher in net-hunting areas than in archer areas, and (3) the return of net-hunting women's labor in villager gardens is less than the return from their labor on hunts.

In addition to these three primary predictions, we also investigated several related variables. Population density of villagers could be important, since it could affect demand for BaMbuti meat and labor. We predicted that the value of meat would be higher in areas of higher villager population densities since there should be a greater demand for meat and a shorter per consumer supply. Therefore, we expected BaMbuti to adopt net hunting in areas with higher population densities.

The size of villager gardens is a good measure of household food production (Wrangham and Ross, 1983; Jenike, 1988) and should be indirectly related to the amount of food villagers have available to trade to BaMbuti for labor and meat.

METHODS

Many of the direct observations reported in this paper come from over 39 months of research conducted throughout the Ituri Forest by the senior author since 1978. Both authors were in the field from January to August 1987 expressly to test the above hypotheses. Data were collected from four different areas in the Ituri Forest designated as study areas A, B, C, and D in Fig. 1. In two of the study areas (A and B), the BaMbuti are archers, and in the other two areas (C and D), they are net hunters. Study area A is inhabited by Lese villagers and Efe archers. Extensive research has been conducted among the Lese and Efe since 1980 by the senior author and by other members of the Ituri Project (Bailey, 1985: Bailey and DeVore, 1989) and by Terashima (1983, 1985, 1986, 1987). Study area B is inhabited by Mamvu villagers and Efe archers. Since the bow-hunting BaMbuti in both areas A and B are called Efe, we will distinguish between them by refering to the Efe-Lese and the Efe-Mamvu. Study area C is inhabited by Budu villagers and Tswa (Sua) net hunters. Bantu-speaking Bila and Mbuti net hunters reside in study area D. Study area D is close to Epulu, the location of extensive research by Putnam (1948), Turnbull (1965a,b, 1968, 1972, 1983), and Hart and Hart (1986). The four study areas are not isolated from one another. Except between areas B and D, villagers and BaMbuti travel across the forest

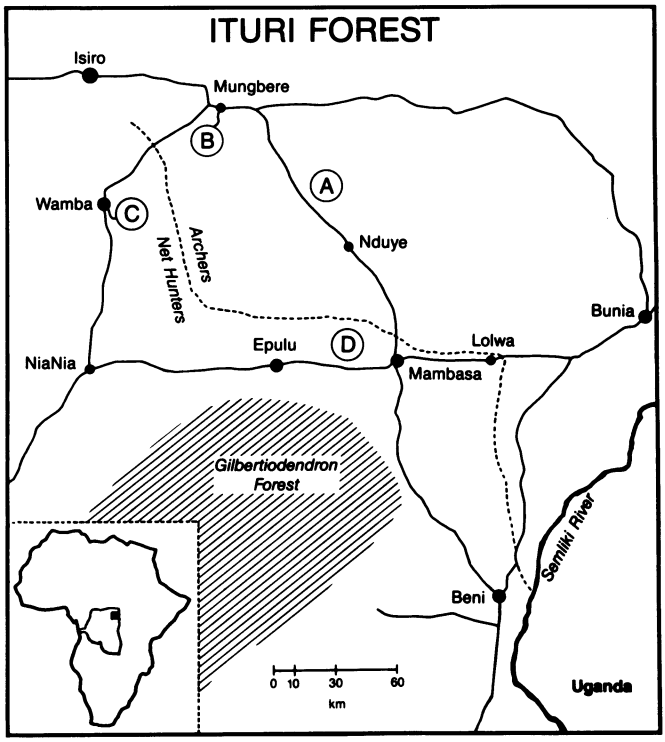

Fig. 1. Map of the Ituri Forest, Zaire, showing the location of the four study areas, the distribution of *Gilbertiodendron* forest, and the distribution of net hunters and archers.

between the four areas, intermarriage occurs, and there is ample opportunity for exchange and diffusion of knowledge and technologies.

The value of meat in each area was determined by sampling, on an *ad libitum* basis (Altman, 1974), all exchanges of meat for food or currency. For each transaction, the food items and species of animal were recorded and the meat and food were weighed using portable hanging scales.

The returns from women's labor in each area were measured by recording the time and identity of persons leaving their residence camp between 6:00 a.m. and nightfall and weighing all items they carried. Each person was asked where they had been and what activities they had performed. From these data, we estimated the calories returned per hour women worked for villagers. In each area, we also accompanied BaMbuti women to villager gardens. We recorded the amount of time each woman worked and the weight of all items received in exchange for her labor. Weights were converted to

edible weights using values calculated by Bailey and Peacock (1988), and edible weights were converted to caloric values using Leung (1968).

The villagers of each area lived along a road. Villager population densities were estimated by counting the number of inhabited houses along a stretch of road and dividing by the number of kilometers of road to arrive at the number of houses per kilometer. We conducted a census of a subsample of houses (approximately 50 in each area) to calculate the average number of inhabitants per house. This number times the number of houses per kilometer resulted in our estimates of villager population density.

Villager gardens were measured using a Silva Ranger compass, a two and one-half meter stick, and an Opti-meter Model 120 range finder. Angles and distances around the perimeter of each garden were measured and recorded in the field and entered into a DBase III file upon return to the U.S. A program was written in Fortran that drew polygons representing the gardens and that calculated the area of each polygon. The mean measurement error calculated by comparing the areas of two alternate polygons derived from the garden measurements was 2.7%.

To characterize the tree species that constituted the upper canopy of the forest exploited by the BaMbuti in each area, a straight-line transect perpendicular to the direction of the nearest road was created using a Silva Ranger compass. Each transect was approximately 8 kilometers long, a distance that equalled approximately one-fourth of the total distance that a BaMbuti band usually ranges from the village with which it is traditionally affiliated. The transect was walked at a steady pace (approximately 4 kilometers per hour). Every 2 minutes, the observer (RCB) and a Lese informant stopped, sighted, and recorded the local KiLese name of the nearest tree greater than 18 inches in diameter at breast height (dbh). The majority of species encountered were familiar to the senior author. For a few species whose Latin names were unknown to the authors, we used Terashima, Ichikawa, and Sawada, (1988) and Wilkie (personal communication) to convert local names to scientific names. Simpson's Diversity Index was calculated following Pielou (1977, p. 311).

RESULTS

Forest Composition and Diversity

The purpose of sampling the forest in each of the four study areas was, first, to be able to characterize the archer and net-hunting areas as either *Cynometra* or *Gilbertiodendron* forest, and second, to detect differences in the general composition and diversity of species in the forests exploited using the two hunting techniques. Table I shows the results of the four straight-

Table I. Forest Composition and Diversity: The Results of Straight-Line Forest Transect Samples in Each of Four Study Areas

Study area	Number of trees recorded	Number of species recorded	Proportion of *Cynometra*	Number of unique species[a]	Species in common			Simpson's Diversity Index
					Area B	Area C	Area D	
A (Lese)	59	29	34%	13	14	12	13	.917
B (Mamvu)	55	20	29%	3		13	14	.954
C (Budu)	57	25	23%	10			12	1.116
D (Bila)	53	22	36%	6				.872

[a]The number of species not observed in other study area samples.

line transect samples in each of the study areas. Across the four sample transects, a total of 224 individual trees were sighted and classified as 52 different species. All four areas can be characterized as *Cynometra* forest. *Cynometra alexandrii* was by far the most frequent species sighted in all four areas, ranging from 23% of all individuals in study area C to 36% in study area A. The second most common species occurring in all four areas was *Celtis mildibraedii,* which accounted for only 7% of the total sample, and the third most common species was *Brachystegia laurentii,* which accounted for 6% of the sample. Although a small patch of *Gilbertiodendron* was observed in three of the four study areas, just one individual from that species appeared in one sample transect.

There were not large differences between the areas with respect to diversity. Study area A had the greatest number of species (29) and it also had the most species that did not appear in any other area's sample. However, calculating Simpson's Diversity Index for each area, we found area C to be the most diverse, while, according to the same index, area D was the least diverse. We conclude from these results that there is no systematic difference in the diversity of forests between net-hunting areas and archer areas.

The results presented in Table I also indicate that the species composition of forests in net-hunting areas are no more similar to one another than they are to the forests in archer areas. There are similar numbers of species held in common by all the study areas regardless of hunting technique. For example, in the archer areas (areas A and B), 14 species were common to both areas, while area A had 12 and 13 species that were recorded in areas C and D, respectively, and area B had 13 and 14 species that were recorded in areas C and D, respectively. The net-hunting areas (areas C and D) had just 12 species recorded in common. From these results, we conclude that the forest ecologies of net-hunting areas are no more similar to one another than they are to archer areas. Put another way, it is not possible to conclude that differences in forest habitat account for differences in BaMbuti hunting technique.

Value of Women's Labor

Figure 2 shows the calories that women earned by working in villager gardens. For each hour they worked for villagers, net-hunting women procured food that had an average caloric value of 1149 calories, while archer women procured food at the rate of 2097 calories per hour. Thus net-hunting women returned to camp with significantly fewer calories of food per hour they worked for villagers than did archer women ($p < .001$; $df = 65$). Among net-hunting groups, there was little difference in the returns of Mbuti and Tswa women ($p = .516$), and the same was true for the two groups of Efe archers ($p = 818$).

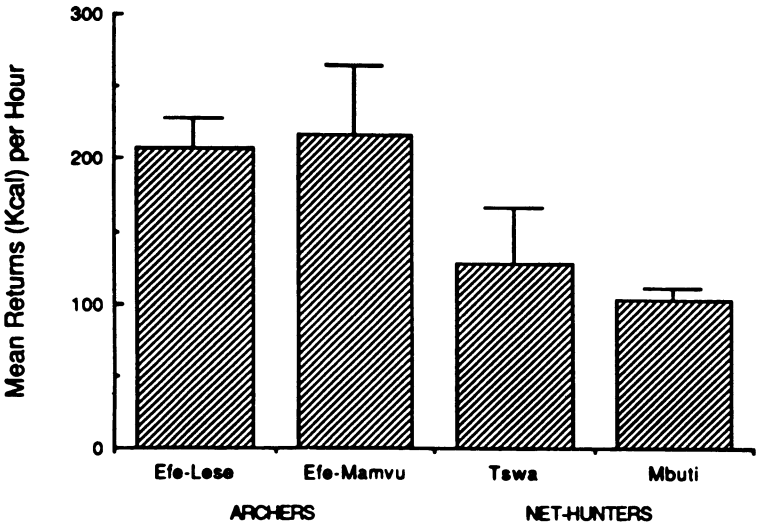

Fig. 2. The value of women's labor. The mean returns (kcal) to women per hour they work in villager gardens.

Previous studies have shown that returns to net hunters and archers per hour of hunting are very similar. For the purposes of our analyses of the caloric value of meat returned per hour of hunting, we use the largest samples available for each method: 27 net hunts from Ichikawa (1983,pp. 62-63) and 71 archer hunts from Bailey (1985). Net hunting yields 280 grams of edible meat per person hour of hunting, and bow hunting yields 266 grams of edible meat per person hour. Assuming each 100 grams of meat contains 180 calories, each person hour of net hunting yields 504 calories, and each person hour of hunting by archers yields 479 calories. If women were to participate in archer hunts as beaters, as they do habitually among net hunters, they could expect to return only 25 fewer calories (5%) per hour of hunting as net hunting women.

The Value of Meat

It was not possible to obtain reliable samples of exchanges of meat for villager food among the Tswa (area C) and the Efe-Mamvu (area B). Among the Mbuti, we observed just three exchanges of meat for argicultural food. The Mbuti traded 4.5 kilograms of meat for 59 kilograms of cassava, or 642 calories of meat for 5275 calories of villager food. For every calorie of meat given to the villagers, the Mbuti net hunters received 8.2 calories of agricultural food in return. Hart (1979, p. 98) observed 20 exchanges be-

tween Mbuti and villagers in the southern Ituri. He found that every kilogram of meat traded to villagers returned 6.13 kilograms of starch. By our calculations, this means that for every calorie of meat given to villagers, the net-hunting Mbuti in the southern Ituri received approximately 5.2 calories in return.

Eight exchanges of meat for villager food were observed among the Efe-Lese. The Efe traded a total of 15.2 kilograms, or 2736 calories of meat, and they received a total of 5418 calories of villager garden foods in return. Therefore, for every calorie of meat Efe gave to villagers, they received just less than two calories of food in return. These results strongly indicate that Mbuti net hunters can get a much higher return for their meat than can the Efe archers.

Additional data concerning the value of meat in net hunting and archer areas come from our observations of meat being sold for cash. In each area, there is a standard price for a standard unit of meat. The standard unit is either the hind leg of a mid-sized duiker (*Cephalophus nigrifrons, C. natalensis, C. leucogaster, C. dorsalis*) which weighed 1.96 kg (n = 12; SD = .35), or the hind quarters of a blue duiker (*Cepholophus monticola*), which weighed 1.74 kg (n = 9; SD = .24). In both the archer areas (study areas A and B), the standard price for a unit of meat was 150 Zaires (approximately U.S. $1.50 at the time of the study). In study area C where the net hunting Tswa live, the price of a standard unit of meat was 250–300 Zaires, and in study area D, it was 200 Zaires. The results indicate that, as we predicted, meat is more highly valued in net hunting areas than in archer areas. The standard price of meat was 33–100% higher in net-hunting areas than in archer areas.

The Value of Hunting vs. Working in Villager Gardens

The above results show that net hunting women earn fewer calories per unit time working in villager gardens than do archers. Table II illustrates how the caloric returns to Mbuti women living in net-hunting areas

Table II. Value of Hunting vs. Working for Villagers: Calories Earned per Person-Hour by Hunting, by Working, and by Exchanging Meat for Villager Garden Food

BaMbuti group	Returns from hunting (Kcal)	Returns from garden work (Kcal)	Ratio of exchange meat for starch	Returns from exchange meat for starch
Mbuti (area D)	504	1149	8.2:1	4133
Mbuti (Hart, 1979)	504		5.2:1	2620
Efe-Lese (area A)	479	2097	2.0:1	958

are higher when they hunt than when they work for villagers, and it illustrates how women living in archer areas have higher returns working for villagers than they do hunting. An Mbuti net-hunting woman, by trading meat for villager food, can earn from 2620–4133 calories every hour she hunts, whereas, she can earn only 1149 calories every hour she works for a villager. Thus, for an Mbuti woman, there is greater than a twofold advantage to hunting as opposed to working for villagers. On the other hand, if an Efe woman hunted, she could earn only 958 calories per hour by trading meat for garden food, as opposed to earning 2097 calories by working in a villager garden. Therefore, for an Efe woman, there is greater than a twofold advantage to working for a villager rather than hunting.

Villager Population Densities

Table III shows the results of our measures of the population densities of villagers in the four different study areas. There is no clear difference in the population densities of villagers in net hunting areas vs. archer areas. The Lese (in study area A) are distributed more sparsely than the other three villager groups, but the villagers in the other three areas are living in similar densities, at least along the 6-kilometer section of road that we censused in each area. There was a distinct difference, however, between net-hunting and archer areas in the access that people had to large population centers where there were active open markets and high concentrations of potential consumers of bush meat. The net-hunting Tswa were only 6 kilometers from a large weekly market to which traders came on trucks and bicycles, and they were 21 kilometers from Wamba, a major town of more than 25,000 people with an active daily market. The net hunting Mbuti lived along the major route connecting eastern Zaire to Kisangani, the principle port on the country's main artery, the Zaire River. Truckers provided the people in area D not only with a major market for meat, but also frequent rides and easy access to Mambasa, a major town 18 kilometers to the west with 18,000 inhabitants, a daily market, and numerous commercial traders. The archers

Table III. Population Densities of Villagers per Kilometer in Each of Four Study Areas

Study area	Number of villagers per kilometer
A (Lese)	59
B (Mamvu)	88
C (Budu)	85
D (Bila)	83

in study areas A and B, on the other hand, did not have easy access to large population centers and markets for bush meat. The Efe-Mamvu lived 36 kilometers from the nearest large town (Mungbere) on a poor road that was untraveled by a vehicle for as much as 3 months at a time. The Efe-Lese lived along a road that hasn't experienced commercial traffic for 20 years, and they are 72 kilometers from Mungbere. So while the population densities of villagers in the small areas we censused were similar, when we consider the proximity of large population centers, it is apparent that net-hunting BaMbuti exploit areas with higher overall densities and greater numbers of potential buyers of bush meat.

Garden Size

Table IV shows the mean size of food and coffee gardens in each of the four study areas. The Mamvu in study area B had both the largest subsistence gardens and the largest coffee plantings. The Lese and Bila had similarly-sized subsistence gardens. While neither group had very much coffee, the Lese placed slightly more emphasis on coffee than did the Bila. The Budu had the smallest subsistence gardens by far, but planted larger areas of coffee than the Bila and Lese.

Looking at the villagers in net-hunting areas (areas C and D), they had subsistence gardens that were significantly smaller than the gardens of the villagers in archer areas (areas A and B; $df = 54$; $p = .005$). We interpret these results as reflecting the greater variety of economic opportunities other than subsistence farming available to villagers living in less remote areas with greater access to alternative means of subsistence. For example, Budu are well-known throughout eastern Zaire for their production of oil from the palm *Elaeis guineensis*. Families forage for palm nuts and make palm oil, which they then transport on foot or bicycle to Wamba for sale. Budu also emphasize education, and many become teachers or government bureaucrats. Many Bila, on the other hand, earn substantial sums of cash by panning for gold and selling it either legally to government agents or illegally on the black market.

Table IV. Garden Areas: The Mean Areas (m^2) of Coffee and Food Gardens in Each of Four Study Areas

Study area	*N*	Mean (± SEM) coffee garden size (m^2)	Mean (± SEM) food garden size (m^2)
A (Lese)	28	798 ± 362	2539 ± 370
B (Mamvu)	30	2321 ± 915	3498 ± 258
C (Budu)	30	1241 ± 452	1457 ± 220
D (Bila)	28	49 ± 35	2402 ± 544

The Mamvu and Lese have large gardens because they have fewer means of earning cash income. The Lese can sell small amounts of coffee to entrepreneurs who dare risk their vehicles on the very poor road, but they cannot sell other cash crops and are essentially subsistence farmers, having an average annual household income of less than $50.00 (Wrangham and Ross, 1983). The Mamvu have the largest gardens because the road on which they live is still passable. This means they can sell cash crops (peanuts, rice, and coffee) to entrepreneurs who come seasonally in small trucks to buy. But since the Mamvu are far from a large population center, with few opportunities for transport, they have few alternative means other than agriculture to earn income.

DISCUSSION

We have proposed an explanation for the distribution of hunting by BaMbuti women in the Ituri Forest in Zaire. Based upon what was known concerning the ecology of the Ituri Forest and the subsistence economies of the village-living horticulturalists and BaMbuti foragers, before going to the field we hypothesized that women in net-hunting areas could earn more calories per unit time by hunting than by working for villagers; whereas women in archer areas could earn more calories by working for villagers than by hunting. The results of this study support our hypothesis. We found that meat has both greater currency value and greater exchange value in net-hunting areas than in archer areas, and we found that women's labor earns more calories per unit time in archer areas than in net hunting areas. Therefore, there appears to be a twofold advantage (measured in calories) to women in net-hunting areas to hunting over working for villagers; whereas in archer areas there appears to be a twofold advantage to working for villagers over hunting.

We have also shown that there is no significant difference in either the composition or the diversity of the forest areas exploited by many net hunters vs. archers. Since large numbers of net hunting bands exploit areas that are not dominated by *Gilbertiodendron* and that are no more similar to each other than they are to areas exploited by archers, similarities in the abundance and diversity of species within net hunting areas vs. archer areas cannot account for the distribution of the two different techniques. These findings indicate that while it is important to take into account the ecology of the habitats exploited by peoples using different subsistence technologies, there is not always a simple linear relationship between habitat and economy. History, demography, social relationships, and economic relations with neighboring peoples must be considered too.

Our censuses in the four different study areas were taken over too small an area to accurately reflect the relative population densities in net-hunting

vs. archer areas. Our results show that the bow-hunting Lese-Efe live in an area where the villager population is very sparse, but the densities of villagers in the Mamvu-Efe area are approximately the same as in net-hunting areas. However, when we consider the densities of villages over areas larger than those we censused, it is clear that the net hunters we studied live in parts of the Ituri that are more densely populated than the archer areas. This is so because they live near large towns—Wamba in the case of the Tswa and Mambasa in the case of the Mbuti.

Although several interpretations of the results of our measurements of garden size in each of the four study areas are possible, we reason that Ba-Mbuti in archer areas earn more food per hour they work for villagers because gardens in those areas are larger. Larger gardens should mean that both more food is available for the villagers to give starch in return for BaMbuti labor, and BaMbuti labor is in greater demand to help plant, maintain, and harvest the larger areas. These factors should contribute to higher payoffs in food for BaMbuti who assist villagers in gardens. While we might expect the exchange value of meat for starch also to be greater in areas where more food is available, we believe the availability of large numbers of people demanding meat in net-hunting areas far outweighs the greater availability of garden food in the sparsely populated archer areas.

Individual and Seasonal Variation

Besides explaining why BaMbuti women in some areas hunt while in other areas they primarily work for villagers, our emphasis on the value of meat and women's labor also explains much of the individual and seasonal variation in BaMbuti women's subsistence activities in the Ituri Forest. For example, although it has been assumed that the success of net hunts depends upon women acting as beaters to drive game into the nets (Harako, 1976; Abruzzi, 1979), we discovered that among the Tswa net hunters, women frequently do not participate in hunts. Tswa women do hunt when the Tswa are camped in the forest more than an hour from Budu villages. However, when the Tswa are camped near the road on the edges of the Budu gardens, men hunt by themselves without the assistance of women. Instead of hunting, women work for the Budu in the gardens to earn agricultural food. The men go to the forest for the day without women, and they hunt with some men tending the nets, as usual, and others acting as beaters.

We consider the subsistence behavior by the Tswa as rational and consistent with our explanation for the distribution of net hunting. The Tswa camp near the Budu villages at the time of year when their labor is most needed, when crops are being either planted or harvested. At such times, we predict Tswa women will garner more food from villagers in return for

their labor than at other times. Also, since forest areas near the Budu villages are more intensely hunted, returns from hunting near the road are less than returns deeper in the forest. Moreover, since it is women who carry the heavy loads of food to and from Tswa residence camps, working for villagers to earn heavy starch foods when camps are close to the village, and hunting for meat and other forest products when camps are far from the village makes sense for them. All of these factors combined suggest that Tswa women gain a greater return by working for villagers than from hunting when Tswa camps are close to the Budu villages, and the same women gain a greater return by participating in hunts rather than working for villagers when Tswa camps are far from the Budu villages. We believe seasonal and individual variation in women's subsistence strategies in other parts of the Ituri can be similarly explained.

Explaining the Distribution of Net Hunting and Archery

It is important to point out that we have not explained what factors account for the geographic distribution of net hunting and archery in the Ituri Forest. Nor have we explained why some BaMbuti have adopted net hunting and others have retained bow hunting as their primary hunting technology. Assuming archery preceded net hunting as the predominant hunting technology, showing the advantages of hunting by women in net hunting areas does not explain why the BaMbuti in those areas adopted net hunting in the first place, nor why they remain net hunters today. If the relative values of meat and women's labor were the same in archer areas as they are today in net-hunting areas, women could simply participate in archer hunts; they need not turn to net hunting, unless there are some characteristics of net hunting itself or the areas where net hunters live that have not yet been taken into consideration.

The debate concerning the distribution of net hunters and archers in the Ituri has thus far produced overly simple explanations for what is a complex problem. We believe the information necessary to properly address this issue is still not available, but we would like here to suggest briefly several lines of inquiry that would bring the issue into sharper focus.

Abruzzi (1979) has argued that population pressure and the concomitant shrinking of available forest habitat has produced the need for BaMbuti to intensify exploitation of a given unit of land and to increase cooperative subsistence activities. Abruzzi maintains that net hunting is a form of intensification and represents a higher degree of cooperation because it requires the addition of women's labor to what was originally an exclusively male activity. As we have indicated, it is not clear that net hunting is an intensification of hunting by BaMbuti, if intensification is considered as more labor

per unit return. The large amount of data available on net hunting and bow hunting suggests that the returns per hour by the two techniques are equal. However, there are also some preliminary data that suggest if manufacture and maintenance of nets vs. bows and arrows are added to the equation, net hunting does require more labor per unit of meat killed. At the same time, it is possible that, due to greater exploitation of forest animals in areas of higher human population densities, the biomass of prey mammals in net hunting areas is lower. If such were true, we would have to conclude that net hunting is more efficient at killing the available animals than is archery. One possible test of the relative efficiencies of net hunting and archery is to collect sufficiently large samples of archers employing their technology to hunt in net hunting areas and net hunters using their technology to hunt in archer areas. If net hunting is more efficient per unit time hunting, net hunting should capture more prey per hour and archery less. Something similar to this experiment has been done in the Lolwa area where both net hunters and archers exploit essentially the same forest. As we have indicated previously, Harako (1976) found the two groups achieve virtually identical returns per person hour. In addition, data collected by Wilkie (1989) during net hunts by Efe archers in an archer area showed the returns from 27 net hunts to be comparable to the returns from bow and arrow hunts in the same area.

What has been ignored, however, is that hunting is not the only subsistence activity of BaMbuti; it is just one of several alternative subsistence tasks that BaMbuti women may perform. By joining hunts, BaMbuti women may or may not have increased the amount of time they devote to total subsistence. To determine if net hunters have intensified their total subsistence activities over what they did as archers will require comparative data on time spent on all subsistence activities by men and women in both archer and net hunting areas. Such data do exist from one Efe archer area (Bailey, 1985; Peacock, 1985; Bailey and Peacock, 1989), but there are as yet no comparable quantitative time allocation data available from any net-hunting group. However, even if we were able to show that BaMbuti in net-hunting areas work longer hours to obtain the same level of subsistence as BaMbuti in archer areas, this would not allow us to conclude, as Abruzzi has on even less evidence, that net hunting *per se,* and not some other aspect of the entire range of BaMbuti subsistence activities, was adopted in order to intensify production in response to population growth and a shrinking resource base.

Social Organization and Hunting Technology

Group size and social organization may place constraints on the distribution of net hunters and archers in the Ituri. Net hunters tend to live in larger residential groups than do archers (Turnbull, 1965a, 1968; Bailey,

1985). Most authors have stated that net hunters reside in larger groups because that method of hunting requires a certain minimum number of nets and "demands cooperation between a minimum of six or seven nuclear families and a maximum of thirty" (Turnbull, 1968, p. 135; Harako, 1976; Tanno, 1976; Abruzzi, 1979). Bow hunting, on the other hand, is considered to be more efficiently conducted by solitary males or "the ideal number of archers for either tracking or ambushing game is three. Five would already by unwieldy" (Turnbull, 1968, p. 135; Harako, 1976; Abruzzi, 1979), and so archers reside in small groups. While the causal relationship between hunting technique and residential group size is widely accepted, there are scant data to support it. Net hunts with fewer than five nets, and even as few as two nets, have been observed in the Ituri (Bailey, personal observations) and in the Central African Republic (Hewlett, personal communication), and archers conduct hunts with more than 20 hunters participating (Bailey, 1985; Terashima, 1983). Contrary to what is often cited in the literature, archers are far from solitary hunters and more often than not hunt in groups.

The average hunting group size during 71 Efe group hunts was 9.75 (SD = 4.32; Bailey, 1985). In contrast, the mean number of men and women participating in the 44 Mbuti net hunts listed by Ichikawa (1983, pp. 74-75) was 16.1. However, if the sizes of archer and net hunting residential groups are constrained by the efficiency of hunting in different-sized groups, we should expect hunting returns per person hour by each method to be optimized within a different range of hunting group sizes. Bailey (1985) found no relationship among Efe archers between hunting group size and returns per person hour. Hunting groups ranged in size from 4–27 participants, and there was neither one group size nor a discernible range of group sizes that increased Efe hunting efficiency. A plot of the data from 44 Mbuti net hunts presented by Ichikawa (1983, pp. 74-75) yields similar results. The net hunts ranged in size from 9–23 participants and the efficiencies of the hunts are very similar. These sample sizes are small, and it is clear that we cannot reject the hypothesis that hunting technology constrains residential group size. However, it is equally clear that until additional quantitative data on hunting returns by the two different methods are available, we cannot accept the widely held belief that there is a causal relationship between hunting technology and residential group size.

The Diffusion of Net Hunting

Harako (1976), by arguing that some BaMbuti became net hunters simply through contact with Bantu-speaking villagers who brought the technology, presents a simple diffusion model for the distribution of the two hunting methods. While not providing a reason for why net hunting should be at-

tractive to the BaMbuti who adopt it, Harako's simple explanation does provide a productive line of inquiry. In Lolwa, where Harako conducted his research, there were both Mbuti net hunters and Efe archers. While each group did hunt on opposite sides of the road, Mbuti to the south and Efe to the north, the forests they exploited were similar, the villagers with whom they exchanged and worked were the same, the population density in the area was the same for both groups, the returns from hunting were the same, and most other factors were the same or similar for the two groups. The greatest difference between them was the Efe archers arrived in the area only 20 years before Harako's study, whereas the Mbuti net hunters had resided there with the Bila villagers for generations (Harako, 1976, pp. 45-48). Therefore, during 20 years of close contact and exchange with Bantu-speaking Bila and with net-hunting Mbuti, the Efe had not adopted net hunting, but rather retained their original mode of hunting with bows. Harako's diffusionist model is not actually supported by his own study, since the Efe speak the language of the Bila (KiBila) and have as much contact with the Bila villagers as the Mbuti do, but it does suggest a productive approach to the question of why the Efe do not adopt net hunting.

One possibility is that, when BaMbuti originally adopted net hunting, they actually received nets from the villagers and were encouraged to hunt with nets because the villagers would receive part of the kill in return for the Mbuti's use of the nets. Lending of nets by villagers to BaMbuti in exchange for part of the kill does occur today in parts of the Ituri and the Central African Republic as well (Bailey, personal observation; Hewlett, personal communication). It is conceivable that over time, as the BaMbuti maintained the nets, they would be reluctant to return them to the villagers, and the villagers would abandon hunting to concentrate their subsistence effort on growing food crops for themselves and for trade to BaMbuti in exchange for meat. According to this speculative scenario, the BaMbuti did not incur the original very substantial cost of making the nets themselves, but rather, in a sense, paid for them gradually over many years.

What may inhibit many Efe archers from adopting net hunting is the high initial cost of making nets. A rough estimate of the time required to make a net 60 meters long (average length of nine nets in study area D was 66.4 meters) is 300 person hours. While Efe know well how to make such nets, they may be unwilling to make such a high initial investment, especially if other group members are unwilling to undertake the shift to net hunting. In addition, in most parts of the Ituri, there are no longer any villagers with nets who might loan or trade them to BaMbuti. When we have asked Efe why they do not adopt net hunting, they have said that they believe they can kill more animals with nets, but making the nets is too much work. The implication is that, if they were given nets, Efe would use them and perhaps

be willing to adopt them as their permanent hunting technique. This indicates that further research in areas where Efe archers and net hunting BaMbuti are contiguous and exploit similar areas, e.g., east of study area C where the Tswa and Efe overlap, could be productive. Also, further research in areas where villagers still own nets and lend them to BaMbuti could provide insights into the process of adoption of net hunting by BaMbuti.

CONCLUSION

Previously, the contributors to the debate concerning the distribution of hunting techniques in the Ituri have either ignored ecological constraints acting on subsistence technologies or they have invoked direct causal relationships between ecology and subsistence strategies. In the process, they have minimized the very long-standing close economic and social relationships between BaMbuti and horticulturalists, and they have neglected the significance of the diversity of women's alternative subsistence strategies. While many factors, including temporal and spatial distribution of forest resources, human population densities, and the history of contacts between cultures with different technologies, all surely contribute to the present geographic distribution of hunting techniques, we believe that, ultimately, the returns that individuals earn per unit effort will dictate their choice of subsistence strategy.

In this paper, no attempt has been made to explain the distribution of net hunting and archery in the Ituri; rather, we have shown why some BaMbuti women engage in hunting as their primary subsistence activity, while others engage primarily in exchanging their labor in villagers' gardens for food. In the process, we hope to have clarified many of the issues that have been introduced into the debate, and outlined some productive avenues for further research.

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