

## **Chapter 5**

# **Production Across the Lifespan: Age/sex Division of Labor and Wild Tuber Foraging**

### **A. Introduction**

In every human society, men, women, and children perform different tasks, and they perform them with different degrees of success. For the Mikea, age and sex division of labor is important to a household's diversified economic strategy. In the absence of a labor market, the labor performed by the men, women, and children in the household defines the quantity of resources which the household can produce, process, exchange, and consume (Chayanov 1934; Barnum and Squire 1979). This chapter explores how the residents of one Mikea community, Behisatse, allocated labor among people of different ages and sex, with specific attention paid to age/sex specific rates of wild tuber foraging.

Age and sex differences in food production are of interest to researchers of human life history (Kaplan 1997; Hill and Hurtado 1996; Kaplan et. al. 2000). Humans differ from other primates in having a long overall lifespan; a prolonged period of juvenile dependency and partial dependency; and a long post-reproductive senescent period (females). In contrast, smaller-brained quadrupedal primates experience most of their dependent phase while still in the womb; they can perform the same tasks as adults within their first year of life. Most nonhuman primate females remain reproductively capable throughout their lifespan (Charnov and Berrigan 1993; Hill 1993; Ross 1998; Hill and Kaplan 1999).

For humans, resource procurement tasks change in nature over the course of their lifespan. While other primate young can produce the same quantity as they consume within the first year of life, Kaplan (1997) has demonstrated that for three South American populations, the Machiguenga, Piro, and Ache, production does not equal or exceed consumption until about the age of 20. Kaplan et. al. (2000) have argued that forager children fail to produce at the same rate as adults because they are still learning the difficult techniques by which resources are acquired; women, in general, never learn to hunt large game because the time they have to learn such skills is curtailed by the onset of childcare responsibilities.

Bliege Bird and Bird (Bliege Bird and Bird in press, Bird and Bliege Bird in press) have argued for an alternative hypothesis. Human juveniles produce less food while foraging than adults because small physical size and strength, not learning, limits children's foraging potential. They used data and observations from marine foragers on the island of Mer (in the Torres Strait, between Australia and New Guinea) to demonstrate that because juveniles are lighter, shorter, have less strength and endurance, and travel at a slower pace than adults, they are less efficient at capturing top-ranked resources and so incorporate more low-ranked resources into their diet breadth. While juveniles may appear to be inefficient foragers from an adult point of view, youth from the island of Mer are expert foragers within the constraints set by their limited strength and size.

Research among the Hadza of Tanzania (Hawkes, O'Connell, and Blurton Jones 1995) and Ju/'hoansi (!Kung) of Botswana (Blurton Jones, Hawkes, and Draper 1994) has demonstrated considerable variation in how much foraging is performed by children in different African foraging societies. Ju/'hoansi children rarely accompany their parents to collect *mongongo* nuts whereas Hadza children frequently forage with their mothers for tubers and berries. In the Ju/'hoansi case, the travel distance from the camp (which is located near a water source) to a mongongo grove is considerable, and foragers must transport heavy loads of unprocessed nuts back to camp. Ju/'hoansi foragers are susceptible to heat stress as

they haul their take across the open savanna. Once in camp, mongongo nuts require considerable time and effort to process into food. Blurton Jones, Hawkes, and Draper (1994) have argued that the presence of children on these trips would considerably limit the distance and duration of foraging trips, and that the children's own haul of nuts would be insufficient to compensate for the loss in adult's foraging efficiency. Team rate is maximized if Ju/'hoansi children stay at camp and process the nuts their mothers have collected. Hawkes, O'Connell, and Blurton Jones (1995) have argued that, contrary to the Ju/'hoansi, Hadza children forage at a sufficient rate to offset the losses that adults incur by bringing the children with them. The Hadza foraging environment is more favorable to children's foraging effort, for travel distance to patches is low, heat stress is a minor hazard, and foraged foods are relatively easy to obtain and process.

As juveniles mature into adults, the labor of males and females becomes increasingly differentiated. Bliege Bird (1999; in press) has presented two models to explain sexual division of labor. In the "cooperative parenting model," males and females specialize in different tasks that complement one another to maximize household intake of food value and minimize the risk of food shortage. Males and females differ in the roles they adopt because of differences in potential mobility. Females must nurse fragile young and so are limited to activities that occur near camp. Females focus on gathering resources that are easy to procure and require considerable processing back at camp—usually vegetal resources. To complement the starch and fiber gathered by females, males employ their greater potential mobility to pursue high protein and fat resources such as big game. The result is a balanced diet, a monogamous pair bond, and a central-place foraging scenario. This model is a traditional one in anthropology (see for example Brown 1970) and has influenced theories for the evolution of early hominid subsistence behavior (Isaac 1978; Lovejoy 1981).

The alternative hypothesis presented by Bleige Bird (1999; in press) is that males and females within a family or household specialize in different activities because of divergent and sometimes conflicting reproductive goals of individuals. Females chose to perform those

tasks which maximize the amount and security of food available to their current offspring, or which do not limit their future physical ability to carry a pregnancy to term. These activities would include foraging for easily captured, low-variance food resources, such as plant foods. Males face a tradeoff between supplying their current offspring with resources and investing their time in foraging activities that may gain them additional mating opportunities. Men may prefer hunting large game because success at high-variance activities may “signal” good mating potential (Smith and Bliege-Bird, 2000) or function to “show off” to potential mates (Hawkes 1990, 1991), and because large game is sharable, and sharing may enhance status and create social debts. The logic of the “conflict model” is supported by natural selection theory, and the model itself comes from behavioral ecology studies of infidelity among monogamous birds (Westneat 1987; Birkhead and Pringle 1988; Davies 1992; Burley et. al 1996; Davies et. al 1992; Westneat and Sherman 1993; Whittingham and Liffjeld 1995).

At the far end of the lifespan, the long post-reproductive senescent period of human females suggests that there may have been some evolutionary advantage to menopause. In a series of papers, Hawkes and her colleagues have argued that premature menopause may have evolved among early hominids because grandmothers that focused their effort on supplying their dependent grandchildren with food realized a greater inclusive fitness than those grandmothers who invested in more, higher-risk pregnancies (Hawkes, O’Connell, and Blurton Jones 1997, 1989; O’Connell, Hawkes, and Blurton Jones 1999). In their study of Hadza foragers, post-menopausal grandmothers were found to forage for long durations and experience return rates similar to those of other adults, and to contribute to their grandchildren’s diet through cooperative provisioning.

In exploring issues such as these, anthropologists seek “natural experiments” in the form of existing variability among different foraging societies. The Mikea differ from previously-studied hunter-gatherers in that (1) there is no large game for them to hunt; (2) the most important foraged resource, wild tubers, grow in sandy soil and are easily and efficiently gathered by all age groups; and (3) there are no large predators to threaten

foraging children. Herein I explore the time allocation and wild tuber foraging rates of various age/sex groups at Behisatse. In the absence of large game I discover that Mikea men specialize on small game which is not shared and not advertised to the rest of the camp members. In an environment where tubers grow near human habitation sites and in sandy soil, I find very little overall variation in tuber return rates among individuals of different age/sex groups. Foraging efficiency tends to increase with age, and females tend to forage at lower rates than males of the same age class, perhaps due to differences in physical size among other factors. In the absence of predators I find that juveniles are efficient foragers who can potentially produce the same number of calories as they consume at a very early age, considerably earlier than the Piro, Machiguenga, and Ache examples used by Kaplan (1997). Age-sex specific patterns of food production among the Mikea deviate from those previously reported, and suggest that there may have been variation in the effects of food production on the evolution of human life history.

## **B. Field Methods**

### **1. Time allocation**

Scan-sampling (spot check) time allocation methodology (see Borgerhoff Molder and Caro 1985) was performed at the Mikea Forest camp of Behisatse during nine different months from 1996 to 1999. Table 5.1 lists the months and days during which observations were performed.

Observation times (sampling events) were scheduled twice or three times a day, during daylight hours. Observation times were selected randomly and scheduled at the beginning of each month. We sampled each half hour increment twice during the course of 19 to 24 days. During the long days of the summer months, the range of observation times was 6:00 to 18:30; during winter months, the earliest possible observation time was 6:30 and the latest 18:00. Thus, we sampled at either 48 or 52 times during 19 to 24 days for each sampled month.

Table 5.1: Summary of time allocation project at Behisatse

Month&year	Dates	# days	# observation times	# data points	average population <sup>a</sup>	season
Jul 1996	Jul 7-15, 19- Aug 3	24	48	total:2245 A-C: 1129	23.19	<i>Asotre</i> (cool, dry)
Nov 1997	1-10, 14-18, 20-28	24	52	total: 2187 A-C: 1340	21.38	<i>Faosa</i> (hot, dry)
Jan-Feb 1998	Jan 8-15, 22-29; Feb 7,8, 14	19	52	total: 2187 A-C: 1419	23.54	<i>Litsake</i> (hot, wet)
Mar 1998	5-10, 12-16, 21-29	20	52	total: 2747 A-C: 2005	36.30	<i>Fararano</i> (warm, dry)
May-Jun 1998 <sup>b</sup>	May 16-18, 21-28; Jun 2-4	14	38	total: 2100 A-C: 410	6.0	<i>Asotre</i> (cool, dry)
Jul 1998	Jun 30-Jul 2, 8-14, 16-20, 24-28, 30-Aug 1	22	48	total: 2243 A-C: 1072	17.15	<i>Asotre</i> (cool, dry)
Oct 1998	6-26	20	48	total: 2238 A-C: 873	12.88	<i>Faosa</i> (hot, dry)
May 1999	9-17, 20-30	20	48	total: 2121 A-C: 1162	16.67	<i>Fararano</i> (warm, dry)
Jul 1999	Jun 27-Jul 17	21	48	total: 2173 A-C: 890	12.19	<i>Asotre</i> (cool, dry)
TOTAL				total: 20,241 A-C: 10,400		

Notes:

a. The average number of people (residents and visitors) present at a camp at each observation time (those coded as category D, "not based at Behisatse," excluded).

b. The Behisatse camp was temporarily abandoned during April and May of 1998 following crop loss and witchcraft accusations. Time allocation project during May was conducted at the goat camp adjacent to Behisatse's well instead, where several Behisatse households resided. Data from this month are not included in this chapter's analyses.

The great challenge of doing a time allocation study of mobile people is how to sample so that the data can speak of the diversity of activities and locations that the subjects use, when the observer is limited to a single site that may have a specific function. For example, if one were to limit his or her observations to activities at a small camp in the thorny forest where the ground is too sandy for agriculture and where hunting and gathering are the only productive activities possible, then the data would report frequencies of various foraging activities but would say nothing about how much time the same individuals may spend engaged in slash-and-burn agriculture or fishing. One would know how time is allocated to different activities *at this site*, but relatively little about how time is allocated by these households in general. In the case of Behisatse, which is located deep in the dense deciduous forest, most households used this site seasonally for slash-and-burn maize cultivation, foraging, and goat herding while spending significant periods of time in other villages such as Bevondro and Namonte. A time allocation study limited to Behisatse would describe maize agriculture, foraging, and herding activities but could not tell us how much of the subject's yearly time was budgeted to manioc cultivation or visiting relatives back home.

Therefore, I employed a system by which I coded the location and activities of some people who were absent from Behisatse, as well as those who were actually present. At the beginning of a sampling month I would discern through conversation with people at Behisatse, the current location of other probable Behisatse residents and when they were likely to return. Eight households spent a significant portion of the year based at Behisatse. These households consisted of 47 individuals at the beginning of the study, and, through marriage and birth, 50 individuals at the end of the study. At each observation time we recorded the name, location, and activity of people in the following categories:

- (A) All the people currently within the Behisatse camp itself, which included visitors, part-time residents, and some members of the 8 focal households.

- (B) Those people currently staying at Behisatse (visitors, part-time residents, and members of the focal households) who were doing some activity outside of camp, in the general environs of Behisatse.
- (C) Those people currently “based” at Behisatse but who have left Behisatse for a short period of time and for a specific purpose.
- (D) Finally, at the end of the study, for each observation time I added an entry for each individual in the eight focal households that were not already included in (A), (B), or (C). Although their activities and location at the observation time were unknown, in each case I knew where the household was “based.” Because certain activities are specific to certain locations, in many cases I can make educated guesses about work activity for these people during these sampling events.

Therefore, by making these four categories of observations, this dataset represents a complete sampling of the allocation of time by Behisatse people between different sites as well as the time allocation within the area of the camp itself. Observations from these categories decrease in resolution from A to D. For the analyses in this paper I have excluded category (D) cases because the resolution is too coarse to reflect differences in activities of individuals of different age/sex classes. When households were not based at Behisatse, usually all household members were absent, including males, females, young, and old.

## 2. Foraging log

During eight of the nine months during which I collected time allocation data I also maintained a daily “foraging log” that included the following information: the times that foragers left camp and returned to camp, the type and weight of the products they captured, and the names of the foragers. Times were measured to the nearest minute, and weight was

measured with a spring scale to the nearest 100 g. The majority of entries in this foraging log pertained to collection of two species of wild tuber, *ovy* and *balo* (*Dioscorea acuminata*). These data are used to calculate return rates (Kg/person hr) and Net Acquisition Rate (NAR: net kcal/person hr) for foraging individuals and groups.

Complications to this method included (a) separating out individual from pooled returns; (b) the social obligation to share that the methodology itself invited; (c) and knowing how much of the time away from camp was dedicated specifically to digging tubers as opposed to other activities such as taking rest and snack breaks.

(a) In some cases, foragers pooled their returns before returning to camp. This occurred especially when there were great disparities between the returns of different foragers, presumably to equalize the weight of tubers for transport among all present (but also a *de facto* intragroup food transfer or “sharing” method). In ambiguous cases, I recorded group rather than individual rates. In analyses of individual’s foraging rates, these group rates are excluded from analysis.

(b) Often, foragers attempted to hide their foraging production from everyone else in camp, to avoid the obligation to share, what Peterson (1993) calls “demand sharing.” The unwritten rule seems to have been that any resource that was publicly visible was open to demand-sharing while food hidden from view, even if not hidden from sound or smell, was exempt (see Chapter 6). When I asked to see and weigh what people had captured, they often misinterpreted this action as a request for their generosity. Despite our numerous explanations to the contrary, our weighing of products was often followed immediately by the subject giving a part of their take to us. For tubers this was relatively unproblematic, for tuber returns were usually ample enough that sharing caused the foragers little difficulty—and they allowed me to reciprocate the gesture after some delay with rice, coffee, beans, tobacco, sugar, or peanut butter. For small game resources this was more problematic. Small game was difficult to share, both because it could be easily divided and because these small packets of protein and fat were extremely valuable to the local diet, which was otherwise

dominated by starchy staples, especially maize, manioc, and wild tubers. Foragers who caught animals would often return after dark or from an unusual direction and immediately stash their game inside their house so that I (and other meat-starved Mikea) could not demand share (I discuss sharing and sharing-avoidance behaviors in greater detail in the next chapter).

As a result, this dataset accurately represents tuber return rates but is an incomplete record of return rates for other types of foraged products. Only return rates for wild tubers will be discussed here. This problem did not, however, affect the frequency with which I recorded foraging for game in the scan-sampling time allocation data set, for here I relied on informant reports of the nature of game sought and captured rather than observation of the returns.

(c) The “foraging log” method assumes that all the time spent between departure and arrival is productive foraging time, and that none of the foraged products were consumed before return to camp. This assumption may have been invalid for long-duration foraging trips, during which foragers may have taken a break to roast and consume part of their take. For children this is especially likely. During times of food shortage such as occurred during July 1998, adults foraged all day long and at a considerable distance from camp, leaving children at home, hungry and bored. These children sometimes spent two or three hours away from camp “foraging,” but would have in fact spent half that time cooking tubers and eating them. If invisible “snack breaks” have compromised the accuracy of these data via a consistent underestimation of acquisition rate during long duration foraging trips, then we would expect acquisition rates to be lower for long duration trips. I explore this prediction below.

The final dataset contained 102 tuber foraging observations. Behisatse residents foraged for tubers during trips that lasted 60 to 710 minutes (mean = 300 minutes, sd= 141), in groups of 1 to 7 foragers (mean= 2.6, sd=1.8).

### 3. Age classification

The people of Behisatse were illiterate and could not recall their ages. Most adults carried national identification cards that listed their approximate age, but in some cases these estimates were obviously unreliable. I classified subjects into broad age categories using the following guidelines. In the field, our team constructed an age-rank order list. I then divided the list into the following categories: Dependent, Juvenile, Young Adult, Adult, and Old Adult according to behavioral criteria (see Table 5.2). Dependents, including infants and toddlers less than about 5 years old, depended upon their mothers or other caregivers. Dependents cried a lot, required constant supervision, and did not perform any work tasks. Juveniles (ages approximately 5 to 13 years old) spent most of their time with other juveniles rather than with caregivers. Groups of juveniles went on foraging jaunts or to the well without adult supervision. The young adult period began at roughly age 13 or 14, when children became sexually active (gossip ensured that this event was impossible to miss) and began speaking of marriage. Young adults of both sexes usually tried to distance themselves from juveniles and they disdained childcare activities; they owned some of their own means of production (fields, livestock), and often traveled great distances in the forest alone in search of opportunities for financial gain and romance. The line between young adult and adult was clearly drawn by marriage, which in all cases considered here occurred in the late teen years. I distinguished old adults from adults by the presence of grandchildren.

In some of the time allocation analyses I have lumped young adults, adults, and old adults into a single “adult-inclusive” category. This is because observations of young adults and old adults are based on repeated sampling of the behavior of very few individuals. Even

Table 5.2: Age classification summary

Approximate age range	Classification	
0-4	Dependent	
5-12	Juvenile	girls / boys
13-18	Young adult	
19-54	Adult	women / men (adult inclusive)
55+	Old adult	

if statistical differences were to be found among these age groups, the differences may describe the idiosyncratic behavior of those individuals rather than to represent the general trend for the age/sex group as a whole. When lumped, I will refer to young adult females, adult females, and old adult females collectively as “women” and their male counterparts collectively as “men,” and to juveniles as either “girls” or “boys” (see Table 5.2).

### **C. Age and sex division of labor**

#### **1. Time allocation**

Table 5.3 summarizes time allocation for all age/sex groups. Values in this table are displayed as percent of total time spent based at Behisatse (category A, B, and C observations). Observations of non-resident visitors and category D observations were excluded from analysis.

To discover which of the apparent differences in time allocation were statistically significant, I used multiple chi square tests to make pairwise comparisons between each possible pairing of age/sex groups, for each activity. Table 5.4 displays the results of this analysis. Because the overall number of observations for each age/sex category were large and the individual activity categories were each quite broad, the chi square test was overly sensitive to differences. To counteract the hypersensitivity of these tests, I considered significant only those differences less than .001.

Overall, most people spent most of their time engaged in “leisure” activities, a category that included all social and individual activities that are not directly involved in production. Social activities included chatting, social grooming, playing musical instruments, playing dominoes, listening to cassettes, playing games, caring for ill people, and religious/spiritual activities. The category “researcher-social” is time spent in social activities involving the researcher. I included this category because the presence of researchers in a community could result in an artificial increase in social activity. Individual

Table 5.3: time allocation by age and sex at Behisatse (as percent of time spent based at Behisatse)

	Juevniiles		Young Adult		Adult		Old Adult	
	female	male	female	male	female	male	female	male
<b>In-camp and near camp production</b>								
Hatsake fieldwork	0.55	1.32	1.88	2.32	2.01	3.32	2.93	7.83
Foraging	10.45	12.14	16.54	13.47	14.38	13.17	16.22	3.03
Weaving	0.07	0.00	0.38	0.00	2.30	0.00	8.56	0.00
<b>Away from camp production</b>								
Away for hatsake work	4.57	4.28	0.00	5.26	6.71	8.82	0.00	0.00
Away foraging/fishing	2.77	3.97	0.00	15.79	8.34	9.34	4.50	0.00
Away for Manioc	1.38	2.26	1.13	13.89	3.93	4.56	5.41	9.34
Away for Wage Labor	2.77	0.39	0.00	0.00	0.00	10.27	0.00	0.00
<b>Processing</b>								
Maize processing	1.52	1.25	1.88	0.63	1.25	0.62	2.25	3.03
Meal preparation	4.64	2.26	10.90	0.63	11.70	0.93	10.81	1.52
<b>Household maintenance</b>								
Childcare	0.69	0.23	0.38	0.00	3.07	0.21	1.35	0.00
Goat herding	0.35	5.37	0.75	5.05	0.86	3.01	0.00	2.78
Other livestock	0.07	0.23	0.75	0.42	0.19	0.41	0.00	1.01
Housework	4.84	3.74	13.16	2.95	5.18	3.84	9.01	5.81
Manufacture/repair	0.14	0.70	0.00	0.21	0.77	1.76	1.80	7.07
<b>Leisure</b>								
Individual	22.01	20.70	20.68	10.95	17.26	11.41	14.86	24.49
Social	34.74	30.27	13.91	12.21	10.55	13.28	11.94	14.39
Researcher-social	3.39	3.04	0.75	0.84	0.58	1.24	0.00	2.53
<b>Other</b>								
Away to conduct market exchange	0.35	1.40	4.14	0.84	1.25	1.35	0.45	1.01
Away to conduct non-market exchange	0.14	0.16	2.63	0.63	0.00	0.21	1.35	0.00
Away from camp for other reason	3.04	2.57	5.64	9.05	4.03	7.68	6.98	13.38
Other	1.52	3.74	4.51	4.84	5.66	4.56	1.58	2.78
<b>TOTAL</b>	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 5.4: Statistical comparison of time allocated to different activities by age/sex groups. Each comparison was made with a separate chi-square test.

Results of Chi-Square comparisons (based on Fisher's exact test 2 sided values)

	Pearson chi sq	Asymp. sig. 2-sided	girls-boys	girls-women	girls-men	boys- women	boys-men	women-men
<b>In-camp and near-camp production</b>								
Slash-and-burn maize field labor	52.156	0.000	<	<	<	-	<	-
Foraging	20.667	0.000	<	<	-	-	-	>
Weaving	161.212	0.000	<	<	-	<	NA	>
<b>Away from camp for production</b>								
Away for slash-and-burn maize work	9.206	0.027	-	-	-	-	-	-
Away foraging/fishing	67.269	0.000	<	<	<	-	<	-
Away to tend or transport manioc	107.737	0.000	<	<	<	-	<	-
Away for wage labor	143.038	0.000	>	>	<	-	<	<
<b>Processing</b>								
Maize processing	2.078	0.556	-	-	-	-	-	-
Meal preparation	234.073	0.000	<	<	>	<	-	>
<b>Household maintenance</b>								
Childcare	57.176	0.000	-	<	-	<	-	>
Goat herding	108.984	0.000	<	-	<	>	-	<
Other livestock	7.053	0.070	-	-	-	-	-	-
Housework	28.034	0.000	-	-	-	<	-	>
Manufacture/repair	45.663	0.000	-	-	<	-	<	<
<b>Leisure</b>								
Individual	41.413	0.000	-	-	>	-	>	-
Social	393.186	0.000	-	>	>	>	>	-
Researcher-social	47.227	0.000	-	>	>	>	-	-
<b>Other</b>								
Away to conduct market exchange	10.937	0.012	-	-	-	-	-	-
Away for non-market exchange	11.327	0.010	-	-	-	-	-	-
Other	93.234	0.000	-	<	<	-	<	<

- no significant difference
- < significant at .001; the second group had a greater frequency than the first
- > significant at .001; the first group had a greater frequency than the second
- NA both groups being compared have frequency of zero

activities included rest, sleep, eating, urinating, defecating, smoking, or recovery from illness. Adults enjoyed significantly less leisure time than did children in many cases.

The most time consuming work activity for all age/sex groups was foraging. Foraging occupied 174 percent more time than did swidden maize agriculture for men, 583 percent more time than maize for women, and 1800 percent more time than maize for girls.

All age/sex groups spent about the same amount of time foraging—over 10 percent of their total daylight time. According to Table 5.4 women spent significantly more time foraging than did girls or men. The difference between men and women may be illusory, however, because the adult-inclusive male category contains one outlier, the single old adult male in this study. This grandfather has a particular preference for agricultural labor and a dislike of tuber foraging which may not represent the preferences of Mikea grandfathers in general. If we exclude him from the category and perform the chi square test again, there is no significant difference between men and women (Fisher's exact 2-tailed sig. = .128), or between men or women and boys. Only girls spent significantly less time foraging, although this difference is quite small.

In addition to foraging, women occupied their work time with meal preparation and weaving. The strongest significant differences of any work category were here: women spent significantly more time preparing meals than all others. Also, girls spent significantly more time preparing meals than boys, suggesting that the socialization of this gender division begins at an early age. The most physically demanding activity in the food preparation category was pounding a staple—maize, rice, dried manioc, or more rarely dried *ovy*—in a mortar. All age/sex groups help out with this activity, but it is still more likely to be practiced by women.

Weaving was almost entirely done by females; the dataset contained no observations of men or boys practicing this activity. Only once in 19 months did I see a man work on weaving a mat, and that was to help his wife during a family emergency when the household was forced to leave camp suddenly to attend to matters elsewhere in the forest.

Agricultural field activities appear to have been most often performed by men. Men devoted 81.5 percent more time to swidden maize agriculture than did women. This difference was not statistically significant at  $> .001$ , but Fisher's exact 2-tailed significance equaled  $.001$ . Swidden field labor was a minor activity for children.

There were no significant differences in time spent processing maize among the age/sex groups. This activity occupied 1.14 to 1.60 percent of everyone's time. Maize processing tasks, which included dehusking, degrading, and bagging, were a social activity often conducted in public space to which anyone (including dependents, children, visitors, and researchers) lent a hand and joined into conversation.

Manioc field labor showed the same gender pattern as maize field labor. Manioc was cultivated at the village of Bevondro, 11 km distant. Men spent more time than any other age/sex group away from Behisatse to tend manioc. Men spent 109 percent more time than women away from camp to tend manioc, but this difference was not significant; differences between men versus boys or versus girls were significant. The sexual division of labor here is even more extreme than these numbers indicate. Time that men spent at Bevondro was mostly devoted to weeding, whereas much of the time spent by women, boys, and girls was devoted to transporting manioc back to Behisatse for consumption. People of all ages and sexes participated in the manioc harvest that I witnessed in November of 1997.

Wage labor included two types of work targeted specifically at different age/sex groups. Chopping new swidden cornfields in the forest was an activity that attracted men and a few boys. Girls were employed in the agricultural village of Basibasy to perform the tedious task of replanting rice shoots. Men spent considerably more time away from camp to clear new swidden fields than girls did replanting rice.

The primary task involved in goat herding occurred each morning, when the adult goats voluntarily left camp to forage and their nurslings had to be forcibly restricted from following the rest of the herd. Nurslings accompanying the herd would have been unable to keep up with the pace of the adult goats as they foraged. The task of separating nurslings

from the rest of the herd involved running and great spurts of energy; an optimal task for juveniles (Thomas 1973). The task was performed significantly more often by boys than by girls. Men also concerned themselves with goats significantly more often than did women. Tasks performed by men included leading goats to the well to drink and castration..

Childcare activities are easily underreported in scan-sampling time allocation studies; the problem results from how one codes the activities of a subject who is involved in two activities simultaneously (Borgerhoff Mulder and Caro 1985:327-328). Childcare is very often practiced at the same time as meal preparation, maize processing, weaving, or some other work activity. In this study, I assigned the childcare code only if the subject was doing nothing other than childcare. My impression was that women and girls are most often responsible for dependents, but that this is not an exclusively female task.<sup>1</sup>

In sum: women occupied their time with foraging, meal preparation, and weaving. Men foraged as often as did women, but invested more time in agricultural field labor and wage labor and rarely prepared meals. Children occupied their days with significantly more leisure time than adults, but interestingly, they spent about the same time foraging; children rarely did agricultural field labor. Girls earned extra cash by replanting rice, and boys spent their early morning hours herding goats. There was considerable overlap between the work of adults and children, males and females. In very few cases did an age/sex group not participate at all in an activity—although males never wove mats or baskets, and women were never away from camp to do wage labor.

## 2. Time allocation to foraging activities

Foraging was the number one work activity for everyone at Behisatse, so it is worth examining age/sex differences in time allocation to specific foraging tasks. In most foraging societies, males specialize in high-risk, difficult resources such as big game whereas females

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<sup>1</sup> I hope to address the childcare issue in a future analysis through an examination of the location of dependents at observation times and the proximity of potential caregivers.

specialize in low-risk, easily captured resources with high processing time such as vegetal foods (Bliege Bird 1999). In the Mikea case there is no large game, and processing time is low for most resources. To determine if these conditions have affected the division of foraging labor, I performed the same analysis as above on the individual activities that composed the “foraging” activity category (see Table 5.5).

First, it should be noted that the most time consuming foraging activity for girls, boys, and women was digging tubers, and it occupied 71 percent, 62 percent, and 65 percent of the total foraging time respectively. Men are the only exception, and spent only 32 percent of their time in pursuit of tubers, which is 103 percent less than females. For men, pursuing animals took priority, and occupied 54 percent of the time they allocated to foraging, significantly more than any other age/sex group. Women also pursued animals (2.74 percent), at about the same frequency as boys (2.80 percent).

Honey foraging was solely an adult activity with no significant difference between men and women. Honey foraging appears in Table 5.5 to be a very rare activity, but this is false because most honey foraging trips lasted over several days and are classed under “away foraging/fishing” (see Tables 5.3 and 5.4). Children probably did not engage in this activity because they lacked the stamina and independence necessary for foraging trips of this duration. Honey foraging requires a lot of skill as well, both to locate hives and to extract honey without being stung too many times.

Examination of time spent away from camp foraging and fishing (Table 5.4) shows no significant difference between men versus women, although adults in general spent more time at this than did juveniles. A few times, two or three men left camp for four days or so to pursue *tambotrike* or *tandrake* during their hibernation season, and once a small party of women went to a lake for a week to fish. But in general, household heads left camp to forage together, bringing only those older juveniles who could keep pace and leaving younger juveniles and dependents behind, often in the care of grandparents. Long-distance foragers would often concentrate on a single resource, such as tubers, *tambotrike*, or freshwater fish.

Table 5.5: Foraging activities: Statistical comparison of time allocated to different activities by age/sex groups

	Pearson chi sq	Asymp. sig. 2-sided	Results of Chi-Square comparisons (based on Fisher's exact test 2 sided values)							
			girls-boys	girls- women	girls-men	boys- women	boys-men	women- men		
Tubers	56.898	0.000	-	-	>	-	-	>	>	
Fruits and melons	16.974	0.001	-	-	-	-	-	-	-	
Animals	63.225	0.000	<	<	<	-	<	<	<	
Honey	33.243	0.000	NA	<	<	<	<	<	-	
Grasshoppers	10.543	0.014	-	-	-	-	-	-	-	
Eggs	7.223	0.065	-	-	-	-	-	-	-	

- no significant difference
- < significant at .001; the second group had a greater frequency than the first
- > significant at .001; the first group had a greater frequency than the second
- NA both groups being compared have frequency of zero

There were no significant differences between age/sex classes in the frequencies of foraging for eggs, grasshoppers, or fruits and melons, and all these activities were extremely rare.

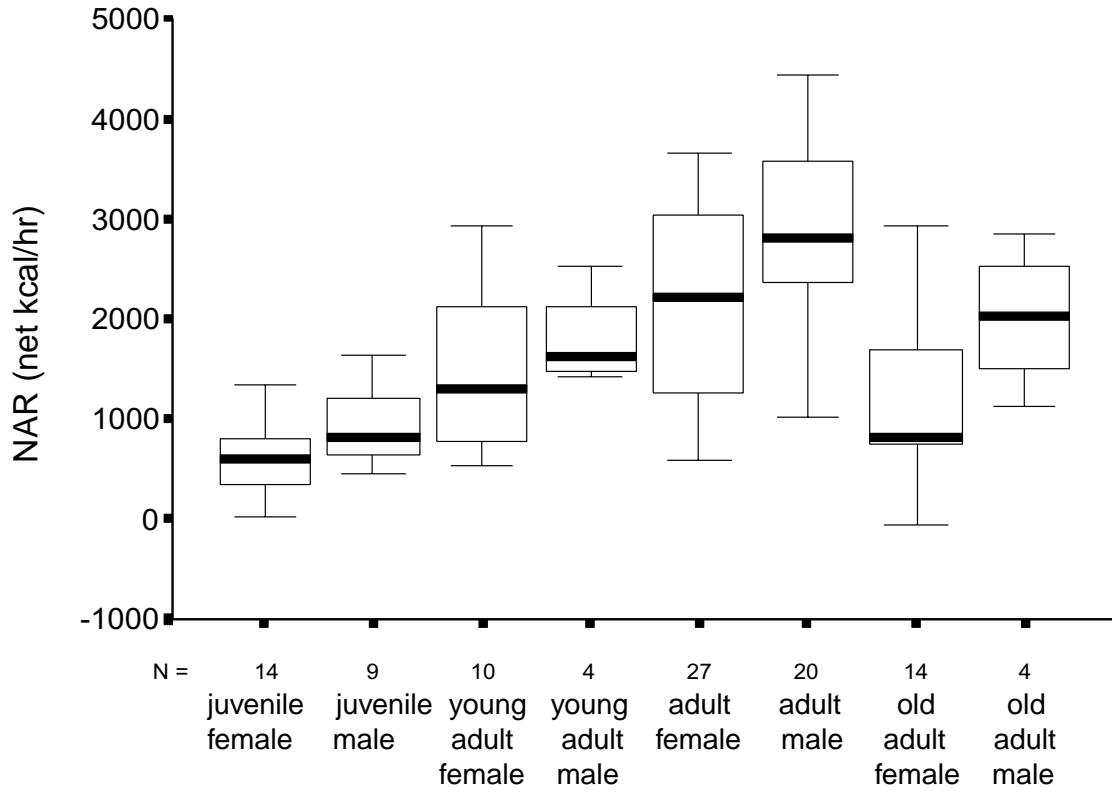
In conclusion, even in the absence of large game, males tended to specialize in animal resources rather than plant resources although women also spent important amounts of time pursuing animals. Tuber foraging was clearly the most important foraging task, and so it is worthwhile to continue this exploration of age/sex differences in labor by examining the age/sex specific rates at which tubers are excavated.

#### **D. Age and sex differences in tuber foraging rates**

##### **1. Analysis and results**

To explore age and sex differences in tuber foraging rates, I performed a one-way analysis of variance (ANOVA) on the dataset containing individuals' return rates for wild tubers ( $n=102$ ). The dependent variable was net acquisition rate (NAR, net kcals gained per hour). The factor variable was age/sex group, this time without lumping age categories. The results are displayed in Figure 5.1. The ANOVA revealed the existence of significant differences in the tuber foraging return rates of the different age/sex classes ( $F=9.871$ ,  $df=101$ ,  $p=.000$ ). A Tukey post-hoc test revealed which differences were significant. Adult females were significantly more efficient foragers than juvenile females ( $p=.000$ ) and old adult females ( $p=.000$ ). Adult males were significantly more efficient than juvenile females ( $p=.000$ ), juvenile males ( $p=.000$ ), young adult females ( $p=.002$ ), and old adult females ( $p=.022$ ).

This analysis revealed two trends. First, foraging efficiency increased with age until adulthood, and then decreased again for old adults. Second, for each age group, males tended to forage at a higher rate than females, and the difference between male and female return rates increased with age. The first trend is more robust and is supported by the pattern of significant differences visible in the Tukey-post hoc test. The second trend is also



ANOVA SUMMARY:

df = 101  
 F = 9.871  
 sig = .000

Tukey post-hoc pairwise comparisons:

juv male							
YA female							
YA male	**						
adult female	**	**	*				
adult male							
OA female					*	**	
OA male							
	juv female	juv male	YA female	YA male	adult female	adult male	OA female

\* significant at < .05  
 \*\* significant at < .001

Figure 5.1: Age/sex differences in tuber foraging efficiency-- results of oneway ANOVA

interesting to explore, but because no sex differences within a particular age group differ significantly, this trend may not represent an important difference in the lives of these foragers.

How can we explain these age/sex trends in tuber foraging efficiency? I consider the following hypotheses (or combinations thereof):

(a) The differences may have been due to the presence of dependent children, including nursing infants and needy toddlers, who retarded the progress of their foraging caregivers—who were more likely to be juveniles and females.

(b) The differences could have been related to the presence of juvenile foragers in the foraging group. Young adult and adult females, as well as old adults of both sexes may have experienced lower return rates because they were more likely to forage in groups that included foraging juveniles who, through their social and educational needs, reduced the foraging efficiency of the accompanying adults.

(c) Differences could have been due to the size of the foraging group. Age/sex groups with lower NAR values may have tended to forage in larger groups, where social activity and diminishing marginal productivity of labor resulted in a lower average return rate. Adult males may have tended to forage in smaller groups or alone.

(d) Differences could have been due to the duration of the foraging event. Age/sex groups with lower NAR values may have tended to forage for longer periods of time, during which they suffered diminishing marginal returns over time. Adult males may have tended to forage for shorter durations. Plus, it is possible that longer-duration foraging events actually had higher NAR than was calculated here, if foragers were taking “snack breaks.”

(e) Different age/sex categories may have varied according to how much opportunity cost the foragers incurred by spending time searching for wild tubers. Perhaps, for example, old adult females were not motivated to be time-efficient because they had no better use for their time. Perhaps they’d rather have spent as much time away from camp as possible, to

avoid such household maintenance tasks as childcare and food preparation.

(f) The age/sex differences may represent differences in foraging ability related to learning (Kaplan et. al., 2000).

(g) The age/sex differences may represent differences in foraging ability related to physical strength or size (Bleige Bird and Bird, in press; Bird and Bleige Bird, in press).

## 2. Hypotheses (a), (b), (c), and (d)

The first four hypotheses are each associated with a number of individual predictions that I explore here, because they reveal interesting details about tuber foraging (Table 5.6). Then, I test the importance of these hypotheses in explaining the overall trends in age/sex specific tuber foraging rates using a regression analysis.

**Hypothesis (a):** At first glance, the hypothesis that age/sex differences in task group performance are the result of the presence of dependent children, is a very attractive explanation—especially considering traditional anthropological explanations for the evolutionary origins of division of labor in which women’s foraging efforts are thought to have been constrained by childcare responsibilities. However, upon examination (and to my own surprise), I found that in the majority of cases, mothers did not bring their dependents with them on foraging trips. In a dataset of 119 foraging groups, in only 14 (11.76 percent) were dependents present (eight groups had one dependent, five groups had two dependents, and only one group had three dependents).

As expected, females were more likely to forage in a group accompanied by dependents than were males. However, a chi square test showed that these differences were not significant. Men foraged in groups that contained dependents only 2 percent of the time; women foraged with dependents 5.9 percent of the time (Pearson chi-square = .477, Fisher’s exact 2-sided significance = .707). Only juvenile females, adult females, and adult males ever foraged in groups that included dependents, so this variable alone cannot explain the age-related trends in tuber foraging efficiency. Grandmothers never foraged with

Table 5.6: Testing predictions of hypotheses a-d

Prediction	Test	Significant result?
a. presence of dependents reduces the NAR of some age/sex groups		
1. age/sex groups with lower return rates should tend to be accompanied more often by dependents.	Chi square, presence of dependents by sex (excluding juveniles)	No. Pearson's chi sq.= .477 Fisher's exact 2-tailed sig =.707.
2. individuals foraging in groups that include dependents should have a lower NAR than individuals that forage without dependents	T-test, NAR with dependents vs. without	Yes. t= 12.63 2-tailed sig= .010
b. presence of foraging juveniles reduces the NAR of some age/sex groups		
1. age/sex groups with lower return rates should tend to be accompanied more often by juveniles.	Chi square, presence of juveniles by sex (excluding juveniles)	No. Pearson's chi sq.= 1.90 Fisher's exact 2-sided sig =.214
2. individuals foraging in groups that include juveniles should have a lower NAR than individuals that forage without dependents	T-test, NAR with juveniles vs. without	No. t= .449 2-tailed sig= .655
c. some age/sex groups tend to forage in larger groups, and thus suffer diminishing marginal returns on labor		
1. There should be statistically significant differences between age/sex groups and group size	Oneway ANOVA, group size by age/sex	No. F= 1.27 sig= .274
2. There should be a negative, significant correlation between group size and NAR	Correlation, group size by NAR	No. Pearson's R = -.082 2-tailed sig= .414
3. People foraging alone should have higher NAR than people foraging in groups	T-test, NAR of people foraging alone vs. in a group	Yes. t= -2.595 2-tailed sig= .010
d. some age/sex groups tend to forage for longer periods of time, and thus suffer diminishing marginal returns on time		
1. There should be statistically significant differences between age/sex groups in foraging duration	Oneway ANOVA, duration by age/sex	Yes. F= 2.878 sig= .009
2. There should be a negative, significant correlation between duration and NAR	Correlation, duration by NAR	Yes. Pearson's R = -.325 2-tailed sig= .001

dependents, so the unusually low NAR of grandmothers is not explained by presence of dependents.

A t-test comparing the NAR of individuals foraging in groups with dependents versus individuals foraging in groups without dependents found the latter group to have significantly greater average NAR ( $t = -2.63$ , 2-tailed  $p = .010$ ). However, these differences may have been caused by other covariate factors, such as group size or duration effects. Groups containing dependents tended to be larger and tended to forage for shorter periods of time. Groups without dependents had a mean size of 2.2 members ( $sd = 1.3$ ), whereas groups with dependents tended to be a bit larger at 3.1 members ( $sd = 1.6$ ), and a t-test revealed these differences to be significant ( $t = -2.4$ , 2-tailed  $p = .02$ ). Groups without dependents had a mean duration of 303 minutes ( $sd = 152.4$ ) and groups with dependents had a mean duration of 201 minutes ( $sd = 124.2$ ) and these differences were also significant ( $t = 2.403$ , 2-tailed  $p = .018$ ).

**Hypothesis (b):** This hypothesis assumes that females, younger adults, and old adults were more likely to forage in groups that included juveniles, and then asserts that the presence of juveniles in the foraging group depressed the NAR of the non-juveniles in that group. This appears to be the case for Hadza foragers, where mothers tolerate a depression of their own acquisition rates caused by the presence of juvenile foragers, but the juvenile's own returns compensate for the loss (Hawkes, O'Connell, and Blurton Jones 1995). A chi-square test of sex (men or women) versus presence or absence of juveniles in the foraging group failed to confirm that females were more likely to forage with juveniles than were males. Young adult, adult, and old adult females foraged in groups containing juveniles 31 percent of the time whereas males foraged with juveniles 13 percent of the time. The difference is not significant (Pearson chi-square = 1.9, Fisher's exact 2-sided sig. = .214).

In order to examine whether some age/sex groups were more likely to forage with accompanying juveniles than others, I ran a one-way ANOVA of number of juveniles in a foraging group by age/sex group. I found no significant differences—young adults, adults,

and old adults of both sexes tended to forage with accompanying juveniles at a similar frequency ( $F= 1.080, p = .379$ ).

A t-test comparing the NAR of adults foraging in groups that included juveniles versus adults foraging only with other adults found no significant difference ( $t= .449, 2$ -tailed sig. = .655). Thus, the data do not indicate that the presence of juveniles in a foraging group depresses the NAR for non-juveniles in the group.

**Hypothesis (c) :** This hypothesis predicts a negative correlation between group size and NAR, caused by diminishing marginal returns on labor or “too many cooks in the kitchen.” People forage to pursue social goals as well as prey. People forage together as a sign of friendship, to get away from social obligations or work obligations in camp, or to have a chance to exchange gossip out of ear shot of their fellow camp members. Groups of foraging children spend a great deal of time playing and exploring during their foraging time. On one focal follow with a group of juveniles, the boys started a food fight with the girls, and over 2 kg of *ovy* were destroyed in the ensuing volley.

To find out if there was a tendency for females, juveniles, young adults, and old adults to forage in larger groups compared to males and adults, I ran a one-way ANOVA of group size by age/sex group. The test found no significant differences between any age/sex groups in number of team members ( $F=1.27, p = .274$ ). Members of each age/sex group tended to forage in similarly-sized groups.

The predicted negative correlation between group size and NAR also was not demonstrated. A correlation of the two variables found no significant correlation (Pearson’s  $R= -.082, 2$ -tailed  $p = .414$ ). However, a t-test comparing the NAR of foraging alone (group size = 1) versus foraging in a group found that people foraging alone experienced a significantly higher NAR ( $t= -2.595, sig. 2$ -tail = .010).

**Hypothesis (d):** This hypothesis predicts a negative correlation between foraging duration and NAR. Foragers may experience diminishing marginal returns over longer periods of time, due to fatigue and patch depletion. Duration is a tricky variable here for it

may actually cover multiple conditions. A long foraging duration could indicate that foragers traveled a great distance—in which case they may have traded off travel time for higher in-patch return rates. However, long durations could also represent intense foraging efforts close to camp. As predicted, the correlation between NAR and duration is negative and significant (Pearson's  $r = -.325$ , 2-tailed  $p = .001$ ). Longer duration-foraging trips were indeed associated with lower NAR values.

To find out if there was a tendency for females, juveniles, young adults, or old adults to forage for longer periods of time than males and adults, I ran a one-way ANOVA of duration by age/sex group. The test confirmed the existence of significant differences in foraging duration between age/sex groups ( $F=2.878$ ,  $df=101$ ,  $p = .009$ ). A Tukey post-hoc test revealed that old adult females foraged for significantly longer periods of time than juvenile females, adult females, and adult males, although no other duration differences were statistically significant. Duration may not explain the entire age/sex trend in tuber foraging returns, but it may help to explain why grandmothers experienced such paradoxically low acquisition rates.

**Hypotheses (a), (b), (c), and (d):** What importance did these four variables—number of dependents in foraging group, number of foraging juveniles in group, group size, and duration—play in determining the age/sex trends in tuber return rates identified above? To find out, I ran a linear regression for each of these variables against NAR, and a regression of all four variables by NAR. The results are summarized in Table 5.7. The  $R^2$  value indicates the percent of the total variance in NAR accountable by each variable. Number of dependents accounted for only 7.4 percent of the variance; number of foraging juveniles accounted for 4.4 percent; group size accounted only .7 percent, and duration accounted for 10.5 percent. Together, they accounted for only 17.2 percent of the variance in NAR, leaving 82.8 percent of the variance unexplained.

Are the age/sex trends identified above contained within the 17.2 percent of the explained variance? To test this, I saved the unstandardized residuals from the regression

Table 5.7: Results of Regression analysis testing hypotheses a-d.

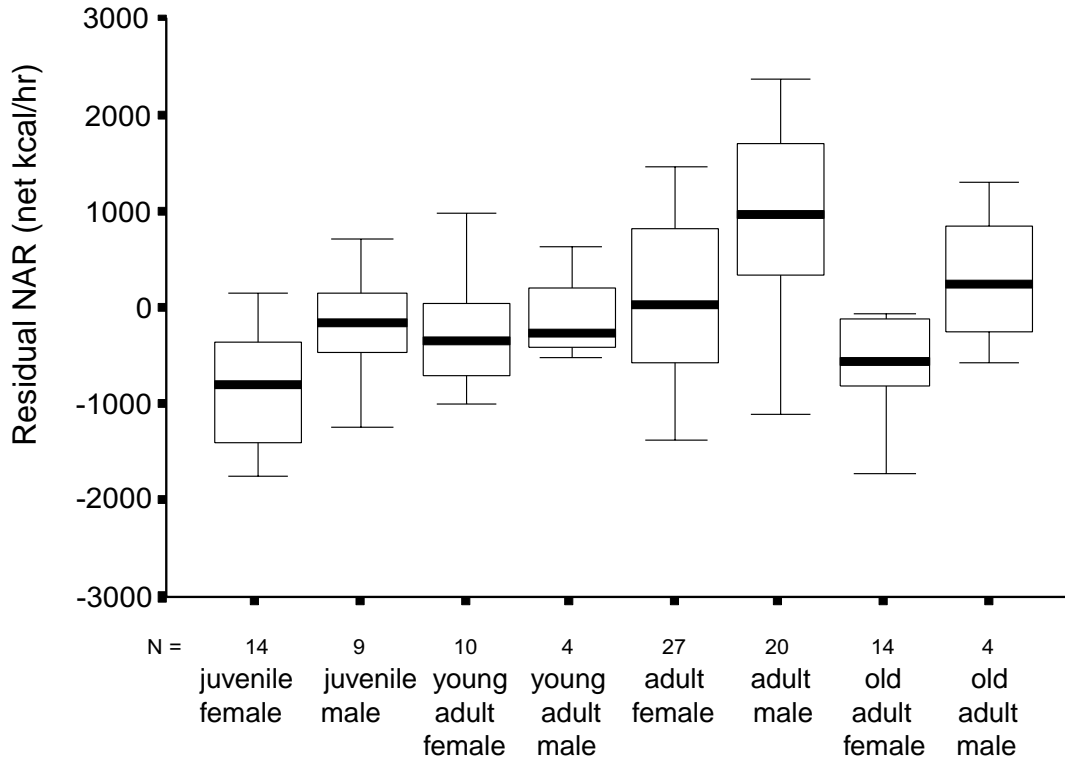
Independent variable	R <sup>2</sup>	adjusted R <sup>2</sup>	Pearson's R
no. dependents	.074	.064	.271
no. juveniles	.044	.034	-.209
group size	.007	-.003	-.082
duration	.105	.097	-.325
all four variables:	.204	.172	.452

procedures for all four variables. If these four variables are together responsible for the age/sex trends that I am attempting to explain, then a one-way ANOVA of the residual NAR by age/sex group should find no significant differences. The results of just such an ANOVA, with a Tukey-post hoc test, are summarized in Figure 5.2. Interestingly, even after controlling for number of dependents, number of foraging children, group size, and duration, the pattern of age/sex differences is nearly the same. These variables appear to contribute very little to the age/sex trends identified above.

The one exception has to do with the relative position of the distribution of NAR for adult females. Before controlling for these variables, adult female rates were significantly different than old adult female rates. After controlling for the variables, the difference between adult females and old adult females becomes non-significant, but the difference between adult females and adult males becomes significant. ANOVAs performed on the unstandardized residuals for each individual variable reveal that duration and number of dependents are both responsible for this switch. This suggests that adult females may forage *better* when accompanied by dependents, but probably because these trips tended to be shorter.

### 3. Hypothesis (e): opportunity cost

Perhaps analyzing tuber return rates in terms of yield per hour is inconsistent with the motives of some foragers. If foraging success is considered only in terms of net calories *per*



ANOVA SUMMARY:

df = 101  
 F = 7.270  
 sig = .000

Tukey post-hoc pairwise comparisons:

juv male							
YA female							
YA male	**						
adult female	**	**	*				
adult male				*			
OA female						**	
OA male							
	juv female	juv male	YA female	YA male	adult female	adult male	OA female

\* significant at < .05  
 \*\* significant at < .001

Figure 5.2: Age/sex differences in tuber foraging efficiency when controlling for duration, group size, number of accompanying dependents, and number of accompanying juveniles. The trend of significant differences in the Tukey post-hoc test remain nearly unchanged when these variables are controlled for.

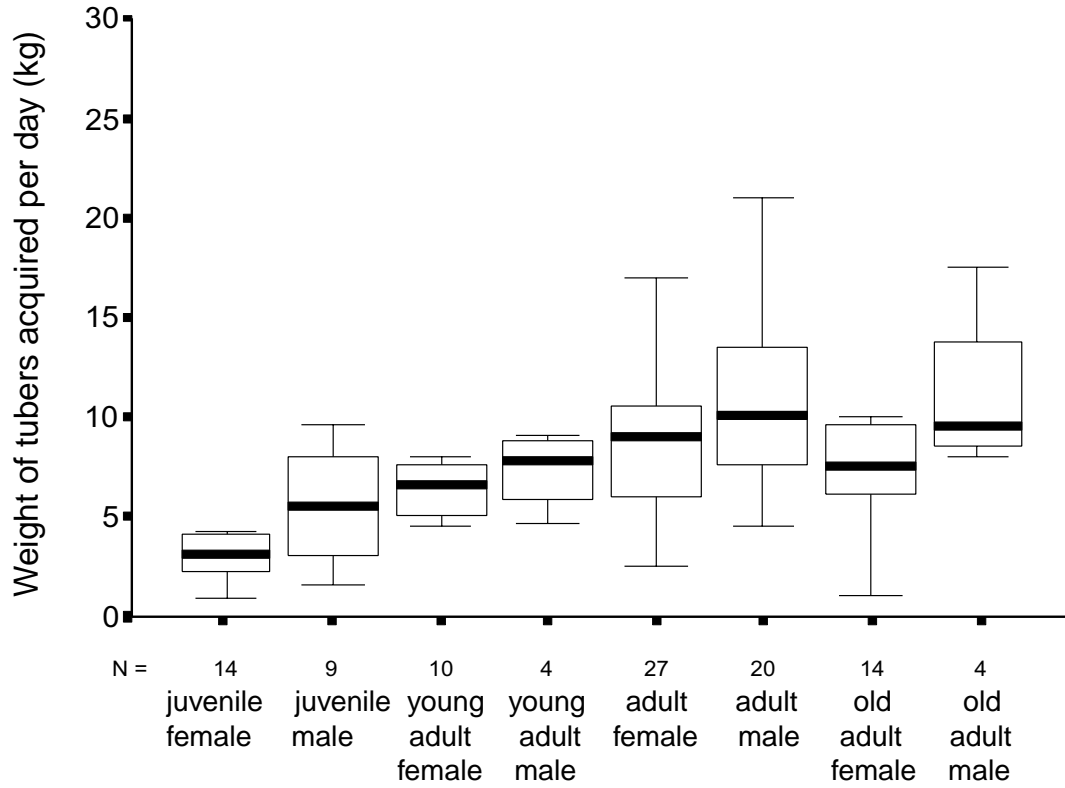
*unit time*, the implicit assumption is that all foragers value energy and time to the same degree (see Bateson and Kacelnik 1995 for a challenge to this assumption). Some age/sex groups may have had fewer alternative uses for their time and energy, and so they may not have been as concerned with how much time or energy they spent foraging—only how many tubers they could bring home to the family at the end of the day.

To see whether this might be the case, I ran a one-way ANOVA using the weight of tubers collected in terms of kilograms *per day* as the dependent variable (see Figure 5.3). The results were significant ( $F= 6.343$ ,  $df= 101$ ,  $p = .000$ ). A Tukey-post hoc test revealed some changes in significant differences from those seen in figure 5.1. The sex trend remains more or less the same, and juveniles were still less productive than were adults. However, this test found no significant differences between the quantity of tubers produced by old adults versus adults. So, while adults produced more *per hour* than old adults, both age groups brought the same average quantity of tubers home at the end of each foraging day.

Perhaps these older age groups, especially the grandmother in this study, had few more appealing uses for their time. Perhaps grandma valued time away from camp as leisure time. While in camp she performed the same activities as her daughter-in-laws, including housework, meal preparation, and childcare (see Table 5.3). Foraging may have been her only chance each day to escape these responsibilities.

#### 4. Hypotheses (f) and (g); learning versus physical size and strength

Current debates on the topic of children's prey choice, children's foraging success rates, and the role of juvenility in human life history evolution have emphasized two non-exclusive hypotheses for the lower rates and broader diet breadth of juveniles. Kaplan's team (Kaplan et. al. 2000) views juveniles as a work-in-progress, proto-adults who forage poorly because they are still learning how to do it well. To Bliege Bird and Bird (Bliege Bird and Bird, in press, Bird and Bliege Bird, in press), juveniles are efficient from a juvenile perspective, which is constrained by small physical size and strength.



**ANOVA SUMMARY:**

df = 101

F = 6.343

sig = .000

**Tukey post-hoc pairwise comparisons:**

juv male							
YA female							
YA male							
adult female	*						
adult male	**	*	*				
OA female	*						
OA male	*						
	juv female	juv male	YA female	YA male	adult female	adult male	OA female

\* significant at < .05

\*\* significant at < .001

Figure 5.3: Age/sex differences in tuber production as measured by the weight (kg) of tubers acquired per day.

Learning is difficult to measure, but a good proxy for learning is age. If variation in return rates for wild tubers were the result of differences in learned skill, then we would expect a strong, positive age related trend in NAR. This pattern is not demonstrated in Figure 5.1—while adults were better foragers than juveniles, old adults were anachronistically poor foragers.

Physical size and strength are easy to measure through anthropometric techniques, but unfortunately, I did not collect these data. If the differences between age/sex groups were based on differences in physical strength and size, then a rank-ordering of age/sex groups by average NAR would end up in rough order of average stature, strength, or some other anthropometric measure. In ascending order by mean NAR, the age/sex groups would be ranked thus:

(1) juvenile females	745 kcals/hr
(2) juvenile males	1142 kcals/hr
(3) old adult females	1159 kcals/hr
(4) young adult females	1440 kcals/hr
(5) young adult males	1797 kcals/hr
(6) old adult males	2010 kcals/hr
(7) adult females	2106 kcals/hr
(8) adult males	2817 kcals/hr

It is possible that this list does parallel the rank order of these groups by physical size and strength. It should be noted that the majority of observations pertaining to old adult females describe the same grandmother, a very short woman weighing only about 40 kg. She is no taller than many of the boys, and shorter than all the young adults. Also, we must consider the effects of senescence on physical strength. Old adult females and old adult males may travel at a slower pace and may be more easily fatigued than their juniors.

I suspect that an important anthropometric variable here might be arm length (see Figure 5.4). *Ovy* and *balo* tubers grow 75 to 120 centimeters below the surface. People with long arms can dig a small, quick hole and use the length of their arms to reach the tuber and pull it to the surface. Children and other people with shorter arms like the grandmother in this study must dig much larger holes that they partially crawl into in order to reach the tubers.

## E. Discussion

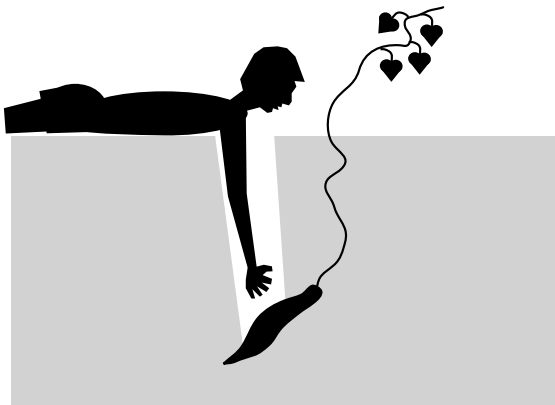
### 1. Foraging children

Perhaps the most intriguing aspect of Mikea juvenile's foraging behavior is the relatively high rate at which they acquire wild tubers. Juvenile females averaged 744 net kcal/hour and juvenile males averaged 1142.39 kcal/hour. Juvenile males' NAR did not differ significantly from that of young adult males, young adult females, adult females, old adult females, or old adult males.

Given these average NAR, Mikea children can produce enough to cover their caloric needs within just an hour or two. The time allocation values presented in Table 3 show that boys and girls both spent 7.5 percent of daylight time foraging, which is roughly equivalent to an average of 54 minutes per day. Meanwhile, the average duration of a foraging trip for a juvenile was 265.96 minutes (sd= 131.84), suggesting that a given juvenile foraged for tubers only an average of once every five days. Thus, while children had the potential to produce enough to feed themselves, they rarely did so.

In contrast, Hadza children averaged only 331 gross kcal/hr digging the tubers *makalita* and *//ekewa* (see Table 5.8). There are several possible reasons for this considerable difference. Tubers in Hadza country grow in very rocky soil, whereas Mikea tubers grow in easily-dug sandy soil. Also, *makalita* and *//ekewa* have lower caloric value per kilogram than *ovy* or *balo*. An analysis performed by Kelly (1995) revealed that *ovy* contains 1190 kcal/kg.

a: tuber digging with a long arm



b: tuber digging with a short arm

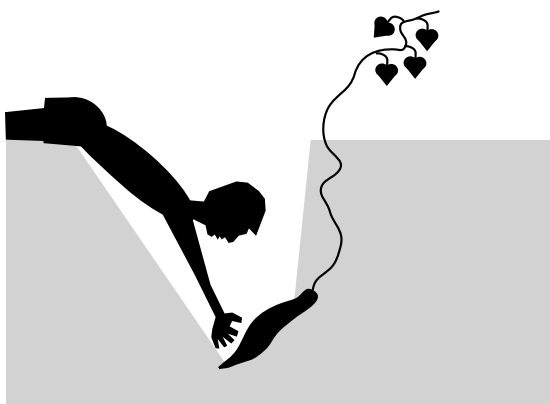


Figure 5.4: Arm length and tuber foraging. Photo (a) by James Yount.

Hawkes, O'Connell, and Blurton Jones (1995) state that *makalita* averages 730 kcals/kg and */ekewa* averages 850 kcals/kg.

As discussed above, the presence of juveniles in a foraging group had no significant affect on the NAR of non-juveniles; in short, it didn't cost young adults, adults, and old adults anything to bring their foraging children along with them. Likewise, there was no benefit to juveniles to forage with adults; juveniles experience the same rates when foraging with adults as they did when foraging in groups composed only of juveniles ( $t = -.505$ ,  $df = 101$ , 2-tailed  $p = .621$ ). It would appear, then, that juveniles had already learned that part of tuber foraging that may be taught.

The foraging behavior and foraging ecology of Mikea children differs importantly from that of the Ju/'hoansi or Hadza. In the Ju/'hoansi case presented by Blurton Jones, Hawkes, and Draper (1994), Ju/'hoansi children had low return rates for *mongongo* nuts. The nuts required considerable processing time, travel time to the nut patch was high, heat stress was a menace, and there was a risk that children could be attacked by predators. Thus, Ju/'hoansi children stayed at home to process the nuts that their mothers and grandmothers brought to camp. For the Hadza (Hawkes, O'Connell, and Blurton Jones 1995), the presence of children reduced the NAR of their adult companions but the children's own production compensated the adults' loss. Travel time was lower than it was for Ju/'hoansi, heat stress was less menacing, and processing time was much lower, although predators were also a problem. For Mikea children, travel time is potentially quite low, heat stress in the shady forest is not a danger, processing time is inconsequential, and there are almost no predators (the only exception is the fossa, *Cryptoprocta ferox*, which is rare). Mikea childrens' return rates are quite high, and so they can accompany their parents or chose not to accompany them without affecting team success rates.

The age differences in tuber NAR that do exist are perhaps best explained by differences in physical size and strength, and in particular, arm length. This explanation simultaneously accounts for the very low return rates of the grandmother in this study and the

male-biased sex trend. However, the “learning hypothesis” cannot be ruled out. If old adults have lower NAR because of decreased stamina or lower opportunity costs, then the trend shows increased NAR with increased learning. It is likely that the “learning hypothesis” is more appropriate when applied to wild resources other than tubers, especially *tandrake* and honey. These resources are difficult to locate but require little strength to capture once they are located.

## 2. Division of Labor

The cooperative model of sexual division of labor is largely based on the logic that women experience restricted mobility due to childcare responsibilities. The time allocation data from Behisatse agrees that men spent more time in some “away from camp activities,” primarily, working in their manioc fields in Bevondro or clearing forest for new cornfields in exchange for wages. Likewise, women specialized in two important “in camp” activities, meal preparation and weaving. However, there is little evidence that female mobility was otherwise restricted. The primary work activity for women was tuber foraging, an activity that requires considerable mobility. By the end of our data collection project, we were familiar with a great many placenames within the forest and would quiz returning foragers about where they had collected the tubers they brought to camp. Women who had foraged for more than three hours reported having dug tubers in places 7 to 12 kilometers away. Women also pursued the same animal prey as did men. Women at Behisatse spent an average of 22 minutes per day capturing wild animals, which is about half as often men. Women were mobile enough to accompany their husbands on long distance “away from camp” foraging trips and to lead their own fishing expeditions.

Female foragers do not appear to have been negatively affected by the presence of children. Most often, they left dependents in the care of alternative caregivers. Half of the juveniles did not forage on any given day, and the oldest juvenile or a young adult would look after the needs of dependents. As I have shown above, the presence of both dependents

and juveniles in a foraging task group did not significantly affect the NAR of the adult foragers in that group. Individuals, including mothers, who foraged in the company of infants, toddlers, and juveniles produced at the same rate as individuals in groups without children. Together, presence of dependents and juveniles accounted for only about 12 percent of the variance in NAR. Similarly, Hawkes, O'Connell, and Blurton Jones (1997:558) found no significant differences in the time budgets of nursing and non-nursing Hadza mothers, and Bliege-Bird (in press) discovered that children had no negative effect on the return rates of mothers line fishing on the beaches of Mer. It appears that foraging mothers in a variety of situations have found ways to forage effectively despite the presence of children. Children do not necessarily restrict a mother's mobility, as the cooperative hypothesis avers.

The competitive model predicts that females will forage for resources with low variance and low mean yield so as to best insure offspring survivorship and the woman's own future fecundity. Men, meanwhile, will focus on resources with high variance and high mean yield when this choice of prey could increase future mating opportunities. In the Mikea case, women specialized on tubers—which provide low variance but high yield—while men specialized in foraging for small game, for which the success rate is quite variable and the average yield extremely small. Furthermore, as discussed in more detail in the following chapter, men do not share meat with other households and they do everything possible to hide the quantity of their catch from public view. Behisatse men are neither showing off nor signaling; they appear to have been provisioning their household.

The absence of large game among the Mikea—or of some other high variance, high yield, sharable resource—makes foraging an unprofitable activity by which to show off or signal to potential extramarital mates. But perhaps the key question here is, to *whom* would male foragers at Behisatse be showing off, anyway? At a small foraging camp such as Behisatse, where the residents consist of brothers and their wives and families, the only potential extramarital mates for men are their own brother's wives, who are also actively

involved in reproduction and may only be receptive for short periods of time. The social penalties for attempting reproduction with a sister-in-law may be prohibitive. The younger, unmarried women in camp would be the mens' own daughters and nieces and so would not be potential mates due to the incest taboo.

The competitive hypothesis predicts that males seek high-risk resources when this is likely to offer some future reproductive advantage; however, if the probability that capturing risky prey will win future mating opportunities is *lower* than the marginal benefit of offering more support to current offspring, then men ought to concentrate on provisioning their current, living children. If Behisatse men have no one to whom to show off, it is more conducive to fitness enhancement for them to concentrate their efforts on supplying valuable protein and fat to their children.

Lest I portray an overly rosy and monogamous view of marriage among the Mikea, I should point out that many marriages in the Mikea Forest end in divorce, polygamy is a possibility, and men and women engage in extramarital affairs with some frequency. However, extramarital affairs usually require mobility. The region of forest where Behisatse is located is primarily populated by people from the same village (Namonte) who are all closely genealogically related, often in multiple ways. For many Mikea, even finding one mate while avoiding incest taboos is a difficult task. Most often, extramarital affairs occur in villages bordering the forest or between residents and visitors. These are not arena where foraging skill is publicly demonstrated or valued.

### 3. Surmises on grandmothers

The preceding analysis is inadequate for evaluating Hawkes's "grandmother hypothesis," as only one grandmother was present at Behisatse. However, because her NAR values were significantly lower than those of adult males and females, her case is worth brief discussion here. The grandmother hypothesis holds that grandmothers forage at roughly the same rate as adult females, and that they share their take with their grandchildren, thus

increasing their own inclusive fitness through kin selection. However, in the case of this particular grandmother, her return rates were equivalent to those of the children she was supposedly provisioning.

The children she was provisioning only spent an average of 54 minutes per day foraging for tubers. Grandma, however, spent an average of 94 minutes foraging each day, and the average length of a foraging day for her was 435 minutes (thus, she foraged on average once every 4.6 days). While she and the children were both producing at the same rate, the children brought home only 1 kg when they foraged, and grandma brought home an average of 8 kg tubers (and sometimes as many as 20 kg) when she foraged.

This grandmother may have foraged at the same rate as juveniles because she is a small woman, no larger than a juvenile. However, it is also possible that she could have foraged at a faster rate if she felt the need to do so. The value of foraging grandmothers to a household—and from an evolutionary perspective—may have been their lack of opportunity costs rather than (or in addition to) their productive ability. Younger adults must preoccupy themselves with mating and childcare. Grandmothers no longer have these preoccupations. Even if senescence has reduced their strength and stamina to the point where their foraging efficiency decreases, they can still help provision dependent grandchildren because they can afford to spend much longer periods of time procuring food. Future empirical evaluations of the grandmother hypothesis should consider the amount (and value) of the food she is supplying to her grandchildren, in addition to NAR.

## **F. Conclusions and implications for diversification**

This chapter has explored age/sex differences in time allocation and tuber foraging return rates. The pattern that emerges from this analysis may be summarized as follows. First, people of all ages except for infants and toddlers contributed equivalent amounts of their time to food production, processing, and preparation. Foraging occupied considerably

more time than farming for each age group, with the exception of the one old adult male individual in this study. Agricultural field labor was primarily the purview of adults, especially adult males, while people of all ages helped in maize processing tasks. Men and women both foraged for animals, although men spent about twice as much time pursuing animals as did women. The majority of all foraging time was spent excavating wild tubers. Excluding one outlier (the old adult male), men and women foraged for tubers at similar frequencies.

Above, I have attempted to explain the patterns of age/sex differences in tuber foraging return rates. However, the *similarities* in foraging efficiency among age/sex groups may be even more enlightening. First, tuber foraging by males and females of all ages is extremely profitable. Mikea juveniles and adults at Behisatse dug tubers at return rates comparable to those among the Hadza of Tanzania, the Ju/'hoansi of South Africa, Australian Aborigines, and Great Basin foragers (see chapter 4; Table 4.2). However, Mikea children were two to four times more efficient digging *ovy* than Hadza children were digging *//ekwa* (Table 5.8). Secondly, while tuber foraging differed between age/sex groups, few of these differences were statistically significant. Juveniles, young adults, and old adults of both sexes foraged at rates that did not differ significantly. Third, all age/sex groups foraged at rates sufficient to meet all their own personal caloric requirements with an average of less than three hours of work per day.

Does the profitability of wild tubers mean that Mikea live in a Rousseauian state of affluence? Not necessarily. This chapter has not considered temporal or spatial variation in tuber return rates; the foraging data analyzed here are lumped from different seasons. Recall from the previous chapter that tuber foraging efficiency appears to decrease as the year progresses. Wild tubers are abundant in the beginning of the dry season (*fararano*), but become increasingly difficult to procure as those patches nearer to camp are sequentially exhausted. In years during which maize or manioc is plentiful, *ovy* is not likely to be

Table 5.8: Tuber foraging return rates among the Hadza. Notice that children's foraging efficiency is considerably lower than that of adults.

Age-sex group	tuber species	NAR (kcal/hr)	n	source
children	//ekwa, <i>Vigna frutescens</i>	364	13	A
children	makalita	445	12	A
unmarried girls, season 1	//ekwa, <i>Vigna frutescens</i>	715	4	B
unmarried girls, season 2	//ekwa, <i>Vigna frutescens</i>	1041	1	B
childbearing women, season 1	//ekwa, <i>Vigna frutescens</i>	1580	10	B
childbearing women, season 2	//ekwa, <i>Vigna frutescens</i>	1966	5	B
older women, season 1	//ekwa, <i>Vigna frutescens</i>	1712	5	B
older women, season 2	//ekwa, <i>Vigna frutescens</i>	697	5	B
adults ?	shumuko, <i>Vatovaea pseudolablab</i>	1816	14	C
adults ?	//ekwa hasa, <i>Vigna frutescens</i>	3240	12	C
adults ?	do'aiko, <i>Vigna macrorhyncha</i>	1967	5	C
adults ?	penzепенze, <i>Vigna sp.</i>	884	?	C
adults ?	//ekwa gadabi, <i>Vigna frutescens</i>	1077	9	C

Sources:

- A: Calculated from Hawkes, O'Connell, and Blurton Jones 1995:692.  
 B: Calculated from Hawkes, O'Connell, and Blurton Jones 1989:349.  
 C: Presented in Vincent 1985:136.

gathered with much intensity, and it may remain abundant throughout the dry season. However, in a year of agricultural failure like 1998, *ovy* is rapidly depleted and foragers must travel increasing distances to find profitable tuber patches.

Juveniles are productive members of Mikea society. Theoretically, this ought to affect reproductive decisions, for individuals ought to be able to maximize fitness through maximizing births. However, Mikea households were rarely large; of the 26 households highlighted later in this study, the average number of children was 2.7. There must be other costs to having children. These could include the costs and risks of pregnancy. Pregnant women may remain active until the birth (one woman from Behisatse foraged for hibernating *tambotrike*, which involves chopping trees, the same day she gave birth), but there follows a long postpartum period of inactivity, during which time she is not procuring food. I did not collect quantitative data on the frequency of miscarriage, infant mortality, or birthing complications, but local lore and gossip are replete with accounts of these phenomena.

I suspect that mobility might be a more significant cost limiting family size. Women are not very mobile during their postpartum rest phase. Juveniles appear to be less mobile than are adults. Mobility requires not only strength and stamina, it also requires endurance of hunger and thirst, especially when traveling through those parts of the forest where there are no *babo* tubers or wild cucurbits. I witnessed that adults often leave children in the care of relatives when they travel to other locations for brief periods of time, and especially when they practice *mihemotse*, complete nomadic foraging. As discussed in the previous chapter, because of a high seasonal covariance and a low spatial covariance of activities such as maize and manioc, mobility is necessary for maintaining a diversified portfolio.

When children foraged alone, they tended to remain within a radius of one or two kilometers from camp. Children sometimes accompanied adults on longer trips, but long trips were not attempted by parties composed only of juveniles. A twelve year old boy and his 10 year old brother once told me that they were afraid to travel alone to the well, a mere

two kilometers away, for fear of encountering *olo raty*, evil people. This lack of juvenile mobility means that large households may deplete local tuber patches faster than smaller households. Once the local supply of tubers has been exhausted, juveniles become very costly.

In conclusion, the degree to which a household can potentially invest in agriculture may be limited by labor supply if there are few adults in the household; a household with many juveniles does not necessarily have more access to agricultural labor than a household with few juveniles. Juveniles are productive foragers, but their lack of mobility can make them costly to the household.