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Female Subsistence Strategies Among Ache Hunter-Gatherers of Eastern Paraguay

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Anthropologists have frequently proposed that sexual division of labor is produced by childcare constraints on women's subsistence work. We present data on the forest activities of Ache women that show that differences in parental investment partially account for variation in food acquisition among individual women. Data also suggest that childcare constraints are important in understanding the sexual division of labor.

KEY WORDS: women; hunter-gatherers; sexual division of labor; childcare; subsistence work.

INTRODUCTION

In recent years, anthropologists have given increased attention to levels of work by female hunter-gatherers. A popular view is that women in these societies are the main providers of food in all habitats except for the arctic regions (Lee, 1968; Dahlberg, 1981; Leacock, 1978). Based on this generalization, some have argued that hominid females in the Plio-Pleistocene were also the principal food producers (Zihlman, 1978a,b, 1981; Tanner and Zihlman, 1976), and others have speculated that heavy female workloads served as a mechanism to increase birth intervals (Hayden, 1972) and reduce population growth rates (Harris, 1979).

In contrast, investigators using the ethnographic record over a wider range of subsistance types have shown two general features of the sexual division of labor which contradict the popular view of a single archetypical gatherer-hunter pattern.

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First, high variation in the contribution of women and men to subsistence has been documented across hunter-gatherer societies (Ember, 1978), agrarian and industrial societies (Minge-Klevana, 1980; Ember, 1983; Evenson, 1983), and among women in single societies (Evenson, 1983).

Second, considerable empirical evidence suggests the importance of childcare constraints in patterning this variation. Women are the primary caretakers of children in all societies, while men spend relatively few minutes per day in direct childcare or domestic tasks (Minge-Klevana, 1980; Evenson, 1983). J. Brown (1970) has suggested that the relative contribution of women to subsistence is correlated with the compatibility of childcare with the main economic activities undertaken by the members of the society.

The perspective of evolutionary biology provides a useful theoretical framework for analyzing female behavioral choices. Behavioral ecologists have argued that natural selection has favored human females who invest a great deal of time and effort in caretaking of altricial young (Daly and Wilson, 1983; Trivers, 1972). This perspective points out that women must solve the problem of allocating energy to both food acquisition and competent parenting in diverse ecological contexts. The solution to this problem might best be understood in cost-benefit terms. Individuals are confronted with behavioral options which vary in fitness payoffs. In order to maximize reproductive success, females must choose strategies that result in higher rates of offspring production and viability relative to the rest of the population. These behaviors will be favored by natural selection, and should become most prevalent through time.

Modeling optimal solutions for women's behavioral choices is currently problematic, due to the difficulty of measuring the fitness consequences of time use in humans and other organisms (Sibly and McFarland, 1976). We can, however, begin to make well-educated guesses about the fitness payoffs for various behavioral options by collecting quantitative data on female time use and energy capture. We can also examine the ways in which behavioral choices may increase or decrease the chances of survival for altricial young.

The present paper is designed to provide a quantitative description of female foraging in Ache society. We present data on women's time budgets and show the extent to which females allocate time and effort to activities and foraging strategies that are compatible with childcare. A detailed description of resource choice and acquisition techniques is followed by tests of the hypothesis that childcare constrains women's productivity. The results show that parenting contributes to differences in behavior among Ache women.

BACKGROUND

Clastres (1968) provides a general ethnographic description of the Ache, but no quantitative data on Ache behavior was collected until 1980. Since then, descriptions and analyses of foraging behavior (Hawkes, Hill, and O'Connell, 1982), hunting (Hill and Hawkes, 1983), men's time allocation (Hill, 1983), food sharing (Kaplan, Hill, Hawkes, and Hurtado, 1984), and seasonal variance in the diet (Hill, Hawkes, Kaplan, and Hurtado, in press) have been published. These earlier studies show that the vast majority of calories consumed by Ache bands come from meat, that males are the principal providers of food, and that food is shared widely.

The women in this study belong to the northern group of Ache of Eastern Paraguay, full-time hunter-gatherers until they settled at mission-sponsored colonies in the past decade (Hill, 1983). They currently live at a Catholic agricultural settlement, Chupa Pou, about 30 km from the town of Curuguaty, Department of Canindeyú. The population of Chupa Pou during 1981–1982 was approximately 200 but fluctuated almost daily. The adult female, (approximately 18 and over,) population consisted of about 41 individuals.

At the mission, Ache women live with their nuclear families in huts usually constructed by their husbands. Women's activities include harvesting crops such as manioc, corn, sweet potatoes, and sugar cane, food processing, domestic chores, manufacturing goods to sell, foraging in the surrounding forest, and visiting. While most activities are carried out in the company of children, women seem to prefer to leave behind children older than 2 years when they work in the fields. School, and the presence of many juvenile, adolescent, and adult playmates and caretakers may frequently allow women to harvest without the burden of young dependents.

Despite their current horticultural existence, the Ache of Chupa Pou also spend considerable periods of time in the forest living from wild foods. Foraging trips last from a few days to a month or more in the forest and are organized around the daily food quest.

In the forest, women's activities differ from those at the mission in important ways. One difference between foraging and mission life is that, in the forest, women spend a great deal of time and effort moving the household from one location to another. Ache bands usually move camp every day and only rarely stay at one location for more than two nights. Each nuclear family's children, tools, cooking untensils, firebrands, bedding, and pets are carried by an adult woman every time camp moves from one site to another. Women walk steadily and slowly through the forest, carrying baskets weighing from 6–27 kg (mean = 15 ± 1 kg; n = 19) and

one or two children whose individual and/or combined weights ranged from 5–24 kg (mean = 1 ± 1 kg; n = 26).

Women's daily moves may be primarily determined by men's foraging patterns. Men frequently leave camp and begin to search for game early in the morning. A few minutes to several hours later, the women begin to pack their baskets. The group of women then follows the hunters' trail in single file. They walk slowly through the forest, stopping briefly to look at the surrounding trees. However, while men hunt all day long, women pass numerous edible resources which they do not stop to acquire. It appears that women walk several hours a day primarily to carry the game that men killed so that men can cover more territory while hunting, rather than to seach large areas for vegetable resources.

Walking is frequently interrupted by stops of various lengths. During these times, women may engage in a number of activities. They either sit with the other women and children by the trail or they forage a few meters away from the main group. While foraging, they sometimes leave older children and carrying baskets with the main group, but they seldom leave infants behind. The women who sit together might converse, hand weave, and/or try to locate the hunters by shouting and waiting for their response. When women stop at a spot where the men are hunting, they occasionally help the men spot game. After these hunts, women generally gut and clean the dead animals. Intestines are often roasted and consumed on the spot. Small game is then packed in the women's baskets, and the group prepares to leave. Women who foraged during the rest stop now join the main group and share the resources they acquire.

Women customarily stop walking early in the afternoon. They almost always choose campsites near water sources. After unloading baskets and children, individual women clear small areas for their family's fire and sleeping spot along the perimeter of the camp. Some of the women may sit, while others clear the center of camp or leave the main group in order to collect firewood. The remaining women may wait for some time before they too search for more. After building the family fire, women may process game while others forage nearby. Still others might weave for the rest of the afternoon and evening.

Later in the afternoon, the men begin to arrive. At this point, both men and women start to process the game brought by the hunters. While both men and women gut and butcher small game, only men process large animals. In addition, some men usually leave the camp to chop down palm trees nearby. These trees are often exploited subsequently by women who may collect the palm heart and pound the fiber for starch. When women foragers return with palm fiber, portions are distributed to each family. The starch may be sucked directly from handfuls of fiber or squeezed in water in order to cook pieces of game in the thick juice. While pots are left boiling

on the fires, women engage in other activities, such as grooming husbands, children, and themselves. When cooking is completed, the meat and broth are shared widely (Kaplan et al., 1984). Cooked game is usually cut up and redistributed by men. Some food is saved for consumption in the early morning.

Occasionally, Ache bands camp in the same spot for 2 or 3 days. These are usually rainy days. On such days, men build palm-leaf roofs to protect the family and its fire. When it stops raining in the morning, women often pound large amounts of fiber. This fiber is processed immediately upon return to camp, and the starch is cooked with meat left over from the previous day and consumed. The group then sits under dripping shelters for the remainder of the day. If the weather clears later in the afternoon, some of the women might forage again. Occasionally, factors other than rain may also prompt the group to camp in the same spot over several nights. When fruits are in season, they stay in one location in order to exploit large groves. At other times, women spend two days in the same camp in order to hand weave baskets and mats.

METHODS

Data on women's time allocation and food production were collected from October 1981 to April 1982 on a total of nine foraging trips out from the mission base. The length of trips ranged from 7–15 days. We collected data on 461 woman-days of food production and have so far analyzed 63 focal person days of women's time allocation. Table I lists dates, group composition, number of anthropologists, and number of women-days sampled for each trip.

While we planned the departure dates for some of the foraging trips, the Ache chose the remaining dates. They also determined band composition. On the morning of the announced day, a few families, single males, and adolescents interested in foraging would show up at a spot on the mission road. At this point, we noted the names of individuals and recorded their weights. We also attempted to collect data on mission food brought on trips. Women were reluctant to show us items in their baskets, so we were only able to collect data on mission food carried by some women on some trips. However, on the basis of the consumption patterns we observed, this amount of food was never substantial, and most of it was consumed by the end of the first foraging day.

We used three different methods to collect data on women's food acquisition and activity budgets. Virtually all items acquired by women were weighed or counted throughout the day, and occasionally, when weighing was not possible, estimates were made. Since women usually either bring

collected items to camp, or stay within observational distance of the main group of women while they forage, it was relatively easy for one anthropologist to weigh most collected items. We were able to collect food production data on all women on all days of all trips. Data on Trip 7 is not complete, however. On this trip, a large quantity or larvae was taken by ten women, and total acquisition was too difficult to monitor. Our analysis only includes data on palm starch calories for this trip.

We used two methods to collect data on activity budgets. On Trips 1–5, we collected data on focal persons; that is, at the beginning of each day, a woman was chosen and was followed by one of the anthropologists throughout the day. Entries were made whenever activities changed. On Trips 6–9, we employed a form of scan sampling. One of the anthropologists stayed with the largest group of band members (mainly women) and recorded all individuals' activities at 10-minute intervals throughout the day. On occasion, activities were noted only once in 20 minutes in order to allow the investigator time to set up or bathe. These data points were weighted appropriately for calculating time spent in various activities.

In order to render the data collected on Trips 6–9 comparable with those collected on Trips 1–5, a focal woman was randomly chosen from each day of the former trips. We then calculated time allocated to activities by assigning 10 minutes to activities recorded at each time point. Because women's behavior was always sampled while women were in the presence of others, this sample of focal data may be biased for group activities. However, the average number of unaccounted minutes for the women in this sample is only 29 min/day. This suggests that on the average, Ache women spend about a half hour per day away from the main group of women, and that focal data from scan samples is only minimally biased.

RESULTS

Time Allocation

Ache women's activities are defined in Table II. While these activities are not mutually exclusive by definition, we observed no cases where two of the listed activities took place simultaneously except for "active interaction with children" and "grooming." Grooming of children is a subset of the former category.

Our list of activity categories excludes "childcare." This is perhaps the most difficult activity to operationalize in studies of Ache society. Care of offspring and almost all other women's activities usually take place

Table 1. Foraging Sample 1981–1982

Trip number	First day	Last day	Number of adult males	Number of adult females	Children > 3.5 years	Infants	Anthro	Days sampled	Time allocation days sampled	Food production total woman days
1	Oct 2	Oct 8	12	5	2	3	3	6	5	30
2	Oct 17	Oct 23	9	8	3	3	3	6	5	48
3	Nov 6	Nov 14	9	7	1	3	3	8	7	56
4	Dec 10	Dec 16	7	4	6	3	3	6	5	24
5	Jan 7	Jan 14	12	10	8	5	3	6	5	60
6	Feb 6	Feb 16	7	4	6	0	2	10	9	40
7	Feb 25	Mar 11	10/8[a]	9/8[a]	7/6[a]	3	2	13	11	104[b]
8	Mar 28	Apr 7	10	6	5	2	2	9	8	54
9	Apr 18	Apr 27	11	5	17	4	3	9	8	45
Total								73	63	461[c]

[a]Number of people changed once during the trip.
[b]Data on palm starch calories only.
[c]When days for Trip 7 are subtracted from this total, the total number of woman days is 357.

Table II. Definition of Activities

1.	*Walk.* Walking in single file with any other member or members of the band.
Food-Related activities	
2.	*Vegetable pursuit.* Chopping, pounding or climbing trees for vegetable resources and collecting fallen fruits.
3.	*Larvae pursuit.* Chopping and extracting larvae from rotten logs.
4.	*Game pursuit.* Collecting logs to cover animal burrows, digging burrows, and helping hunters spot game.
5.	*Honey pursuit.* Chopping trees for honeycomb, pulling of comb, and building a fire to smoke bees out of hives.
6.	*Food processing (vegetable).* Processing and cooking palm fiber, larvae, honey, and fruit items.
7.	*Food processing (game).* Butchering and cooking game.
Miscellaneous work	
8.	*Tool manufacture and repair.* Weaving baskets, mats, fans, babyslings, bowropes, palm fiber strainers, making "kotos" (the Ache spoon), building spits for cooking, and acquiring and processing natural fibers and palm leaves.
9.	*Campwork.* Clearing brush for camp, building huts, getting firewood or water, building fire, making "palm-leaf" mats, feeding pets, packing baskets, retrieving axes, and/or machetes from the camp's periphery.
10.	*Grooming/hygiene.* Grooming self, bathing, urinating, and defecating.
11.	*Grooming others.* Grooming spouse or other adult women.
12.	*Active interaction with children (own).* Grooming, bathing, feeding, and playing with own children.
13.	*Active interaction with children (other).* Grooming, bathing, feeding, and playing with other's children.
Leisure	
14.	*Waits at honey.* Waiting for band members actively engaged in the pursuit and distribution of honey (usually males).
15.	*Waits at vegetable.* Waiting for band members who are actively engaged in vegetable pursuit, including larvae (usually females).
16.	*Waits at game.* Waiting for hunters engaged in game pursuit.
17.	*Sit/rest/talk.* Time spent involved in no other category on this list; frequently recorded as "sits."
18.	*Sleep.* Resting in prone position doing no other activity.
19.	*Eating.* Holding food and intermittently consuming it; drinking.
20.	*Unknown.* Time when focal person's activities were not monitored.

simultaneously. Infants spend close to 100% of their time with their mothers, and older children of both sexes up to the age of approximately 8 years spend most of their time with the main group of women. While in camp, women work or rest in close proximity to their own or other children. When they forage away from the group, women usually take their infants along. Older children may be left behind with the main group of women. These forms of childcare are difficult, if not impossible, to operationalize, because babysitting requires various levels of attention. Factors such as who else is present, the babysitter's relationship to the child, and the age of the child affect the extent of care for children other than one's own offspring.

For these reasons, we have excluded childcare and babysitting from our list of activities, and added the mutually exclusive and operationalizable

Table III. Women's Average Activity Budget (min/day)

Activities	All days[a]	Total (min/day)	Percent	Total percent
1. Walks in line	114 ± 10	114	16	16
Food related				
2. Vegetable pursuit	55 ± 9		8	
3. Larvae pursuit	15 ± 5		2	
4. Honey pursuit	6 ± 2	111	1	
5. Game pursuit	3 ± 1		–	14
6. Food processing (game)	11 ± 2		1	
7. Food processing (vegetable)	21 ± 4		3	
Miscellaneous work				
8. Tool manufacture	71 ± 14		10	
9. Campwork	42 ± 5		6	
10. Grooming/hygiene	15 ± 2		2	
11. Grooms others	6 ± 1	150	8	20
12. Active interaction with own children	13 ± 3		1	
13. Active interaction with others children	3 ± 1		–	
Leisure				
14. Wait at honey	10 ± 3		1	
15. Wait at vegetable	4 ± 2		–	
16. Wait at game	7 ± 3	330	–	46
17. Rest, sit	230 ± 14		32	
18. Sleep	15 ± 4		2	
19. Eating	64 ± 6		9	
20. Unknown	17 ± 5	17	2	2
Total		722		

[a] $N = 63$; $X \pm SE$.

activity "active interaction with children." Instead, in the discussion to follow we will note for each activity the spatial distribution of women in relation to camp or rest stops, that is, places where children are customarily found.

Table III shows the average number of minutes spent by women in the 19 activities defined in Table II. Activities were grouped into four categories: walking, food-related activities, miscellanous work, and leisure. Except for time spent in the active pursuit of resources and a small subset of time spent in camp work, all the listed activities take place in camp or at rest stops. The unknown category refers to the 17 minutes the women spent on average out of sight of the anthropologist. Because this average includes both time point and focal person data, it is lower than the mean minutes calculated for time point data (only 29 min). We sampled an average of 722 minutes per day or 12.2 hours beginning on the average at 6:30 am and ending at approximately 7:00 pm.

The average Ache woman allocates about the same amount of time to "food-related activities" and to "walking." Women spend only 111 minutes

per day in food-related activities (14% of their time). They spend 114 minutes per day walking (16%) and 150 minutes per day in miscellaneous work (20%). By contrast, women spend a major portion of their time in leisure (330 minutes per day or 46% of their time) (Table III).

The main food-related activity is pursuit of resources (79 minutes per day), followed by food processing (32 minutes per day). Time spent pursuing resources is usually also time spent out of camp, or some distance away from the main group of women, and females only allocate 11% of the monitored time period to this activity. Even though some food processing takes place out of camp, e.g., the peeling of palm hearts and oranges, the vast majority of food processing takes place in camp.

The "miscellaneous work" category includes a variety of activities. "Campwork" consists of time spent clearing underbrush, collecting firewood, building fires, and collecting water. "Manufacturing" includes the production of palm starch strainers, baskets, fans, mats, and baby slings. These activities actually include some of the time costs of processing food. For example, fires are used for both providing warmth and cooking, while fans are employed to build fires and to swat insects. On the other hand, mats are primarily used for sitting and sleeping, and baby slings for carrying infants.

Women spend more time manufacturing (71 minutes per day) than in any other activity within the miscellaneous work category. This activity is followed by campwork (42 minutes per day) in importance. The only class of campwork which actually takes place out of camp is firewood and water collection (approximately 10 minutes per day).

Women also engage in grooming primarily in camp or at rest stops. Most of the time devoted to "active interaction" with their own children (13 minutes per day) are spent bathing and removing parasites from the young. Similarly, time spent in "active interaction with others' children" (3 minutes) is primarily allocated to the same activity. While women spend few minutes grooming other adults (6 minutes), they spend more than twice as much time grooming themselves (15 minutes). Altogether, then, they spend close to 37 minutes per day grooming. Even though this activity is minor in terms of time spent, it may be important for continued good health.

All activities in the main category "leisure" take place in camp or at rest stops, and women allocate more time to this main activity category than to any other (330 min/day). All activities of offspring and intermittent active care. Most of this leisure time is spent sitting, resting, and waiting for others in active pursuit of food (251 min). Minor activities are eating (64 min), sleeping (15 min), and waiting for others in active pursuit of food (21 min).

Similarly, when women walk, they do so primarily in the company of the main group of women and their offspring. The rarely walk long distances from the main group to search for resources.

Table IV. Activity Budgets According to Portions of the Day (mean min/day)[a]

Activities	A[b]		Percent	B[b]		Percent	C[b]		Percent
1. Walks in line	0		0	145		42	0		0
Food-related									
2. Vegetable pursuit	2			16			19		
3. Larvae pursuit	0			10			6		
4. Honey pursuit	0			6			1		
		7	5		42	12		44	18
5. Game pursuit	0			7			0		
6. Food processing (game)	2			1			9		
7. Food processing (vegetable)	3			2			9		
Miscellaneous work									
8. Tool manufacture	24			8			11		
9. Campwork	10			8			25		
10. Grooming/hygiene	1			5			8		
11. Grooms others	1	40	27	2	30	9	5	54	22
12. Active interaction with own children	4			3			4		
13. Active interaction with others' children	0			4			1		
Leisure									
14. Wait at honey	0			13			0		
15. Wait at vegetable	0			3			2		
16. Wait at game	0			9			0		
		93	64		125	36		132	55
17. Rest, sit	65			80			98		
18. Sleep	3			2			7		
19. Eating	25			18			25		
20. Unknown	2		4	4		1	9		4
Total min	146		20	346		47	240		33
Total average (min sampled per day)									732 (12.2 hr)
x Time begin	6:28 (n = 54)			9:08 (n = 61)			5:34 (n = 59)		
x Time end	8:58 (n = 54)			1:58 (n = 57)			6:47 (n = 61)		

[a]These include "normal activity days" or days when women travel for 2 or more hours (75% of all days).
[b]*A* = minutes prior to leaving camp, *B* = minutes after leaving camp, *C* = minutes after the last stop for the day.

In sum, our data show that Ache women allocate most of their time in activities which they can perform in close proximity to children, and which allow for continuous and uninterrupted care. This amounts to a total of 10.3 daylight hours, i.e., time spent walking, food processing, in miscellaneous work, and in leisure.

During their daily moves, women may stop either to acquire resources or to rest. Rest stops are taken about eight times per day (4.2 times per hour spent walking) and last on average 35 minutes (SD = 48; n = 336). On 30% of these, women exploit resources. Stops that include foraging have a mean duration of 50 minutes (SD = 48; n = 336). Of this time, women spend 22 minutes foraging and 28 minutes resting. Stops during which women do not forage have a mean duration of 28 minutes (SD = 44; n = 336). These data suggest that women stop during their daily travels to rest, and that women forage primarily when stops are longer than the mean number of minutes they usually rest at each stop. Women seem to be taking frequent rests from walking and carrying children and baskets, and appear to forage only after they have rested. These data support the proposition that women travel primarily to move the household items and young dependents from one sleeping site to another rather from one resource patch to another.

The daily sequence of women's activities is also of some interest (Table IV). Women leave camp at about 9:00 am and stop for the day at about 2:00 pm. We have therefore divided the day into activities that take place in the morning before moving camp, between campsites during the day, and at a new site in the afternoon and evening. Prior to leaving camp, women spend 64% of their time in leisure and 27% in miscellaneous work, while they allocate only 5% of their time to all food-related activities, primarily food processing. During the day, they spend 42% of their time walking, 36% in leisure, and 12% in food-related activities, most of which is allocated to active pursuit of resources. After women stop traveling for the day, they spend 55% of their time in leisure activities, 22% in miscellaneous work, and 18% in food-related activities, about half of which is foraging and half is food processing.

In sum, regardless of time of day, Ache women spend most of their time in close proximity to children, and allocate few minutes to the active pursuit of resources.

Food Acquisition

Data on food acquisition are consistent with the proposition that females allocate time and energy to activities that enhance the well-being of offspring. Ache women's contribution to the diet is considerably lower than that observed for men. They produce a mean of 2202 calories per day (n =

Table V. Ache Women's Caloric Contribution

Trip number	1	2	3	4	5	6	7	8	9
Number of women	5	8	7	4	10	4	8	6	5
Number of men	12	9	9	7	12	7	8	10	11
Percent of total calories provided by women	5	7	15	8	23	15	[a]	11	19
Percent of vegetable calories provided by women	81	87	57	98	90	55	[a]	8	62
Daily mean calories acquired per woman	1079	1124	1908	2160	2553	2648	[a]	1195	4373
Single male/ single female caloric ratio	8.5	11.9	4.4	6.9	2.7	2.9	[a]	4.3	1.5
Main vegetable item	F	F	V	F	K	C	F	F	O

[a]Caloric data are incomplete.
[b]F, palm starch; V, virella fruit; K, kurilla fruit; C, challa fruit; O, oranges.

357; $SD = 3227$), or an average of 13% of the total calories produced by the foraging group. Women, however, acquired 80% of the total vegetable calories produced (Table V). If honey is included, women produce only 35% of the carbohydrate component in the diet, and men acquire the remainder. A single Ache man produces 1.5–11.9 times more calories than a single Ache woman. Most importantly, on the average, women produce less than two-thirds of their own daily caloric expenditure (3170 calories per day; see Hill *et al.*, in press, for calculations) and depend on men for the remainder as well as for the provisioning of their offspring.

Ache women acquire a wide variety of resources including palm fruits, starch, nuts, insects and fruits of various kinds, several types of honey, bird and iguana eggs, snakes, and, occasionally, small game. These resources are listed on Table IV along with their corresponding caloric values per kilogram.

Of these resources, the one vegetable resource with the lowest caloric value per kilogram is exploited by women most frequently (palm starch, 297 calories per kilogram). Honey, on the other hand, has the highest caloric

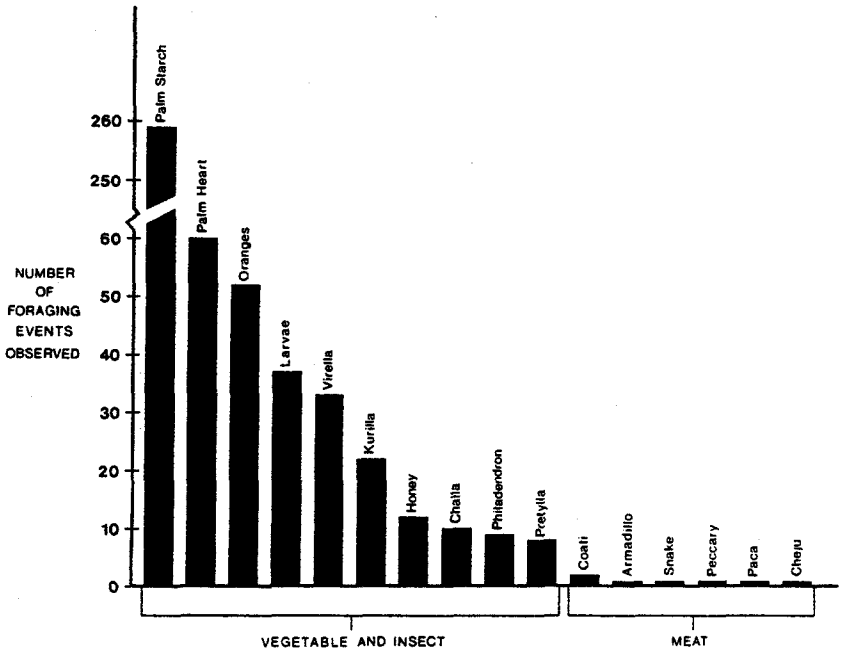

Fig. 1. Frequency of acquisition of food resources by Ache women.

value (3232 calories per kilogram) and it is seldom acquired by women (see Fig. 1). The spatial distribution and relative abundance of resources may account for this pattern; unlike honey, palm trees are encountered frequently and seem to be uniformly dispersed in the environment. Furthermore, women only take honey produced by stingless bees, and these are less frequently encountered than the more common honey of *Apis mellifera.*

Along with caloric value per kilogram, Table VI lists acquisition techniques observed for each resource type. In spite of the great variety of resources exploited by women, all require similar techniques and technology; axes and carrying implements play an important role in women's subsistence work. Females primarily chop for, pound, and collect vegetable resources. In order to transport any of these products from the foraging site to the main group, women use carrying tools such as baskets, pots, and other containers, as well as less durable ones manufactured on the spot. While small packages are wrapped in palm or other leaves, e.g., larvae, honey, and palm fiber bundles, the carrying basket is employed to transport large quantities of fruit and fiber. When large amounts of honey are taken, it is carried in large pots, cans, or in the handwoven, charcoal-and-wax sealed containers.

The Ache men, on the other hand, frequently exploit resources with relatively high caloric content per kilogram such as honey and game (see Hill and Hawkes, 1983), and employ acquisition techniques and technology that are markedly different from women's. Men walk faster than women, run after game, employ bows and arrows, frequently climb trees, and take the honey of stinging bees. Men seldom carry children and allocate few minutes per day to childcare (see Hill, 1983). We suspected that these differences between the sexes in resource array, acquisition techniques, and extent of provisioning are strongly associated with the character of parental care. We hypothesized that women only exploit resources with low caloric content because such exploitation is more compatible with carrying both children and baskets. If the exploitation of higher return resources were also more compatible with parenting, then the relative contribution by Ache women to the diet would be higher. We tested one of the implications of these propositions with data on Ache female foragers.

The proposition that the extent of provisioning by women is a function of compatibility of resource acquisition with childcare (Brown, 1970), and the caloric value of resources accessible to women is supported by analyses of differences in food production across trips. Depending on the month, women in our sample acquire from 5–23% of the total calories produced by the group (Table II). During months when fruits are in season, women's overall production increases. Therefore, on Trips 3, 5, 6, and 9, when women exploited oranges and other fruit groves, women's food production was higher than on the remaining trips. Analyses comparing the number of calories produced by women on 'fruit" trips to number of calories produced on "palm starch only" trips showed that on fruit trips women produced significantly more calories than on palm starch only trips ($p = .00002$, median test for two independent samples).

Variation in women's productive output results not only from the seasonality of main resources, but also from individual differences. Ache women's food acquisition varies a great deal among women and from day to day. An example of this variability is shown in Fig. 2. Daily productive output from these two trips not only show the differences across trips discussed above, but also differences between women, and across days for individual women. Some women produced few calories while other women produced almost enough to provide for their daily caloric requirements. For example, mean total food production for individual women on Trip 3 ranged from 58–3016 mean daily calories. At the same time, regardless of mean productivity, all women produced calories at least some days and produced no calories on other days.

We proposed that individual differences in food acquisition are produced by childcare constraints. In order to test this hypothesis we compared individual women according to their childcare status. Nursing women were

Table VI. Resources Taken by Ache Women[a]

Ache name	Scientific name	Description	Cal/kg (raw weight)	Acquisition technique
Vegetable				
Tangy	Arecastrum romanzolfianum	Palm growing shoot	595	Chops with axe
Kraku	Arecastrum romanzolfianum Acromia totai	Palm trunk starch	336	Chops and pounds with axe
Vi'i	Arecastrum romanzolfianum Acromia totai	Palm flour	1231	Chops and pounds with axe
Pyta	Arecastrum romanzolfianum	Palm fruit	493	Collects from ground
Brovilla eche	Casimiroa sinensis	Sour orange	487	Climbs tree and/or collects from ground
Boilla	Chrysophyllum gonocarpum	Fruit	748	Climbs tree and/or collects from ground
Challa	Jacaratia sp.	Fruit	707	Climbs tree and/or collects from ground
Puchikytalla	Annona sp.	Fruit	420	Climbs tree and/or collects from ground
Kwantolla	Bromelia valancea	Fruit	531	Climbs tree and/or collects from ground
Membe	Philadendron selloum	Unripe fruit	1429	Climbs tree
Biaju	Philadendron selloum	Ripe fruit	1239	Climbs tree and/or collects from ground
Virella	Campomanesia zanthocarpa	Fruit	706	Climbs tree and/or collects from ground
Kurilla	Rhudia brazilense	Fruit	414	Climbs tree and/or collects from ground
Pretylla	Ficus sp.	Fruit	509	Climbs tree and/or collects from ground

Tayrella	Genipa americana	Fruit	509	Climbs tree and/or collects from ground
Honey				
Chei		Honey	2673	Chops with axe
Kiuagi		Honey	2673	Chops with axe
Kuicha		Honey	2673	Chops with axe
Biva, iro		Honey	2673	Chops with axe
Larvae and insets				
Buchu	Calardra palmarum	Palm larvae	3232	Chops with axe
Pichu	Rhyncophorus palmarum	Palm larvae	3071	Chops with axe
Unsp.		Palm larvae	3152	Chops with axe
Chaka acho		Wood larvae	1822	Chops with axe
Kra'acho		Bamboo larvae	3045	Chops with axe
Cha'acho	Macrodontia cerrocornis	Bottletree larvae	1532	Chops with axe
Brocho		Kwanto beetle	2540	Chops with axe
Meat				
Tatu	Dasypus movemantus	Nine-banded armadillo	1290	Digs out with machete
Bywa	Cuniculus paca	Paca	1620	Collects logs to cover burrow entrances/help men find individuals
Kane	Nasua nasua	Coati	1620	Help men flush trees
Chei		Snake	840[1]	Kills with wooden stick
Pia'a		Bird and reptile eggs	2180	Gathers from nests

[a]Adapted from Hill et al. (in press).

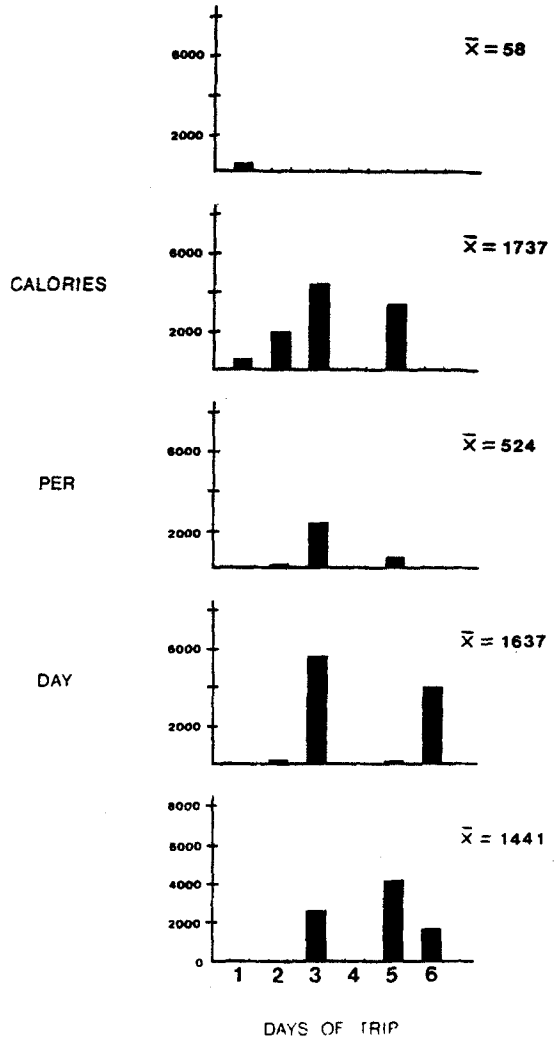

Fig. 2. Daily caloric production for individual women for two foraging trips.

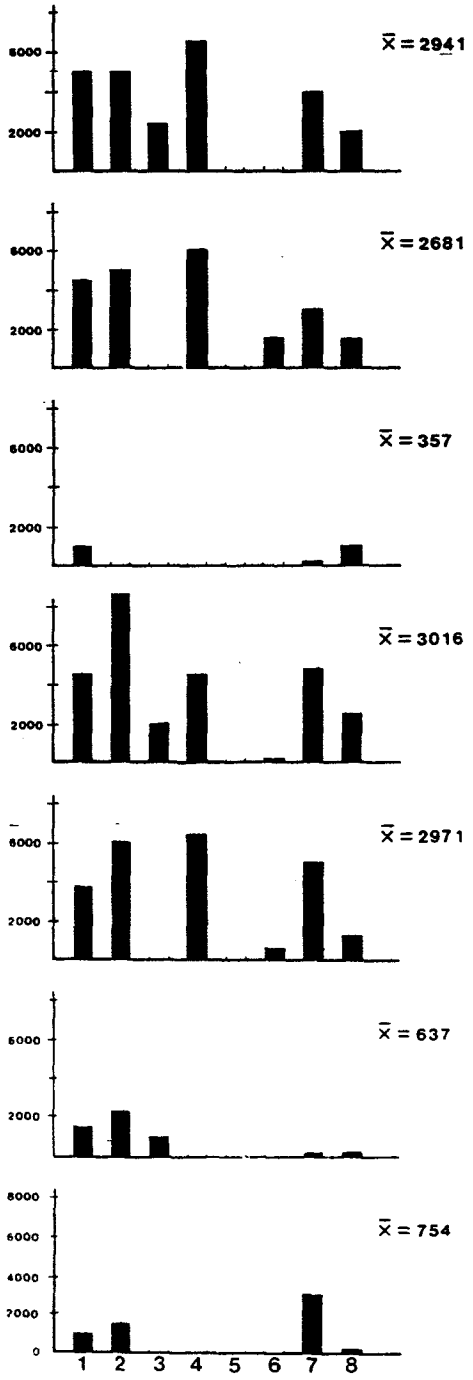

Fig. 2. Continued.

Table VII. Effects of Nursing Status and Number of Dependents on Women's Caloric Contribution[a]

Number of weaned dependents[b]	Nursing	Nonnursing	Results
One or more (n = 14)	−.2	+.2	p = .00044
Zero (n = 5)	−.4	0	p = .00179
Efficiency (calories/hr of palm starch pursuit)	n = 9 events 2601	n = 25 events 3524	p = .05900
Minutes spent in all pursuit (mean rank)	.34	.48	p = .05993

[a]Normalized score = mean calories for all women per trip-individual's mean/standard deviation of mean calories for all women per trip.
[b]n = 25.

expected to be less efficient foragers than nonnursing women due to the constant weight and encumbrance of infants. As children get older, they become less physically dependent upon the mother. This allows mothers to set children down while foraging and to forage for longer periods of time. Hence, nonnursing women were expected to be more efficient foragers. If nonnursing mothers are more efficient and also spend less time directly attending to their children's needs, we might also expect them to produce more calories on a daily basis than do nursing women.

Another factor which should also affect the amount of food produced by women is the number of *weaned* dependents. As the number of weaned dependents, i.e., children between the ages of 3.5–12, increases, the value of women's foraging should increase, since a greater number of offspring may profit from their mother's work effort. Younger dependents acquire few calories for themselves and receive nearly one-quarter of the total vegetable calories they consume from their mothers (Kaplan et al., 1984). As a result, it is expected that as the number of a woman's dependent offspring increases, so will her productive output.

The Ache data support these hypotheses. Nursing women are less efficient foragers than nonnursing women. Table VII shows that nursing women produce fewer calories per hour of palm fiber pursuit than nonnursing women. Even though our sample size of measured events is small (nursing women = nine events, and nonnursing = 25 events), the difference is borderline significant (p = .059).

Table VII also shows the effects of both nursing status and number of weaned dependents on total daily caloric production. Because of large differences in women's production across foraging trips, we normalized the

data prior to testing for differences in productivity between nursing and nonnursing women, and differences according to number of weaned dependents. *Z* values were calculated by subtracting trip caloric means per woman-day from each woman's mean and dividing the result by the standard deviation of the trip's mean. We then ran *t*-tests on randomly chosen pairs of caloric scores for nursing and nonnursing women.

Most nursing women scored negative *z* values while their counterparts with the same number of weaned dependents scored positive values. This means that nursing women produced fewer calories than nonnursing women. These differences were highly significant in spite of low number of cases. Most nursing women in our sample also spent less time in resource pursuit than nonnursing women (Table VII), but once again, due to small sample size, the results are only borderline significant.

Number of weaned dependents, on the other hand, affects women's production in the opposite way. As the number of weaned dependents increases, so does women's food production. Both nursing and nonnursing women in the one or more weaned dependent category produce more calories than their counterparts in the zero weaned dependent category.

In order to test the effect of weaned dependents on production of both nursing and nonnursing women, we ran a correlation between normalized caloric scores for all women and number of weaned dependents. Figure 3

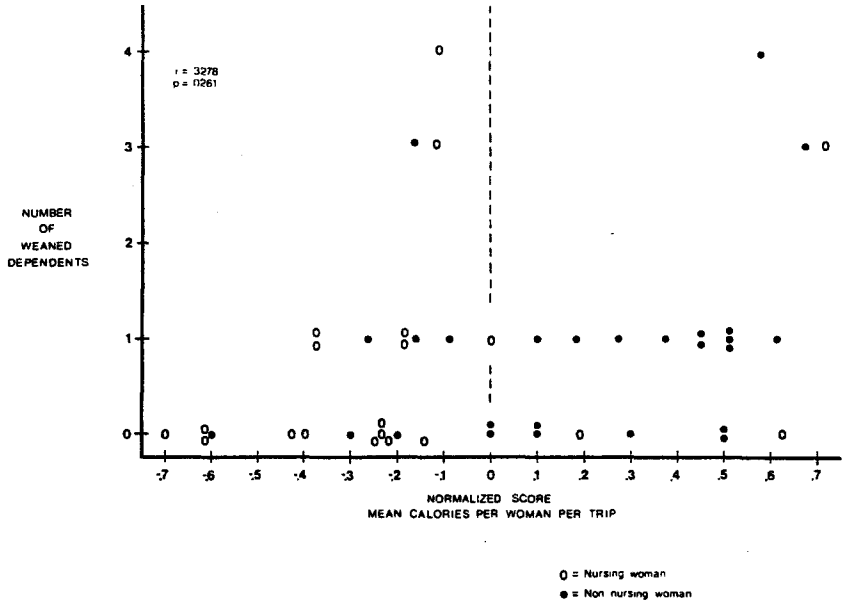

Fig. 3. Mean daily calories produced by individual women according to the number of weaned dependents.

shows the relationship between these two variables. Nursing women are indicated by an open circle, and nonnursing by a closed circle. Even though the relationship between these variables is significant, the *r* value is quite low. Only 10% of the variance across women is accounted for by number of weaned dependents. This suggests that nursing status may be a more important variable determining women's foraging than is number of weaned dependents.

This description and analyses of women's group and individual production support the hypothesis that childcare constrains female foraging in Ache society. Women are the primary caretakers of children, and they are also the secondary providers. It appears that the relatively low levels of female food acquisition may be a function of the low caloric value of resources accessible to them within the limits of compatibility with childcare. When this value increases, so does women's productivity. However, none of the resources available to women foragers in the Paraguayan forest are as high in calories as those frequently exploited by men. Ache males, on the other hand, are not encumbered by household equipment and children. This difference in parental care investment, coupled with the availability to males in this environment of resources with high caloric value, produces a sexual differentiation, where males produce most of the food and women appear to specialize in childcare.

DISCUSSION AND CONCLUSIONS

Description and analyses of female foraging among the Ache suggest that women choose behaviors designed to enhance offspring survival. Women seem to have solved the problem of obtaining energy and allocating time to raising offspring by adopting strategies which increase male productivity, by relying on male provisioning and by spending time and effort in activity types that are readily compatible with childcare and expose the young to minimum risks.

Male provisioning has important implications for female behavioral alternatives. Once women are freed from budgeting time to food acquisition, they are able to use this surplus time for direct parental care. Females are probably also able to increase their fat reserves, and to reduce the length of interbirth intervals (Frisch, Revelle, and Cook, 1971; Konner and Worthman, 1980). These are perhaps the reasons that Ache women spend most of their daily hours in activities that require relatively little energy expenditure and allow them to be in close proximity to children. Dependence on males for food also affects women's decisions regarding how often and when to move camp.

The costly strategy of carrying heavy loads while moving camp may give women high fitness payoffs. By traveling frequently, females probably increase men's foraging efficiency, since hunters can reduce search costs by ranging further. The women can also carry the game the men capture earlier in the day so that men can continue foraging unencumbered. The costs of traveling back to camp with game at the end of the day may be considerably reduced as well. Since men do so well by hunting (see Hill and Hawkes, 1983), women may profit more by moving the household daily than they would by walking less and foraging more for low calorie vegetable resources (Hawkes and O'Connell, 1983, p. 9).

The data suggests that women's travels are not designed to increase female productivity. Women pass numerous edible resources while walking and stop more frequently to rest than to forage. They also fail to disperse during the day, as men do (Hill and Hawkes, 1983), in order to increase encounter rates with vegetable resources. Thus, it appears that the amount of time women spend walking is a strategy designed to increase male hunting returns rather than increase the amount of food that women themselves provide.

An alternative strategy for women would be to hunt or to spend more time in the pursuit of high-calorie resources, such as honey. It is possible that women do not do so because offspring mortality would increase substantially. In fact, there is evidence to support the proposition that women purposely avoid adopting such strategies.

Acquisition data show that women take primarily stationary (vegetable) low risk resources, and acquire mobile (animal), high risk resources infrequently, even though caloric returns are much higher for the latter (Hawkes *et al.,* 1982). Vegetable resources are exploited either by chopping or pounding with an axe, and/or stooping to collect them. Even when women take other resource types, e.g., honey and game, they use similar acquisition techniques. Techniques that require more body displacement and speed, such as running with weapons and climbing trees, are avoided. Women seem specifically to avoid taking resources that increase altricial health risks to their young. Running through the forest with a child might result in bruises and cuts, and climbing trees requires that women leave children unattended.

A possible example of risk avoidance is honey acquisition by women foragers. there are several types of honey in Eastern Paraguay. The more frequently encountered honey, that of *Apis mellifera,* is produced by stinging bees in hives that are found high in trees. Even though women carry the firebrands and axes necessary to exploit this honey, men always acquire it. Instead, women forage only for honey types produced by stingless bees found in lower tree trunks. Once again, the more dangerous activity produces higher caloric returns (unpublished data) but is avoided. Women frequently ex-

pressed fear of bees, and mothers and infants seemed to wait for the honey acquired at a greater distance from the hives than other Ache. Avoidance of health risks seems to be the best explanation of the reluctance women exhibit in the acquisition of honey produced by *Apis mellifera.*

Another possible example of risk avoidance is infrequent involvement in hunting by women. Even though women sometimes carry bows and arrows and machetes, they very seldom hunt animals upon encounter. If game is encountered by women, men are usually called to make the kill. When women help hunters, they primarily act as "extra eyes and ears." In only two out of 63 focal women-days of observation were women observed actually hunting rather than helping men, and only for small terrestrial game. Nevertheless, in a previous field session, a woman was once observed using the more dangerous technique of hand hunting coatis. The woman was also carrying an infant at the time. This event suggests that Ache women are capable of hunting but avoid doing so most of the time.

The proposition that women choose behaviors that enhance offspring survival is supported by analyses of differences in female energy capture according to childcare status. It was seen that nursing women are less efficient foragers, spend less time than other women in resource pursuit, and produce fewer calories per day. This suggests that lactating women allocate more time and effort to the young than nonlactating women. Nursing status, however, only accounts for some of the differences among women. Number of weaned dependents is also an important determinant of women's food acquisition.

The effects of number of weaned dependents are more complex than the effects of nursing status. Even though weaned young benefit from the extra calories mothers produce, they also gain from their mothers' extra attention and direct care. Hence, as the number of weaned dependents increases, increases in food production and in childcare are both possible but competing strategies. Women probably solve this problem by foraging for as long as the benefits for this activity are higher than the costs of leaving weaned dependents unattended. In practice, this means that more weaned dependents mean more time spent foraging for Ache women.

There are several features of Ache women's foraging which remain unexplained. Figure 3 shows that in both the zero dependent and one dependent categories, some individuals score very high and very low. Two important questions arise: what are high producers gaining from the extra work, and why are low producers able to abstain from producing more? Large differences in caloric contribution among individuals having the same number of dependents still remain unaccounted for.

In addition, while women with both infants and weaned dependents are constrained by childcare, women without children are not. Not only do we need to explain why nonnursing women with zero dependents produce

more calories than nursing women with one or more weaned dependents (Table VII), but also why they do not adopt male foraging strategies.

Cost-benefit analyses of female foraging behavior may allow us to better understand phenomena such as hunting by Agta women (Estioko-Griffin, 1981; Goodman, Griffin, Estioko-Griffin, and Grove, 1983; Estioko-Griffin). They hunt frequently and use some male foraging strategies. One of the costs of this behavior seems to be high infant mortality (Estioko-Griffin and Griffin, n.d., p. 15). Close examination of the Agta case might show that if females were to spend more time with children and collecting vegetables at the expense of hunting, fertility rates would decrease. It is possible that male hunting alone is insufficient for adequate provisioning of both mothers and young. It may be that competition with local horticulturalists who are impinging upon the traditional foraging range of the Agta has reduced encounter rates with game considerably. Even though children may die frequently owing to women's hunting activities, overall reproductive success might still be higher than if women did not hunt at all. Therefore, Agta women may have solved the problem of food acquisition and simultaneous competent parenting by acquiring more food at the expense of increased risk to infants.

This analysis of hunting among Agta women points to the futility of using the behavior patterns of one human population as representative of all others, e.g., the Kung model for female hunter-gatherer behavior. There is no *a priori* reason to believe that regardless of ecological context, women should concentrate in hunting (Harris, 1979), gathering, or contribute most of the calories consumed by the group (Lee, 1979). The study of fitness tradeoffs associated with individual behaviors, then, allows us to begin to understand differences in subsistence work between Agta and Ache women, for example.

This brings us to the important question of the validity of our sample population for understanding hunter-gatherer behavior. The mission colony is of central significance in the lives of Ache women. We must consider the effects of a new settled way of life on women's parenting and resource acquisition decisions during periods of time when they depend entirely on forest foods.

Incorporation into a state-level society may affect Ache women foragers in the following ways. Children and adolescents currently attend school at the mission, and only a few joined some of our foraging trips. The presence of fewer children may have an important effect on women's work effort in the forest. It is possible that the Ache now travel longer distances and move camp more often because women are less burdened by the care of children who are too old to ride on baskets but too young to walk as fast as adults. As a result, men might hunt over larger areas because women travel faster.

And yet, women only walked a mean of 5.7 km per day in our sample. It is possible that the daily distance covered by the group is a function of the slowest traveling unit, i.e., mother and children, and since there is at least one such unit in every foraging trip we monitored, distances traveled may be the same as before contact.

The low representation of adolescents in foraging trips may also affect women's foraging decisions. Women's opportunities to forage without children may be fewer today due to the absence of girls in the 10–16 age group. Evidence from other societies (Denham, 1974; Weissner and Gallimore, 1977) and nonhuman primates (Hrdy, 1976) show that adolescent females frequently help mothers care for the young. Before contact, help from adolescent girls may have allowed women to spend more time foraging than they currently do. This might counterbalance the effect of fewer young children on foraging trips. Lastly, fewer dependents may cause women to produce less simply because there are fewer children to feed.

Similarly, the number of nursing women in the Ache population may be higher today than prior to contact. Children are frequently treated for respiratory and other health problems at the mission, and this assistance has substantially decreased infant mortality (Hill, unpublished data). The change from a nomadic to a settled way of life amy have also increased women's fertility (see Sussman, 1972 for a discussion on the effects of mobility on women's fertility). Our data show that nursing women spend less time foraging than nonnursing women and produce fewer calories. If the number of nursing women in Ache society is higher today than in pre-contact bands, women's overall food production in the forest is probably lower today than in the past.

While at the present time we are not able to accurately assess the extent to which changes in childcare produced by a settled way affect female foraging, in the future we may be able to make strong inferences about the character and extent of recent changes in women's behavior by recording differences in their work under differing conditions.

In summary, even though modeling optimal solutions for female behavior choices is currently difficult, we can offer carefully considered guesses about the fitness payoffs for various behavioral strategies guided by data on parenting and energy capture by both men and women of various human populations. The research has pointed out that female time allocation strategies are partially determined by parenting considerations. In order to explain the various levels of work by women across different cultures, we must know something about subsistence behaviors of other members of the population and about food sharing, in addition to the character of resources available for exploitation and parental investment patterns. The child mortality costs of various risky but high-return foraging

strategies may explain why women often fail to produce as much food as men. An examination of the alternative strategies available to both men and women under these conditions may lead to a new understanding of the origin of sexual division of labor.

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