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Ache at the Settlement: Contrasts between Farming and Foraging

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The Northern Ache comprise a small continuously interacting population with a shared community history. Full-time hunter–gatherers until recently, they now divide their time between mobile foraging and settled farming. Here we describe adult time allocation at the settlement and contrast it with our previous descriptions of time allocation during foraging periods. We report that at the settlement men and women work fewer hours each day than they do in the forest, people eat less, women do more work apart from their children, and men invest more in direct parental care. Explanations for differences in time allocation between foragers and farmers should apply to the variation in work effort, production goals, division of labor, and parenting strategies reported here, and conversely.

KEY WORDS: time allocation; sexual strategies; subsistence changes.

INTRODUCTION

The Northern Ache of Eastern Paraguay were full-time hunter–gatherers until the 1970's. Now they divide their time between mobile foraging and settled farming. Between these two modes of subsistence and settlement, their behavior varies along dimensions which may be crucial for understanding

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both causes and consequences of agricultural origins, permanent settlement, and sexual hierarchies. However, the variation observed here does not take the form suggested in common forager–farmer comparisons. Four contrasts are salient.

First, the Ache do not display the lower work effort attributed to most hunter–gatherers (Sahlins, 1968, 1972; Lee, 1968; Cohen, 1977; Harris, 1977). They work harder at hunting and gathering than they do at farming. Second, in contrast to the view that "limited needs" curtail work effort (Sahlins, 1968, 1972) the Ache apparently eat more, especially more meat when foraging *because* they invest more time in subsistence. Third, the differences between the work regimes of men and women are greater in the forest than at the agricultural settlement. Finally, while women invest more time in direct child care than do men, there are important differences in child care between the two subsistence contexts. Women do more work away from their children and men seem to be involved in more direct parental investment at the settlement than in the forest (Draper, 1975).

These departures from common expectation offer an opportunity to seek the factors which predict differences in work effort, production goals, divisions of labor, and parenting strategies. Explanations are required which can account not only for the Ache patterns but for the broader range of variation in human societies. If large-scale differences begin on a small scale, explanations of cultural variation over wider reaches of time and space ought to accommodate the patterns of variation displayed by the Ache. Conversely, explanations for the Ache patterns should be consistent with different instances of cultural transition in the present as well as the past.

We have described several aspects of Ache behavior during periods of mobile foraging. These include foraging strategies (Hawkes, Hill, and O'Connell, 1982; Hill and Hawkes, 1983; Hill, Kaplan, Hawkes, and Hurtado, 1987), seasonal patterns and diet (Hill, Hawkes, Kaplan, and Hurtado, 1984), food sharing (Kaplan, Hill, Hawkes, and Hurtado, 1984; Kaplan and Hill, 1985a), men's and women's time allocation (Hill, Kaplan, Hawkes, and Hurtado, 1985; Hurtado, Hawkes, Hill, and Kaplan, 1985), the relationship between hunting ability and reproductive success (Kaplan and Hill, 1985b), and trade-offs between parenting and mating (Hill and Kaplan, 1986). This paper has two aims. The first is to report aspects of the behavior of this population at the agricultural settlement to complement our previous reports of behavior in the forest. The description allows us to consider three kinds of variation in Ache time allocation: (1) that between men and women, (2) that among adults of the same sex, and (3) that between the forest and the settlement. While no specific hypotheses are tested here, progress toward an explanation of this variation is the second and larger aim of the paper. Our theoretical perspective leads us to focus on co-variation between two kinds

of variables in seeking to account for the patterns of time allocation which we have observed. These include individual characteristics which are likely to affect the reproductive costs and benefits of particular activities on the one hand, and aspects of ecological context also likely to affect those costs and benefits on the other.

The paper begins with a brief outline of this theoretical perspective. Then, the study population is introduced, followed by behavioral variation within it. The settlement is described, and an explanation given of methods of observation there. Results are reported, paying special attention to variations in time allocation between and within the sexes across the two subsistence and settlement contexts.

Discussion of the patterns and some of the questions they raise follow. Finally, there is a review of the contrasts between the Ache variation and forager–farmer differences noted elsewhere.

THEORETICAL PERSPECTIVE

This research has been guided by the theoretical perspective of behavioral ecology which directs attention to the fitness trade-offs individuals make as they pursue alternative strategies for surviving, mating, and parenting. Theory says that to the extent that natural selection has shaped behavior, it has spread heritable characters which increase the relative reproductive success of the individuals carrying them. Populations are then made up of individuals who usually act in ways likely to maximize their reproductive success, or, more generally, who usually choose among available behavioral alternatives so that their overall fitness is likely to be greater than it would be if they chose differently. Many behaviors can only be performed at the cost of foregoing or modifying others. That is, they have an opportunity cost: the value of alternatives foregone. Which alternative nets higher benefit depends upon (1) the kind of benefit at issue, (2) the characteristics of the individual actors, and (3) characteristics of the choices.[4]

The point is a general one, there are trade-offs in the costs and benefits of all dimensions of fitness.

Classic empirical illustrations in evolutionary biology include trade-offs between the quantity and the quality of offspring (MacArthur and Wilson, 1967; Lack, 1968), between early reproduction and adequate parenting (life-history studies reviewed by Stearns, 1976), between investing more in daugh-

[4]One of the elements of the formalist–substantivist debate of the 1960's might be characterized as the ethnographic observation that pursuit of money profit is not everywhere fitness enhancing (Sahlins, 1969). The challenging task is to explain how and why different patterns of behavior net higher fitness benefits in different times and places.

ters or sons (Fisher, 1930; Charnov, 1982), between mating advertisement and predator attraction (Darwin, 1871; Haskins, Haskins, McLaughlin, and Hewitt, 1961; Haas, 1976; Endler, 1978), and between taking a ready food item and looking for something better (MacArthur, 1972; Pyke, Pulliam, and Charnov, 1977; Smith, 1983).

Optimal solutions vary with details of particular situations which determine the fitness costs and benefits and the opportunity costs associated with alternative adjustments.

This cost–benefit perspective has revolutionized the study of animal behavior in the past few years (Williams, 1966, 1980; Stearns, 1982; Krebs and Davies, 1984). Although many of the modeling techniques were originally developed to deal with human behavior, their use in biology is warranted not by assumptions of actor rationality but of natural selection and population genetics (Maynard Smith, 1978a, 1982). Paradoxically, this theoretical foundation in biology provides especially strong grounds for the application of the models to human behavior (Alexander, 1977; Flinn and Alexander, 1982). Extreme phenotypic flexibility would have been favored by selection if it included sensitivity to changing fitness opportunities and a tendency to take rapid (fitness) advantage of them.

These fitness costs and benefits will vary for similar activities across a population, depending, for example, on sex, age, reproductive status, family circumstances, personal resources, skills, and capacities.

THE ACHE

This research was conducted with one of the four living Ache groups, the Northern Ache. Before the 1970's, the Northern Ache numbered 600–800 (Hill, 1983), hunting and gathering in a range extending from 24–25° south and 54–56° west. This forested area, cross-cut by many rivers and streams, receives about 1600 mm of rainfall each year. Extreme yearly temperatures range from less than 0°C to the upper 30's C (see Hill *et al.,* 1984 for more ecological description). The first modern ethnography of Ache populations (Clastres, 1968, 1972) did not pertain to the Northern Ache who remained full-time foragers in only hostile contact with outsiders through the 1960's. Subsequently, they settled in mission-sponsored colonies (see Hill, 1983) but continued to spend time on extended foraging trips during which they lived much as they had before settlement. These periods of hunting and gathering provided us the opportunity to systematically observe aspects of their behavior under the constraints provided by life in the forest (Hawkes *et al.,* 1982; Hill and Hawkes, 1983; Hill *et al.,* 1984, 1985; Hill, Kaplan, Hawkes, and Hurtado, in press; Kaplan *et al.,* 1984; Kaplan and Hill, 1985a,b;

Hurtado, 1985; Hurtado *et al.*, 1985; Hill and Kaplan, 1986). Description of the settlement will allow comparison between the two contexts, exploration of individual variation within each, and some assessment of the possible effects that the opportunities at the settlement may have on behavior in the forest, and conversely.

The Settlement

In 1978, the Divine Word Order of the Catholic Church purchased about 1200 ha of land along the Jequi Guasu river, about 35 km north of Curuguaty in the Canendiyu Province of Eastern Paraguay to establish a mission agricultural colony for the Ache. Most members of this colony had been living in a temporary mission settlement at Arroyo Manduvi since 1975, but about half of them returned to the forest between Janaury and July of 1978 while Divine Word searched for land to purchase (Hill, 1983).

Once established, the staff of the mission normally consisted of the priest in charge, a seminary student, one or two nuns who cooked and managed domestic matters for mission personnel and some services to the Ache residents, one or two teachers who ran a school for children and sometimes adults, and a visiting nurse. The mission services included distributions of food and clothing, occasional communal meals, the school, church services (held not by the mission staff but by Ache who had become Christians in a colony run by Protestant missionaries and who had then moved to Chupa Pou), and a pharmacy from which medical aid was dispensed by the nurse, or, in her absence, other mission staff. In 1984–1985 the mission staff had been cut substantially, to a priest who was a part-time resident, two school teachers who left the settlement on weekends, holidays, and school vacations, and temporary rotating medical help. Free distributions of food and clothing had stopped, although medical services were still provided without charge.

The colony, named Chupa Pou, has become home to a fluctuating population of approximately 200 Ache. During 1981–1982, when data reported here were collected, about 50 Ache families had built houses and were farming at Chupa Pou. About 25 ha of corn, manioc, beans, peanuts, sweet potatoes, and sugar cane were under cultivation. During this period, much of the agriculture was communally organized. Large fields were cleared and planted by teams composed of most of the adult men, although some men were beginning to clear small plots with the aid of only one or two others. Agricultural labor varies seasonally. Our observations cover mid-November through April when new fields were being cleared. But this period does not include the months of most clearing and planting when work may be heavier.

During 1981–1982, most of the houses were spread over a cleared area of about 500 m^2 surrounded by forest. This concentration of houses was ap-

proximately half a kilometer from the river on one side and 3 km from the public road on the other. Fields were cleared and planted through a semicircle with a radius set by the houses and the road. Weaned children rarely accompanied their parents to the fields which could be up to 3 km from the domestic area. The main water sources were two springs about 50 m from the closest houses and about 500 m from those furthest away. A few deep pit latrines had been dug at the forest edge. The main bathing and washing area was the river, although people who lived most distant from it often used a nearer stream. The river was also fished, both with hooks and lines and with the traditional method in which large groups of men and women roll a temporary brushwork barricade constructed by the men through a lagoon, trapping fish in an ever smaller area. Short trips of a few hours to a day into the surrounding forest brought some wild resources for consumption at the settlement.

In 1981, the mission staff spent 338,762 Guaranies on food for the Ache (US $1,732; G200 = US $1). The range was from an unusually low $2.50 in June, to an unsually high $330 in August, with an average of $141 each month, or about $2.90 per family per month. Much of this was distributed in communal meals and family allotments.

The mission food purchases for the Ache during the months of November and December of 1981 were $107 and $105, respectively, including sugar, rice, galletas (hard crackers), fat, oil, flour, powdered milk, noodles, and tinned sardines. The amounts converted to calories are 1,166,550 calories (kcal) in November, 1,118,100 calories in December.[5] This is about 760 calories per family daily, or less than 200 calories per person per day. In addition to allotments, Ache residents bought food from mission stores. They also bought clothing and tools. The mission transactions for our sample of 42 adults from October 1981 to April 1982 show total Ache expenditures equivalent to $900 or an average of $6.14 per family per month. Most of the purchases (75%) were made by men. Only 5% of these expenditures are on food: $0.30 per family per month.

The Ache also bought food from a store run by Paraguayan peasants located at the margin of the colony. From the beginning of February through April 1982, our sample of adults spent the equivalent of $14.48 at this store, 90% of it on food. That is just over $0.46 per family per month. Again most purchases (96%) were by men. The prices at this store were significantly higher than mission prices. People probably purchased goods there when they were not available at the mission. Food purchases included sugar, galletas, rice,

[5]Caloric equivalents, here and throughout, are calculated from food tables for Latin America (Leung, 1961).

oil, noodles, farina, salami, coca cola, and candy. The amounts converted to calories total 52,696. This is about 836 calories per family per month, around 7 calories per person per day.

Ache money expenditures averaged less than $7 per family per month. Money for these purchases came from occasional wage work away from the colony, and from the manufacture of traditional items: fans, mats, baskets, bows, and arrows, which the priest purchased and transported for sale to dealers in native crafts.

In total, the records of the mission and of the peasant store show Ache consumption of about 200 calories per person per day from imported food. Most of this came from mission charity. More than 90% of the Ache diet at the settlement came from local sources, the major proportion from their own subsistence agriculture.

METHODS

To compile a record of time budgets at the settlement we used a version of scan sampling. This technique has been employed in studies of primate behavior (Altman, 1974) and child development (Blurton Jones, 1972). Anthropologists and cross-cultural psychologists have increasingly used it to collect quantifiable records of everyday behavior in small-scale societies (Johnson, 1973; Konner, 1976; Hames, 1979; Gross, Eiten, Flowers, Leoi, Lattman Ritter, and Werner, 1979; Werner, Flowers, Lattman Ritter, and Gross, 1979; Draper, 1975; Nerlove, Roberts, Klein, Yarbrough, and Habicht, 1974; Munroe and Munroe, 1971; Rogoff, 1981; see Gross, 1984 for review; see Borgerhoff-Mulder and Caro, 1985 for further discussion).

The observation day at the settlement was 720 min, compared to 722 min for women (Hurtado *et al.*, 1985) and 705 for men (Hill *et al.*, 1985) in the forest. Observations cover daylight activities only. We divided the day into five 2.4-hr time periods, and sampled these periods in random order between November 11, 1981 and April 30, 1982. Our main concern was forest observations. Consequently we were away from the settlement for much of this period and did not observe activities there on all days. Observations were made on 8 days in November 1981, 11 days in December of 1981, 4 days in January of 1982, 16 days in February 1982, 9 days in March 1982, and 2 days in April 1982. Our sample of subjects consisted of 22 men and 23 women, mostly spouse pairs, chosen because they were people on whom we had extensive forest data. One man and two women were absent from Chupa Pou during so much of the data collection period that they are deleted from all but the pooled figures. A series of random sequences of these 45 individuals was established by drawing their numbers blindly, without replace-

ment, and these sequences were joined to form a long guide for observations. During each sample period, subjects were assigned to 10-min segments in the order in which they appeared in the guide. During the first part of the field period subjects were assigned to 13-min periods with 11 observations during each 143-min period (hence the division of the day into five 2.4-hr periods). We then found we could shorten the observation time to 10 min per subject. We also relaxed an initial rule so that when subjects whose number came next in sequence were away from the settlement, their absence was recorded and their observation slot assigned to the next subject in line. The observer sought out each subject and noted the location, activity, and company of the subject when first observed during the assigned 10 min. Where the observer was unable to judge which of two apparently coincident activities was observed first, both activities were recorded. By binding subjects to 10-min periods, we reduced the bias toward observations of group activities which would be marked without such a rule (Hawkes *et al.,* in press).

Child care, although it may be among the most important ways people spend time, is not coded as an activity category because passive monitoring is largely invisible with this observation technique. Only active interaction with children, nursing, grooming, comforting, and feeding, was distinguished by our coding. Much of the time adults spend in the company of their children may be understood to include childcare. The amount of that time may be better index of direct care than are observations of active interaction.

Subjects were often located through inquiry. When they could not be found and were reported to be at the settlement but in the fields some distance from the residential area, and either clearing, cultivating, or harvesting, this report was recorded. Because many activities other than food acquisition might take place during trips to the fields, the food acquisition time we report must be considered a maximum. This procedure resulted in 694 "spot checks" of men's activities, with a mean of 32 per man, and 574 spot checks of women's activities, a mean of 29.

The age range of our sample is limited to active adults. Children under the age of eight were counted as dependents.

RESULTS

The spatial distribution recorded in the scan samples is shown in Table I. Since subjects were chosen partly because we spent time with them in the forest, the data may biased in the following way: if subjects were more likely to be in the forest at the same time we were, i.e., if their foraging trips were the ones we accompanied, the days we made observations at the settlement may have tended to coincide with days they were more likely to be there as well. During the 6-month period in which the settlement observations were

Table I. Spatial Distribution

Location	Percent of total observations	
	Women	Men
Forest[a]	16.5[a]	16.4[a]
Peasant store	1.5	5
Away unknown[a]	11.7	14.7
At settlement	73	67.4
	Percent of settlement observations	
	Women	Men
Own house	58.1	50.1
Other house	5	4.5
Public space in domestic area	30	35.1
River	5.2	5
Fields	5.1	6

[a]Away unknown includes some undetermined fraction of time in the forest.

collected, we spent 65 days observing behavior in the forest. On 55 of those days, no observations were made at the settlement. During those 55 days, 33% of the total man days and 28% of the total woman days lived by our subjects were spent on foraging trips we accompanied. If we assume that our observations at the settlement represent typical patterns for the people we did not observe in the forest during those 55 days, the minimum proportion of time in the forest for our settlement sample of subjects was 44% for men and 39% for women. Combining the figures of 44 and 39% for men and women, respectively, over 55 days with the figure (in the table) for the 125 days when we might have observed them at the settlement, the corrected proportion of time spent in the forest by our settlement sample of adults during the period from November 1981 through April 1982 was a minimum of 25% for men and 22% for women. This is a minimum because the time away from the settlement which is coded as "unknown" includes not only time visiting other colonies, and time spent in wage work, but also includes an unknown fraction of time in the forest. Table II itemizes the eating observations. Table III reports the company people kept. Tables IV and V show average time allocation at the settlement. For comparison, these tables also cite time allocation patterns for the forest which have been reported and discussed elsewhere (Hill *et al.*, 1985; Hurtado *et al.*, 1985). The differences in time allocation patterns among members of the same sex provide an opportunity to explore some of the trade-offs which may underlie the activity

Table II. Eating Observations

	Number of observations
Ache crops	
Corn	23
Manioc	15
Sweet potato	12
Peanuts	7
Sugar cane	6
Squash	1
Tuber (?)	1
Bean and corn soup	1
Bean and manioc soup	1
Melon	1
Total	68
Meat	
Fish	6
Capybara	3
Sardines[a]	2
Burro	1
Pig	1
Chicken	1
Bird (?)	1
Palm larvae[b]	1
Total	16
Meat and other	
Chicken and rice	2
Burro and noodles	1
Beans, noodles, and paca	1
Manioc and armadillo	1
Manioc and capybara	1
Total	6
Imports	
Galletas (crackers)	5
Cookies	1
Beans and noodles	1
Rice	1
Milk	1
Flour/oil porridge	1
Lollipop	1
Total	11
Gathered products	
Virella (fruit)	1
Palm starch	1
Membe (fruit)	1
Palm heart	1
Total	4

[a]Sardines are imports.
[b]Palm larvae are gathered products.

Table III. Company at the Settlement

	Percent of observations where company known[a]	
	Women	Men
Alone	9	11
With only own children	18	5
With only family (children and spouses and/or other primary kin)	27	31
With only same sex adults	5	2
Same sex adults and own children	6	1
Mixed sex adults	15	23
Mixed sex adults and own children	10	-
Mixed sex adults, spouse, and own children	5	4
Other	5	6
Total with children	56	31

[a]In 29% of the checks on women, and in 38% of the checks on men, company was not recorded.

Table IV. Women's Time Allocation—Forest and Settlement Compared

	Minutes per day		
		Settlement[b]	
	Forest[a] ($\bar{X}$)	$\bar{X}$	*SD*
Carrying	114		
Acquiring food	79	63.0	±50.11
Processing food	32	99.9	±76.0
Eating	64	75.0	±53.0
Sitting/standing	266	170.4	±98.6
Making/fixing tools	71	102.8	±86.3
Building/maintaining camp	42	14.6	±23.9
Playing sports	-	4.5	±11.3
Watching sports	-	20.7	±29.1
Other mission[c] activities	-	37.6	±32.7
Grooming	21	39.8	±50.8
Active interaction with children	16	94.1	±91.82
Other	17		

[a]Observation day = 722 min (Hurtado *et al.*, 1985).
[b]Observation day = 720 min.
[c]These include visiting the pharmacy, the school, the church, etc.

Table V. Men's Time Allocation—Forest and Settlement Compared

	Minutes per day		
		Settlement[b]	
	Forest[a] ($\bar{X}$)	$\bar{X}$	*SD*
Acquiring or producing food	373	115.4	±62.6
Processing food	18	50.8	±40.8
Eating	86	92.4	±50.4
Sitting/standing—no object manipulation	155	220.0	±112.4
Making/fixing tools	36	24.7	±31.8
Building/maintaining camp/house	8	67.7	±52.1
Playing sports	-	39.9	±63.3
Watching sports	-	33.8	±34.5
Other mission[c] activities	-	20.0	±37.2
Grooming	18	32.2	±35.5
Active interaction with children	10	21.7	±24.7

[a]Observation day = 705 min (Hill *et al.*, 1985).
[b]Observation day = 720 min.
[c]These include visiting the pharmacy, the school, the church, etc.

patterns. Table VI and VII show the number of observations of each subject in 11 activities. Subjects are also coded for birth year, number of dependents, birth year of their youngest child, and women are coded for nursing status.

Because the sample of observations for each individual is small, the conservative test for association is a Spearman rank order correlation. But small samples also increase the possibility of missing an association actually present in the universe of interest. We therefore use Pearson correlations which are sensitive to the magnitude as well as the direction of differences. These are reported in Table VIII. Since some readers may dispute the appropriateness of this test, Spearman correlations are also reported. Note that many of the correlations which are significant by the former test, do not prove significant with the latter. A few show the contrary pattern. We remain cautious about our interpretation of these results.

Location

The variations among individual women in this sample in the proportion of checks which found them in the forest is from 3–46%.[6] The follow-

[6]Because the number of observations of each individual is so small, this range must reflect a large sample error here and throughout.

ing summary refers to statistics reported in Table VIII (only those statistics not reported in the table are included in the text). Time spent by women in the forest is *not* correlated with age, or with number of dependent children, nor does it vary with nursing status (Wilcoxon rank sum $p = .55$). There may be a slight tendency for women with younger children (under age 8) to go into the forest less, and the women who make more mission purchases may spend less time in the forest. Women's time in the forest is correlated with the time their husbands spend there.

The range in the proportions of checks which found men in the forest is also from 3–46%. There is a trend toward older men spending more time in the forest. Surprisingly, men's time in the forest does not correlate with their average hourly hunting return rate, i.e., there is no tendency for better hunters to spend more time on foraging trips. Average hourly hunting returns, measured in calories, for a sample of hunters show consistent ranking across the 1980 and 1981–1982 field seasons (Kaplan and Hill, 1985b). The overall average for the 13 men also in the settlement sample is the basis of this test. On the other hand, time in the forest is negatively associated with mission expenditures for men. (Mission expenditures, in turn, are negatively correlated with age). In contrast to women's time, a man's time in the forest may be affected by the number of his dependents. This effect is especially strong for men whose wives are nursing. Men's time in the forest also declines the younger his smallest dependent.

At the settlement, the spatial distribution of the sexes is strikingly similar (Table I). The large proportion of time that adults spend alone or with only their family in their houses is one of the marked social contrasts to life in the forest. This is especially so for women who are almost always within sight and sound of other women when they are in the forest as they walk together and occupy small camps with family hearths only a few meters apart. Men, on the other hand, may be more or less alone during stretches of their hunting day, although they are likely to be in regular audio contact with other hunters. Location at the settlement is patterned by age, older men and women spend more time at home (Table VIII).

Diet

The Ache diet in the forest (Hawkes *et al.*, 1982; Hill *et al.*, 1984) is rich in calories with a large meat fraction. Calories per consumer per day in our sample of forest observations vary across the year from 2535–5585 with a mean of 3827. Seasonal fruits and honey account for most of the fluctuation whereas meat makes a rather steady contribution as the major diet component, providing 47–77% of the calories (Hill *et al.*, 1984).

The diet at the settlement is clearly different. In 16% of the eating instances, meat alone was eaten and 22% of the observations include meat

Table VI. Observations of Women

Subject	Acquiring food	Processing food	Eating	Sitting/standing – no object manipulation	Tool making/fixing	Building/maintaining camp or house	Playing sports	Watching sports	Other mission activities	Grooming	Active interaction with children	At own home	Observations present at settlement	In forest	Away unknown	Total times scanned	Year born	Number of dependents	Nursing	Birth year of youngest
31	3	4	2	3	3	0	1	2	3	1	0	9	21	5	2	28	57	2	0	78.5
32	3	5	0	4	10	1	0	0	0	2	0	20	25	2	1	28	40	1	0	76
33	2	7	4	1	2	3	0	1	1	3	1	17	25	3	1	29	47	2	1	80
34	2	2	3	9	0	0	0	2	0	4	2	11	24	3	0	27	55	2	[a]	[a]
35	2	3	3	12	3	0	0	0	1	0	0	17	25	4	6	35	40	2	0	79
36	1	8	4	7	5	1	0	0	1	1	6	26	33	1	1	35	38	1	1	80.5
37	1	2	5	6	7	0	0	0	2	1	6	19	30	0	0	30	45	2	1	81.5
38	1	1	5	4	3	0	0	0	1	0	0	11	14	17	1	32	49	1	0	74
39	2	2	1	0	2	0	0	1	0	0	0	2	9	0	22	31	40	2	0	77

40	0	6	0	7	6	0	0	0	3	0	7	19	29	2	0	31	47	2	1	[a]
41	3	3	2	5	1	0	0	3	3	1	3	6	22	2	10	34	60	1	[b]	[b]
42	7	3	0	2	0	1	0	0	1	6	0	6	19	7	4	30	55	0	0	-
43	5	4	2	8	4	0	0	0	0	0	0	12	27	1	0	28	47	1	0	71
44	1	1	1	4	3	0	0	0	1	2	9	9	18	5	1	24	54	2	1	81
45	1	1	2	7	6	1	0	0	0	3	7	21	28	5	0	33	51	2	1	81
46	2	2	5	6	1	1	1	2	1	0	3	11	25	6	1	32	52	1	1	81
47	2	2	3	5	1	1	0	1	2	1	2	12	22	6	0	28	56	1	1	80
48	1	0	2	3	0	0	0	1	2	0	4	6	15	3	11	29	56	0	1	81
49	2	1	4	1	1	0	0	0	1	1	3	9	14	9	4	27	45	2	1	81
50	2	1	1	9	6	0	0	0	1	0	1	11	20	9	3	32	48	2	[c]	[c]
51	1	2	1	9	5	1	0	0	0	1	6	19	28	3	0	31	58	1	1	81
52	1	8	1	4	1	0	1	1	1	0	4	12	19	9	2	30	52		[d]	79
53	0	0	0	2	0	0	0	0	0	0	0	1	2	2	6	10	50	?	?	79
Totals	43	68	51	118	70	10	3	14	25	27	64	280	492	111	79	674				

[a]Baby born in February.
[b]Baby died in January.
[c]Baby born in April.
[d]Baby weaned in February

Table VII. Observations of Men

Subject	Acquiring food	Processing food	Eating	Sitting/standing – no object manipulation	Tool making/fixing	Building/maintaining camp or house	Playing sports	Watching sports	Other mission activities	Grooming	Active interaction with children	At own home	Observations present at settlement	In forest	Away unknown	Total times scanned	Year born	Number of dependents	Birth year of youngest
1	1	0	1	10	0	3	5	2	2	1	1	8	27	1	3	31	58	2	78.5
2	5	3	5	7	2	1	0	1	0	1	0	18	22	3	6	31	35	1	76
3	4	2	4	6	0	2	4	2	1	0	1	14	25	5	3	33	49	3	80
4	5	0	2	6	1	1	6	3	0	0	0	11	25	8	1	34	47	2.5	[b]
5	2	2	2	8	1	3	0	0	0	2	0	16	23	3	7	33	38	1	79
6	3	3	3	0	3	3	1	1	0	3	1	12	22	3	1	26	46	1	80.5
7	4	1	3	13	2	1	0	0	0	2	1	19	26	4	2	32	44	3	81.5
8	0	2	2	6	2	4	0	0	0	0	0	12	18	16	1	35	32	0	74
9	3	2	1	2	0	1	0	1	1	0	0	3	11	4	16	31	41	[a]	77
10	1	3	1	9	0	6	0	0	0	0	0	11	20	7	4	31	52	3	[b]
11	3	0	1	7	0	0	0	3	4	0	1	3	20	2	16	38	54	1.5	[a]
12	8	1	1	3	0	1	4	0	0	0	0	3	16	7	6	29	47	0	-
13	3	1	3	5	1	3	1	0	0	1	0	6	18	9	3	30	34	[a]	-
14	4	2	2	11	1	2	0	1	1	1	1	17	25	3	4	32	48	[a]	-
15	2	0	3	13	0	0	0	2	3	0	1	9	24	1	5	30	46	3	81
16	4	1	3	7	0	3	2	2	0	2	0	12	26	7	1	34	50	2	81
17	4	2	6	2	0	3	1	1	0	1	1	7	23	5	4	32	57	2	80
18	6	2	1	5	0	0	0	0	0	2	1	11	16	3	4	33	57	1	81
19	5	2	4	5	0	3	2	2	0	0	1	9	23	6	7	36	53	[a]	[a]
20	1	4	5	5	0	3	0	0	0	3	0	13	21	6	4	31	47	2.5	[b]
21	3	0	3	5	2	1	0	0	1	2	1	10	18	2	3	23	40	2	81
22	4	0	4	7	1	0	0	1	0	0	3	13	19	9	1	29	44	1	79
Totals	75	33	60	142	16	44	26	22	13	23	14	237	468	114	102	648			

[a]Number of dependents changed during study period.
[b]Baby born during study period.

Table VIII. Statistics on Individual Variation in Time Allocation at Chupa Pou

	Women			
	Pearson's correlation		Spearman's correlation	
	r	*p*	*r*	*p*
Proportion of time in forest				
By age	−.06	.79	−.29	.20
By number of dependents	−.26	.25	−.09	.69
By age of youngest child	−.33	.19	−.12	.65
By mission expenditure	−.41	.06	−.07	.77
By husband's time in forest	.72	.0015	.37	.14
Age				
By proportion of time home	.68	.006	.67	.008
By proportion of time with only family	.66	.001	.71	.0004
Number of dependents				
By proportion of time with children	.75	.0007	.51	.02
By proportion of time in food acquisition	−.45	.07	−.34	.13
Age of youngest child				
By proportion of time with children	.55	.027	.37	.16
By proportion of time in food acquisition	−.41	.11	−.47	.07
By proportion of time in food processing	−.21	.41	−.64	.005

	Men			
	Pearson's correlation		Spearman's correlation	
Proportion of time in forest				
By age	.45	.04	.24	.29
By hunting rate rank	.07	.76	.07	.75
By mission expenditures	−.47	.03	−.46	.04
By number of dependents	−.43	.07	−.17	.50
Same for men whose wives are not nursing	−.82	.08	−.95	.01
By age of youngest child	−.55	.03	−.31	.24
Age				
By mission expenditures	−.40	.07	−.45	.04
By proportion of time home	.44	.05	.45	.04
By proportion of time with only family	.51	.02	.53	.01
Number of dependents				
By proportion of time with children	.21	.43	.06	.82
By proportion of time in food production or acquisition	−.41	.09	−.28	.25
By proportion of time home	−.04	.89	.11	.65
Age of youngest child				
By proportion of time in food production or acquisition	.11	.67	.06	.82
By proportion of time with children	.87	.00001	.69	.002

(Table II). Relative frequency of observation is not equivalent to proportion of consumption, but these observations are suggestive. Note that imported food items account for about 10% of all eating observations, a figure similar to that which we estimated on the basis of the mission charity and food purchases described above. A 6-month sample in the forest shows 46% of 6923 consumption observations were of meat eating (Kaplan and Hill, 1985a), which understimates by 9% the mean proportion of the calories contributed by meat to the total forest diet during that period. If we use the 16–22% as an approximate figure for the meat fraction of calories at the settlement, this compares closely to 20.8% of the average American diet in 1981 which the USDA reported to come from meat, fish, and poultry (United States Department of Agriculture, 1983, p. 508). While this is much less meat than the Ache eat in the forest, it is a generous proportion by world standards (Gaulin and Konner, 1977).

It is relevant to provisional assessment of food consumption at the settlement that Ache body weights average 59.6 kg for men and 51.8 kg for women, average heights being 1.61 and 1.50 meters, respectively. By contrast, !Kung men and women at 1.57 and 1.47 meters average 46 and 41 kg, respectively (Lee, 1979). Ache weight changes are small over foraging trips of 6–14 days (averaging − 0.58 kg for men and + 0.38 kg for women with no changes for children and with men showing a gain of 0.67 kg during the week following return to the settlement; see Hill *et al.,* 1984). If adults spend more than half of their time at the settlement, they must be maintaining their robust morphology at least partly on settlement diets. The difference in energy expenditure (noted below) between the forest and the settlement may be nearly coincident with a difference in energy consumption.

Company

There are differences in the company kept by men and women at the settlement which allow some inferences about activities to supplement the information in the activity budgets themselves. Women spend 56% of their time with their children. This is less than the nearly 100% of the time they are with their children in the forest (Hurtado *et al.,* 1985), but it is much more than the 31% of the time men spend with their children at the settlement. In the forest, 47% of the day for men (their time in camp; Hill *et al.,* 1984) is spent with their wives and children. Thus, both men and women spend more time with their children in the forest, but in each place, women do so about twice as much as do men.

Women clearly invest more in direct childcare. The 27% of their time spent alone or with only their children at the settlement underlines the pat-

tern noted in the tabulation of spatial distribution; women are more isolated from other adults at the settlement than they are in the forest.

The distribution of both men and women in social space is patterned by age, older men and women spending more time with only their families (Table VIII). Women with more dependents spend more time with their children, but this does not hold for men (Table VIII).

ACTIVITY BUDGETS

Women

Table IV allows a comparison of women's average time allocation at the settlement with the forest. When all food-related activities, acquisition, processing, and eating, are combined, this category takes up 238 min of an average woman's average day at the settlement compared to 175 min per day in the forest. Agricultural foods demand significantly more processing than do wild resources (100 min compared to 32). But in the forest, women spend on average 114 min walking and carrying. Almost every day they move camp, following the hunters and carrying game as well as children and household equipment. While walking and carrying is not a cost to women's own primary food acquisition (Hurtado *et al.,* 1985), this movement of camp following the hunters may contribute to hunting returns (Hawkes *et al.,* 1982; Hill *et al.,* 1987). If transport is considered part of the overall food search, women spend 289 min of their time in food-related activities in the forest.

In spite of the differences in women's time allocation between the two settings, there are clear similarities. The average of 266 min spent sitting and resting in the forest (which incorporates attention to children), is the same as the combined total of sitting time at the settlement (which may incorporate childcare), and active interaction with children. The difference in the proportion of observations coded as active interaction with children is an artifact of our measures. When these data were collected we were not paying special attention to childcare. In the forest, women and their children are within touching range so much of the time that such proximity went unremarked. At the settlement, where the area of space in use is orders of magnitude larger than a forest camp or resting site, very close proximity between children and adults was much more likely to be interpreted as active interaction. These components show that, in both contexts, for just under 4.5 hr/day women do no food or tool manipulation and can be fully attentive to their children or to other social interactions. The amount of time devoted to food-related activities, if walking and carrying in the forest is counted, is also simi-

lar, although there is probably a marked difference in energy expenditure. Only the 63 min spent in food acquisition at the settlement includes heavy exertion, while in the forest both food acquisition and carrying, a total of 193 min, are energy-expensive activities.

Consider first the pattern in the forest. Women exploit the subset of food resources which is less widely shared than unpredictable game (Kaplan *et al.,* 1984; Kaplan and Hill, 1985a). Women with more weaned dependents, and so more mouths to feed, increase the time they spend in food procurement. This suggests that the benefit of more food outweighs the cost of any reduction in the quality of childcare to weaned children while procuring these resources. But the costs and benefits appear to be different for nursing infants. The variation in these trade-offs is suggested by an analysis of time spent in the acquisition of palm starch, an important forest staple (Hurtado *et al.,* 1985; Hurtado, 1985). Women with nursing infants spend much less time acquiring this resource than non-nursing women. When women are nursing, they limit reductions in the quality of care and attention to their youngest infant even at the cost of potentially lower food consumption for themselves and their other children. For these women, the presence of weaned children makes no significant difference in food acquisition time. However, non-nursing women with weaned dependents spend more time procuring palm starch than do non-nursing women without. Differences in the compatability of acquisition of different resources with childcare and differences in the return rates for different resources mean different opportunity costs for acquiring those resources. We expect these differences to correlate with differences in a mother's time allocation to these resources. For example, much fruit gathering may be done with little body displacement, so it may interfere less with nursing an infant than chopping palms and pounding the trunks for starch (Hurtado *et al.,* 1985).

The range in proportion of spot checks which found women acquiring food at the settlement is 0–37%. While women invest relatively little time in primary food acquisition (especially compared to men) in the forest, they spend even less time in food acquisition at the agricultural settlement. In contrast to the forest, much food procurement at Chupa Pou is not combined with childcare. Trips to the fields separate mothers from their weaned children. The effect that weaned dependents have on the time a woman spends in food acquisition at the settlement is opposite to the effect in the forest. Women with no dependents spend an average of 150 min per day acquiring food while those with dependents spend an average of 54 min (Wilcoxon rank sum $p = .088$). This does not mean they acquire less food. The data are equivocal because in many spot checks women were reported to be acquiring food but were not directly observed. We suspect that it is other activities embedded in food acquisition, like social interactions during trips to the fields, which are reduced or eliminated by women with dependent children. The

location results reported above are consistent with this; women who have more dependents spend more time with their children.

Not surprisingly, the age of children makes a marked difference in the time mothers devote to them. The younger a woman's last child the more time she spends with her children, the less time she spends acquiring food and processing it as well (Table VIII). Women whose youngest child is less than 18 months spend a mean of 36 min per day processing food compared to 122 min for other women (Wilcoxon rank sum $p = .001$). Nursing women spend an average of 43 min per day acquiring food, those not nursing spend 115 min (Wilcoxon rank sum $p = .01$). All of the active interaction with children in the systematic observations is accounted for by nursing women. It appears that, as in the forest, the benefits for concentration on care of infants, or the costs for neglecting them, must be even higher than the costs for neglecting competing activities. There may also be higher costs for many activities to women who are lactating.

At the settlement, women can leave their weaned children behind at less risk than in the forest. In doing, so they trade off child care and food procurement in a different way. In the forest, more dependents (for nonlactating women) increase the benefits more than the costs of resource collecting. At the settlement, more dependents (as they are left behind) appear to increase the cost of time in the fields more than the benefits. Of course, the next, and more difficult step, is to find ways to measure those costs and benefits and to see whether they actually differ in the predicted direction.

Men

While activity budgets for women are similar between the settlement and the forest, they are quite different for men. In the forest, men spend an average of 373 min per day in food acquisition. Combining that with the small amount of food processing they do and their eating time gives a mean of 477 min, nearly 8 hr, allocated to food-related activities. At the settlement, they spend an average of 259 min acquiring, processing, and eating food. They spend a total average of 94 min in activities which have no forest analogue: communal ball games, and such mission activities as visiting the pharmacy, the communal kitchen, the school, and the church.

Men's activity regime is much less energy expensive at the settlement than in the forest where 53% of the time men are engaged in strenuous work. At the settlement, a maximum of 31% of men's time includes high energy activity (food acquisition, community maintenance, and sports).

The heavy work that all men do in the forest suggests that on most days, most of the time, hunting gives higher fitness rewards to most men than any available alternative (Hill, 1983; Hawkes, O'Connell, Hill, and Charnov,

1985). (One man has taken a woman's role and does not hunt. He carries a basket and specializes in acquiring the subset of resources women take). Some of the trade-offs suggested in the pattern of variation among men while on foraging trips are consistent with this hypothesis. Although they do not spend more time in the forest, men who are better hunters, i.e., whose hourly hunting return rates consistently average higher than those of other men, spend more time each day hunting when they are members of foraging parties ($r = .64$; Hill and Hawkes, 1983; Hill, 1983, does this test with a larger data set). The combination of higher hourly rates and longer hours increases the disparity in average daily returns among men. If human behavior is usually shaped to maximize fitness, this pattern suggests that hunting is a higher fitness return activity than available alternatives for most men most of the time they are in the forest. Because better hunters gain more than other men, hunting continues to outrank alternative activities through longer periods of the day for them (Hill, 1983; Hawkes *et al.,* 1985).

At the settlement, men spend less than a third of the time in food acquisition that they spend in the forest. Several things underlie this difference. Because of the communal fields, the size of an individual's harvest is not a simple function of his cultivation work. The population at Chupa Pou is large enough that individuals cannot monitor the activities of all settlement residents. In the forest, all members of the foraging party see the daily returns of each hunter and consume them, so that more credit goes with more successful hunting. But this is unlikely to be true for more daily effort in agriculture. Social penalties may be imposed on those who are obvious laggards, keeping participation generally above some minimum threshold. But returns may diminish rapidly after this minimum.

There is also the matter of alternative activities. In the forest, a rather uniform schedule is imposed on all members of the foraging party by the pattern of daily camp moves. During the day when the previous camp has been abandoned and the new one not yet made, alternative activities are limited. The permanent central places of the settlement allow individuals to stay home (as would longer camps), or to leave and return at independent times. A greater diversity of activities may go on simultaneously. Thus, the opportunity cost of agricultural work at the settlement may be higher than the opportunity cost of hunting during foraging trips.

While there is variation in time allocation among men in the forest (Hill *et al.,* 1985; Hill and Kaplan, 1986), the range of variation seems to be much greater at the settlement. The fraction of spot checks which found men acquiring food varies from 0–50%. The shape of this variation is surprising. The number of dependents makes the same kind of difference in men's activity budgets as it does in women's. At the mission, men who have more dependents spend less time in food acquisition than do men with fewer

(Table VIII). It seems likely, as with women, that food acquisition includes various social activities. Men with dependent children face a trade-off between things they might do for their children in the domestic area of the settlement and the social encounters which may occur in the context of visits to the fields. But the form of the paternal investment men actually make by spending less time in food acquisition is unclear. There is no relationship between the number of a man's dependents and the time he spends at home or with his children (Table VIII).

Whereas the age of the youngest child makes a difference in the time women spend acquiring food, this is not true for men. But the younger a man's smallest child, the more time he spends with his children (Table VIII). Results reported above show that women with younger children are also spending more time with their dependents. Moreover, mothers devote direct attention to younger children at the expense of other things they might do in their company like food processing. The fact that fathers with younger dependents are more often around their children suggests they may make a significant direct investment in them as well. This may be in the form of attention to older dependents less closely watched by mothers with infants. It may also be in services to the mothers themselves. Only finer grained data on parent–child interaction at the settlement can clarify this.

If the activities of men which are alternative to food acquisition have a higher opportunity cost in the forest because of the expected returns for hunting, they might be shifted to the settlement where foregone food acquisition costs less. For example, men spend a surprinsingly small proportion of their time working on tools in the forest. If this resulted from shifting tool manufacture to the settlement we should see more time spent on tools there. The data show, however, that tool manufacture is allocated only a small fraction of time at Chupa Pou. Modeling the shape of return curves for both food acqusition and alternative activities in these two contexts remains a challenging task.

DISCUSSION

The lack of a relationship between parental status and time in the forest for women shown in these data is surprising. The availability of medical care at Chupa Pou and the much larger cleared areas should increase child welfare. This is likely to hold especially for younger children. It has been our impression (supported by the demographic composition of foraging trips we have accompanied; Hurtado *et al.,* 1985) that children go into the forest less often than adults, parents frequently leaving some children behind at the settlement, usually older dependents. (School age children especially are left.

The school provided only instruction, no food). The fact that the parental status of men is correlated with time in the forest and that husbands' time in the forest is the best predictor of time in the forest for women leads us to suspect that a larger sample might show a trend more consistent with our expectations.

We are surprised that hunting skill is not correlated with time in the forest for men. While all members of a foraging party get similar consumption advantages because of the sharing patterns (Kaplan *et al.,* 1984; Kaplan and Hill, 1985a), better hunters, at least in the recent past (Kaplan and Hill, 1985b), gain other rewards. Perhaps men who are better hunters are also better at some settlement skills and so gain no relative advantage in the forest.

While data presented on diet at Chupa Pou are scant, they show that people eat much less meat there than they eat in the forest. However, the consumption observations, combined with body weights, do not suggest either general food deprivation or specifically protein shortages at the settlement. At Chupa Pou, people spend less time in high energy activities and so probably require less food to maintain the same weight. We conclude that when people are at the settlement they are trading off the diet advantages of the forest for commensurate additions in other fitness benefits, e.g., reduced hard work may increase female fertility (see the relevant review in Bentley, 1985), more mating opportunities are available at the settlement, animal and insect pests are less troublesome, and modern medical care is available).

Data presented here show that at the settlement the time allocation patterns of men and women are much more alike than they are in the forest. There are of course differences. Women spend more time with their children. Men and women do different kinds of agricultural work: men do the clearing, planting, and weeding, and women do the harvesting. Yet the amount of time adults of both sexes spend in food acquisition activities is similar, as is the way in which this is associated with reproductive status.

At the agricultural settlement, the probable fitness costs of activity categories differ from those of the forest. It may be of special importance that individual schedules can also vary much more independently with fixed central places than they can with the daily camp moves of foraging trips.

CONCLUSIONS

These results speak to four related issues of general anthropological importance. The first is the widely cited generalization that farming is more work than hunting (Sahlins, 1968, 1972; Flannery, 1973; Cohen, 1977; Harris, 1977). At Chupa Pou, the Ache are dependent on their own direct procurement for about 90% of their consumption. Farming provides the bulk of

the diet. Yet, men (and women, if carrying in the forest is counted as subsistence effort) work less at the settlement than they do in the forest, and much less during our observation period (which did not include the full agricultural cycle). Men spend an average of 6.5 hr/day acquiring and processing food in the forest, and less than 3 hr/day doing this at the settlement. Women spend an average of 3.75 hr/day acquiring and processing food (this includes carrying) in the forest, and 2.71 hr/day acquiring and processing food at the settlement. People not only spend less time on subsistence at the agricultural settlement, they also exert less effort. This may reflect the alternative activities permanent settlement permits which may set higher opportunity costs to food procurement at the settlement. The shape of the return curves for foraging and farming may be quite different with returns diminishing much more rapidly for additional time allocated to farming at Chupa Pou.

The second issue is the production goal of subsistence schedules. The Ache do not work longer and harder in the forest because it takes longer to produce the same nutrient ration. They appear to procure more in the forest *because* they work longer. The data, however, are not inconsistent with the hypothesis that the Ache adjust their work effort in relation to the caloric costs of acquiring food in the forest and at the settlement so that they maintain the same body weight. The widely cited notion that hunters work less because their needs are limited (Sahlins, 1968, 1972) has underlined the point that "needs" are variable. If the potential costs and benefits of every activity can, at least in principle, be counted as additions or subtractions of potential fitness, and if we assume that individuals generally behave so as to try to maximize their fitness, we have a framework for hypotheses. We expect individuals to work more when the fitness returns for that work are greater than return for things they might do instead. The economist's notion of utility is given substantive content (Hirshleifer, 1977).

The third issue to which these data speak is a comparison between the activity patterns of the sexes. While always a contentious issue, there has been a tendency to see hunter-gatherers, at least those at low latitudes outside Australia, as more sexually egalitarian than farmers (Leacock, 1978, 1982). This has been linked to similarities in productive contributions to subsistence (Draper, 1975). Lee's (1968, 1982) emphasis on the similarity in work effort of !Kung men and women at Dobe in the dry season has been especially influential. Draper has compared !Kung foragers at Duda with a population recently settled in the Kangwa valley showing the activity regimes of men and women to be more similar in the bush than at the settlement (Draper, 1975). The data presented here invert that pattern. Men's and women's activity budgets are very different in the forest, much more alike at the agricultural colony. This suggests that it is not just foraging vs. farming, but features which cross-cut these modes of subsistence and settlement that affect the ex-

tent of the differences in patterns of time allocation which men and women adopt.

The fourth issue is that of constraints on the sexes. Brown's (1970) work, that of Murdoch and Provost (1973), and, more recently, that of Minge-Klevana (1980), and Ember (1983) have demonstrated the importance of childcare in shaping women's activity budgets. But these contributions, especially when combined with recent research on nonhuman primates (Hrdy, 1977; Altman, 1980; Wrangham and Smuts, 1980; Witten, 1982; Smuts, 1985; Smuts, Cheney, Seyfarth, Wrangham, and Struthsaker, 1987) also point to the variety of ways in which individuals of both sexes may serve their own fitness. Setting the descriptive fact that females usually emphasize parental investment while males usually emphasize mating investment (Lancaster, 1985) in the theoretical framework of behavioral ecology (Trivers, 1972; Maynard Smith, 1978b) has two advantages. It provides a way to understand the empirical pattern, and it directs attention away from a notion of universal impediments, e.g., that women are burdened with childcare, or that men dominate women. The central importance of continuous trade-offs made by individuals of each sex, which vary across circumstances become the focus of attention (Hill and Kaplan, 1986). Sometimes females gain fitness advantages from widespread copulations (Hrdy, 1981); sometimes males gain fitness from direct investment in infants (Smuts, 1985). The data reported here show that Ache adults use different time allocation and parental strategies in the forest and the settlement. Because humans inhabit such variable environments, we should expect marked variations in human sexual strategies. The challenges is to turn the theoretical notions into practical research, finding ways to measure the costs and benefits of alternatives and pose hypotheses about the trade-offs in testable form.

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REFERENCES

Alexander, R. D. (1977). Natural selection and the analysis of human sociality. In Gulden, C. E., (ed.), *Changing Scenes in the Natural Sciences 1776–1976.* Special Publication 12, Philosophical Academy of Natural Sciences, Philadelphia, pp. 283-337.

Altman, J. C. (1974). Observational study of behavior: Sampling methods. *Behaviour* 4: 227-267.

Altman, J. C. (1980). *Baboon Mothers and Infants.* Harvard University Press, Cambridge.

Bentley, G. R. (1985). Hunter-gatherer energetics and fertility: A Reassessment of the !Kung San. *Human Ecology* 13(1): 79-109.

Blurton Jones, N. G. (1972). *Ethological Studies of Child Behavior.* Cambridge University Press, Cambridge.

Blurton Jones, N. G. (1984). A selfish origin for human food sharing: Tolerated theft. *Ethology and Sociobiology* 4: 145-147.

Borgerhoff-Mulder, M., and Caro, T. M. (1985). The use of quantitative observational techniques in anthropology. *Current Anthropology* 26(3).

Brown, J. (1970). A note on sexual division of labor. *American Anthropologist* 72: 1073-1078.

Charnov, E. L. (1982). *The Theory of Sex Allocation.* Monographs in Population Biology No. 18, Princeton University Press, Princeton.

Clastres, P. (1968). Ethnographie des Indiens Guayaki (Paraguay-Brésil). *Journal de la Société des Américanistes de Paris* 57: 9-61.

Clastres, P. (1972). The Guayaki. In Bicchieri, M. (ed.), *Hunters and Gatherers Today.* Holt, Rinehart and Winston, New York, pp. 138-174.

Cohen, M. (1977). *The Food Crisis in Prehistory.* Yale University press, New Haven.

Darwin, C. (1871). *The Descent of Man and Selection in Relation to Sex.* Appleton, New York.

Draper, P. (1975). !Kung women: Contrasts in sexual egalitarianism in the foraging and sedentary contexts. In Reiter, R. (ed.), *Toward an Anthroplogy of Women.* Monthly Review Press, New York, pp. 77-109.

Draper, P. (1976). Social and economic constraints on childlife among the !Kung. In Lee, R. B., and Devore, I. (eds.), *Kalahari Hunter-Gatherers.* Harvard University Press, Cambridge, pp. 199-217.

Ember, C. (1983). The relative decline in women's contribution to agriculture with intensification. *American Anthropologist* 85: 285-304.

Endler, J. (1978). A predator's view of animal color patterns. *Evolutionary Biology* 11: 317-364.

Fisher, R. (1930). *The Genetical Theory of Natural Selection.* Oxford University Press.

Flannery, K. V. (1973). The origins of agriculture. *Biannual Review of Anthropology* 2: 271-310.

Flinn, M. V., and Alexander, D. (1982). Culture theory: The developing synthesis from biology. *Human Ecology* 10: 383-400.

Gaulin, S., and Konner, M. (1977). On the natural diet of primates including humans. In Wurtman, R. J., and Wurtman, J. J. (eds.), *Nutrition and the Brain* (Vol. 1). Raven Press, New York, p. 1086.

Gross, D. (1984). Time allocation: A tool for the study of cultural behavior. *Annual Reviews of Anthropology* 13: 519-558.

Gross, D., Eiten, G., Flowers, N., Leoi, F., Lattman Ritter, M., and Werner, D. (1979). Ecology and acculturation among native peoples of Central Brazil. *Science* 206: 1043-1050.

Haas, R. (1976). Sexual selection in *Notobranchius quentheri* (Pices: cyprinodontidae). *Evolution* 30: 614-622.

Hames, R. B. (1979). In Chagnon, N. A., and Irons, W. (eds.), *Relatedness and Interaction Among the Ye'kwana: A Preliminary Analysis in Evolutionary Biology and Human Social Behavior. An Anthropological Perspective.* Duxbury Press, North Scituate, Massachusetts, pp. 238-249.

Harris, M. (1977). *Cannibals and Kings: The Origins of Cultures.* Random House, New York.

Haskins, C. P., Haskins, E. F., McLaughlin, J. J., and Hewitt, K. (1961). Polymorphism and population structure in *Lebistes reticulaties:* An ecological study. In Blair, W. F. (ed.), *Vertebrate Speciation.* University of Texas Press.

Hawkes, K., Hill, K., and O'Connell, J. (1982). Why hunters gather: Optimal foraging and the Ache of Eastern Paraguay. *American Ethnologist* 9(2): 379-398.

Hawkes, K., Kaplan, H., Hill, K., and Hurtado, A. M. (in press). A problem of bias in scan sampling. *Journal of Anthropological Research.*

Hawkes, K., O'Connell, J., Hill, K., and Charnov, E. L. (1985). How much is enough: Hunters and "limited needs." *Ethology and Sociobiology* 6: 3-15.

Hill, K. (1983). Men's subsistence work among Ache hunter-gatherers of Eastern Paraguay. Ph.D. dissertation, University of Utah.

Hill, K., and Hawkes, K. (1983). Neotropical hunting among the Ache of Eastern Paraguay. In Hames, R., and Vickers, W. (eds.), *Adaptive Responses of Native Amazonians.* Academic Press, New York, pp. 139-188.

Hill, K., and Kaplan, H. (1986). Trade-offs in male and female reproductive strategies among the Ache. In Betzig, L., Turke, P., and Borgerhoff-Mulder (eds.), *Human Reproductive Effort.* Cambridge University Press, Cambridge.

Hill, K., Hawkes, K., Kaplan, H., and Hurtado, A. M. (1984). Seasonal variance in the diet of Ache hunter-gatherers in Eastern Paraguay. *Human Ecology* 12: 145-180.

Hill, K., Kaplan, H., Hawkes, K., and Hurtado, A. M. (1985). Men's time allocation to subsistence work among the Ache of eastern Paraguay. *Human Ecology* 13(1): 29-47.

Hill, K., Kaplan, H., Hawkes, K., and Hurtado, A. M. (1987). Foraging decisions among Ache hunter-gatherers: New data and implications for optimal foraging models. *Ethnology and Sociobiology* 8: 1-36.

Hirshleifer, J. (1977). Economies from a biological viewpoint. *Journal of Law and Economics* 20: 1-52.

Hrdy, S. B. (1977). *The Langers of Abu: Female and Male Strategies of Reproduction.* Harvard University Press, Cambridge.

Hrdy, S. B. (1981). *The Woman that Never Evolved.* Harvard University Press, Cambridge.

Hurtado, A. M. (1985). Women's subsistence strategies among Ache hunter-gatherers of Eastern Paraguay. Ph.D. dissertation, Unversity of Utah, Salt Lake City.

Hurtado, A. M., Hawkes, K., Hill, K., and Kaplan, H. (1985). Female subsistence strategies among the Ache of Eastern Paraguay. *Human Ecology* 13: 1-28.

Johnson, A. (1973). Time allocation in a Machiguenga community. *Ethnology* 14: 301-310.

Kaplan, H., and Hill, K. (1985a). Food sharing among Ache foragers: Tests of explanatory hypotheses. *Current Anthropology* 26(2): 223-246.

Kaplan, H., and Hill, K. (1985b). Hunting ability and reproductive success among male Ache foragers: Preliminary results. *Current Anthropology* 26(1): 131-133.

Kaplan, H., Hill, K., Hawkes, K., and Hurtado, A. M. (1984). Food sharing among the Ache hunter-gatherers of Eastern Paraguay. *Current Anthropology* 25: 113-115.

Konner, M. (1976). Maternal care, infant behavior and development among the !Kung. In Lee, R., and DeVore, I. (eds.), *Kalahari Hunter–Gatherers.* Harvard University Press, Cambridge, pp. 218-245.

Krebs, J. K., and Davies, N. B. (eds.) (1984). *Behavioral Ecology: An Evolutionary Approach* (2nd Ed.). Sinauer Associates, Sunderland, Massachusetts.

Lack, D. (1968). *Ecological Adaptations for Breeding in Birds.* Methuen, London.

Lancaster, J. B. (1985). Evolutionary perspective on sex differences in the higher primates. In Rossi, A. S. (ed.), *Gender and the Life Course.* Aldine, New York, pp. 3-28.

Leacock, E. (1978). Women's status in egalitarian society: Implications for social evolution. *Current Anthropology* 19: 247-275.

Leacock, E. (1982). Relations of production in band society. In Leacock, E., and Lee, R. (eds.), *Politics and History in Band Societies.* Cambridge University Press, Cambridge, pp. 159-170.

Lee, R. B. (1968). What hunters do for a living: Or how to make out on scarce resources. In Lee, R. B., and DeVore, I. (eds.), *Man the Hunter.* Aldine, Chicago, pp. 30-48.

Lee, R. B. (1979). *The !Kung San: Men, Women, and Work in a Foraging Society.* Cambridge University Press, Cambridge.

Lee, R. B. (1982). Politics, Sexual and non-sexual, in an egalitarian society. In Leacock, E., and Lee, R. (eds.), *Politics and History in Band Societies.* Cambridge University Press, Cambridge, pp. 27-59.

Leung, W-T. W. (1961). *Food composition Table for use in Latin America.* National Institute of Health, Bethesda, Maryland.

MacArthur, R. (1972). *Geographical Ecology: Patterns in the Distribution of Species.* Harper and Row, New York.
MacArthur, R., and Wilson, E. O. (1967). *The Theory of Island Biogeography.* Princeton University Press, Princeton.
Maynard Smith, J. (1978a). Optimization theory in evolution. *Annual Review of Ecology and Systematics* 9: 31-56.
Maynard Smith, J. (1978b). *The Evolution of Sex.* Cambridge University Press, Cambridge.
Maynard Smith, J. (1982). *Evolution and the Theory of Games.* Cambridge University Press, Cambridge.
Minge-Klevana, W. (1980). Does labor time decrease with industrilization? A survey of time-allocation studies. *Current Anthropology* 21(3): 279-298.
Munroe, R. H., and Munroe, R. L. (1971). Household density and infant care in an East African Society. *Journal of Social Psychology* 85: 9-13.
Murdoch, M., and Provost, C. (1973). Factors in the division of labor by sex. *Ethnology* 12: 203-225.
Nerlove, S. B., Roberts, J. M., Klein, R. E., Yarbrough, C., and Habicht, J. P. (1974). Natural indicators of cognitive development: An observational study of rural Guatemalan children. *Ethos* 2: 265-295.
Pyke, G., Pulliam, R., and Charnov, E. L. (1977). Optimal foraging: A selective review of theory and tests. *Quarterly Review of Biology* 52(2): 137-154.
Rogoff, B. (1981). Adults and peers as agents of socialization: A Highland Guatemalan profile. *Ethos* 9: 18-36.
Sahlins, M. D. (1968). Notes on the original affluent society. In Lee, R., and DeVore, I. (eds.), *Man the Hunter.* Aldine, Chicago, pp. 85-89.
Sahlins, M. D. (1969). Economic anthroplogy and anthropological economics. *Social Science Information* 8(5): 13-33.
Sahlins, M. D. (1972). *Stone Age Economics.* Aldine, Chicago.
Smith, E. (1983). Anthroplogical applications of optimal foraging theory: A critical review. *Current Anthropology* 24(5): 625-651.
Smuts, B. (1985). *Sex and Friendship in Baboons.* Aldine, New York.
Smuts, B., Cheney, D., Seyfarth, B., Wrangham, R., and Struthsaker, T. (eds.), (1987). *Primate Societies.* University of Chicago Press, Chicago.
Stearns, S. (1976). Life history tactics: A review of ideas. *Quarterly Review of Biology* 51: 3-47.
Stearns, S. (1982). The emergence of evolotionary and community ecology as experimental sciences. *Perspectives in Biology and Medicine* 25: 621-648.
Trivers, R. (1972). Parental investment and sexual selection. In Campbell, B. (ed.), *Sexual Selection and the Descent of Man.* Aldine, Chicago, pp. 136-179.
United States Department of Agriculture (1983). *Agricultural Statistics 1983.* U.S. Government Printing Office, Washington.
Werner, D., Flowers, N. M., Lattman Ritter, M., and Gross, D. R. (1979). Subsistence productivity and hunting effort in native South America. *Human Ecology* 7: 303-315.
Williams, G. C. (1966). *Adaptation and Natural Selection.* Princeton University Press, Princeton.
Williams, G. C. (1980). Conclusion. In Markl, H. (ed.), *The Evolution of Social Behavior: Hypotheses and Empirical Tests.* Dahlem Konferenzen 1980, Weinheim, Deerfield Beach, Florida, pp. 233-255.
Witten, P. (1982). Female reproductive strategies among vervet monkeys. Ph.D. dissertation, Harvard University, Cambridge.
Wrangham, R., and Smuts, B. (1980). Behavioral ecology of chimpanzees in Gombe National Park, Tanzania. *Journal of Reproduction and Fertility* 28 (supplement) 13-31.