Hunter-Gatherers of the New World

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Foraging peoples live by hunting, fishing, and collecting wild plants and insects. In the last 20 years anthropological research among foragers, or hunter-gatherers, as they are often called, has become increasingly important, for three reasons, First, the opportunity to study humans as foragers has been disappearing at an extremely rapid rate in the last 100 years. Because of worldwide economic trends, the transition from foraging to other forms of subsistence may be irreversible. Thus, we are likely to be the last generation to witness our fellow humans living in a way that was typical of most of human history.

Second, modem foragers live in relatively small groups (usually 15 to 100 individuals) in which subsistence activities produce immediate results, and a limited number of behavioral options are open to band members. This means that the ability to study direct links between ecological or social variables and behavioral patterns is generally greater in foraging societies than in more complex human settings.

Third, because our hominid ancestors spent all but the last 10,000 years (less than one percent of the time span of hominid history) living in small groups that subsisted on wild resources, we should be able to learn a great deal about human history and the evolution of human traits by studying modem foragers. Virtually all modem human anatomical traits evolved when foraging was universal, and the human nervous system and physiological mechanisms that generate behavior also evolved while humans lived by hunting and gathering.

Observations of the Ache, a foraging people in Paraguay, indicate that no single pattern of behavior is typical of the hunter-gatherer way of life

Stimulated by these factors, and strongly influenced by the seminal work of Richard Lee on the !Kung San as well as a provocative conference on "Man the Hunter" (Lee and DeVore 1968), a number of ecologically oriented research projects on modem foragers have been carried out in the past two decades: the Harvard Kalahari project and other !Kung San studies (for example, Lee and DeVore 1976; Tanaka 1980), research in Australia and Indonesia (Meehan 1977; Jones 1980; Griffin and Estokio-Griffin 1985), research in the Arctic and sub-Arctic (Binford 1978; Smith 1985), the Harvard Pygmy Project and other pygmy studies (Hart 1978; Harako 1981; Bailey and Peacock 1988), and the Utah hunter-gatherer project on Ache and Hiwi foragers, as well as the Utah-UCLA Hadza project (O'Connell et al. 1988; Hawkes et al. 1989).

Figure 1. The Ache are a people of eastern Paraguay: most lived as nomadic foragers until the 1970s. Now based at agricultural mission stations, they continue to make short trips into the primary forest, where they move camp each day, gathering insects and plants and hunting mammals for meat. (Photo by A. M. Hurtado.)

The most important lesson that can be derived from these and numerous other forager studies is that very few "typical" hunter-gatherer patterns emerge. Instead, groups vary in almost every parameter that has been measured: composition of diet, food-sharing, men's and women's work patterns, subsistence strategies, child-care, settlement patterns, marriage systems, and fertility and mortality. The nonspedaiist anthropological audience has been slow to appreciate the importance of this variability. Instead, the !Kung San studies of Lee are often cited as the typical hunter-gatherer pattern. This is aimost certainly due to the outstanding quality of Lee's work and to the supposed appropriateness of the African savanna as an ecological context for understanding earlier hominids. Indeed, the !Kung study remains a cornerstone of modem forager research, but we must learn to build upon it if we are to develop our understanding of human evolutionary history.

One of the most useful approaches currently employed in forager studies is that of behavioral ecology, or the study of behavior from an evolutionary perspective. This approach assumes that behavioral patterns are generally adaptive and that variations are due to differences in the costs and benefits to fitness in each environmental and social context.

Much of the work presented in this paper was stimulated by four main issues in hunter-gatherer studies. First, what are the likely causes and consequences of the major dietary and technological shifts observed in the archaeological record, and what can these tell us about the diet of our hominid ancestors? Next, how and why is food shared among current foragers, and what are the implications of these patterns for the evoiution of group living, settlement patterns, and the sexual division of labor in hominids? Third, what can activity profiles of modem foragers tell us about our past? Is the foraging way of life one of ease and leisure or a difficult one requiring hard work to survive? Fourth, in the area of demographics, what are the basic trends in fertility and

mortality that characterize modem foragers?

In addition to these issues, most researchers are now concerned with the relationship between ecological constraints and different behavioral patterns. An understanding of this reiationship should make it possible to build models that specify how independent variables will affect the behavior observed in any human community. Only through this uniformitarian approach can we hope to know what our ancestors did in the unobservable past.

This paper reports some of the results obtained in eight years ot work with Ache foragers of Paraguay and desaioes preliminary findings from an ongoing project with the Hiwi foragers of the Venezuelan savanna. In ail these studies we emphasize the variation through time and across groups of individuals, in order to derive likely explanations for differences observed between foraging groups.

The Ache of Paraguay

The Ache are a native population of Paraguay who until recently were full-time nomadic foragers (Clastres 1972; Melia et al. 1973). They consist of four independent groups; we have studied primarily the northernmost group, the last to make permanent peaceful contact (in the 1970s). This group was made up of 10 to 15 small bands that had no specific territories but roamed over an area of about 18,300 km' in eastern Paraguay. Each band had a smaller home range, but adults generally knew the entire area covered by the group. Recall by mformants 'suggests the median size of a band was 48 people; the range on a given day was from 3 to 160.

The region is mainly neotropical, semideciduous evergreen forest, with a tree canopy about 20 m high and undergrowth more dense than that observed in many other primary tropical forests of South America. Since 1975, much of the area has been cut for agriculture and cattle pasture, but sizable pieces of primary forest (about 2,400 km') still exist near the Ache settlements. Transects measuring mammalian densities suggest a crude biomass of only about 400 kg/km^2 for the most commonly encountered mammals. This is about half the crude biomass measured for the same species in Barro Colorado, Panama (Eisenberg and Thorington 1973), and most forests of South America that have been studied show considerably higher species diversity.

Before contact, Ache bands foraged in this area and moved campsite frequently while hunting and gathering. Now they live primarily at agricultural mission stations but still spend about 25% to 35% of their time on overnight trips back in the forest, foraging for subsistence. We have monitored the Ache diet almost from the point of first contact to the present and are able to reconstruct the traditional diet to some extent by means of observations on forest trips (Hill 1983).

The data from short-term trips (with a range of 4 to 15 davs) suggest that as foragers the Ache eat an astounding 3,700 calories per person per day (Hiil et al. 1984). (By contrast, active adult Americans consume about 2,700 calories per dav.) When the Ache are living in the forest, an average of 56% of their calories come from mammalian meat (ranging from 46% to 66%, depending on the season), with honey making up 18% (range 6–30%) and plants and insects providing an average of 26% (range 1549%).

On a foraging trip, camp members rise earlv, eat whatever is left over from the previous day, and set out in search of food. Men lead the way, carrying only bows and arrows, and women and children follow, the women carrying young children and the family's possessions in a woven basket. Some men walk with their wives and carry children on their shoulders. Ache foragers do not walk on trails but break a new path through the forest each day. Usually the leaders set out in the direction of an area known or thought to contain important food resources.

After walking together for about an hour, the two sexes separate, with men walking further and more rapidly in search of game, and women and children slowly progressing in the general direction the men have set out. Men generally eat very little during the day, but women and children sometimes collect and eat fruits and insects while men hunt, and women often process palm trunks for their starchy fiber near the end of the day. This snacking usually' accounts for less than 5% of ail food consumed (Hill et al. 1984).

All camp members come together again at the end of the day, when they clear a small camp in the underbrush, build fires, and prepare and share food extensive!y. Evening is considered the most pieasant time, with band members enjoying their only large meal of the day, and joking and singing in the night. While in the forest the Ache sleep on the ground or on palm-ieai mats in a small circle. They build palm-leaf huts to sleep in only if it begins to rain. The next morning the band moves on again in search of food unless there is heavy rainfall throughout the day.

A model for food choice

The tropical forests of Paraguay are believed to contain several hundred species of edible mammals, birds, reptiles, amphibians, and fish, but the Ache have been observed to exploit only about 50 of them. Similarly, the forest holds hundreds of edible fruits and insects, yet the Ache exploit only about 40 of these. Over 98% of the total calories in the diet we observed between 1980 and 1983 were supplied by only 17 different resources. What can account for the fact that the Ache seem to ignore many edible resources in their environment?

The optimal diet model (MacArthur and Pianka 1966; Emlen 1966) was developed to predict which of an array of resources will be exploited if organisms attempt to maximize rates of food acquisition. In order to maximize the overall rate of return, foragers should attempt to obtain a resource only when the expected return rate is higher than what they can obtain on average if they

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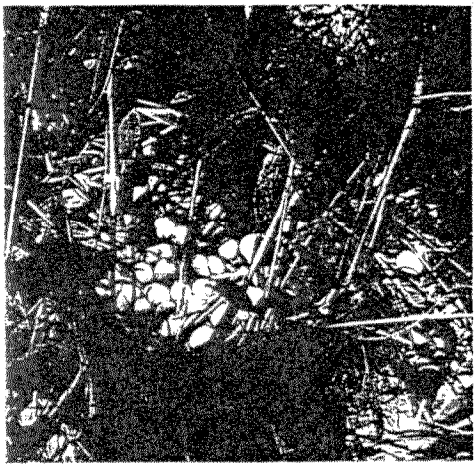

Figure 2. When in the forest the Ache eat well, taking in as much as 3,700 calories per day. The fruit *Rheedia brazilense (above),* which ripens in January, is a favorite food, as is *Cebus apella,* the capuchin monkey *(right).* (Photo above by K. Hill; photo at right by K. Hawkes.)

ignore it and continue to search for other resources.

Between 1980 and 1986, using Ache data, we were able to test the prediction that each resource exploited should be characterized by a higher caloric value than that observed for foraging overall. Our data show that all 16 items observed to be exploited in 1980, and 25 of 26 items exploited in 1981-83, are characterized by higher return rates than a forager could expect to obtain if he ignored the item and continued foraging (Hawkes et al. 1982; Hill et al. 1987). Whereas return rates for a whole 'hay of foraging worked out to about 1,250 cal/h for men and about 1,090 cal/h for women, the average rate for any particular food obtained was, for men, about 3,500 cal per hour of foraging, and for women about 2,800 cal per hour of foraging. Although we were unable to measure resources not taken by the Ache, experience suggests that many would indeed be characterized by low returns (small fruits, birds, insects, reptiles). Thus, Ache foragers apparently do behave as if they chose to exploit only those resources that would increase their overall rate of food acquisition.

The model may be particularly useful for understanding subsistence changes that occur through time, or as a result of changes in technology. For example, in 1980 a few Ache hunters acquired shotguns, which raised their overall return rate from 910 cal/h (with bow and arrow) to 2,360 cal/h. Because some of the game taken by Ache men is characterized by return rates below the new 2,360 cal/h but above the rate of bow-and-arrow hunting, shotgun hunters should ignore some low-return animals that are taken by bow hunters. This prediction was generally met by observations in the field (Hill and Hawkes 1983). Most notablv, shotgun hunters spent less than 2% of their time pursuing capuchin monkeys (with a return rate of 1,215 cal/h), whereas bow hunters spent over 13% of their time chasing capuchin monkeys on *the same* foraging trips. Several times shotgun hunters were observed to leave monkey hunts and continue searching for other, more profitable game.

Continued work with the Ache has pointed out both the utility and some shortcomings of models derived from optimal foraging theory (Hill et al. 1987; Hill 1988). Limitations that we have noted are, first, that some items that must be processed extensively may be exploited even when the resulting return rates are low, if processing normally takes place during times that foraging is not possible. Second, a short-term risk of imminent starvation or a reduction in the variance of daily food intake may lead to foragin g behavior not predicted by simple models. Third, the biological value of foods is probabiy not reducible to calories when food types differ greatly.

A balance of nutrients is likely to be especially important in de&ions in which the forager faces a choice between foods high in carbohydrates (such as plants) and those hugh in protein and lipids (animals and insects). From observations on the Ache, it appears that the sexual division of labor and the foraging strategy of males in general can.be predicted by optimal foraging models only if the higher value or' foods rich in proteins and lipids over carbohydrates is taken into account (Hill et al. 1987). The most important lesson from the Ache studies, however, is that simple models based on the assumption that individuals will attempt to maximize their rate of food acquisition while foraging are indeed useful for predicting subsistence patterns.

Food-sharing

The extensive sharing of food has been reported for many foraging peoples, but until recently there have been no quantitative studies that allow us to determine exactly what the sharing pattern looks like and how it vanes from one foraging group to another. Understanding this variation is crucial, because food-sharing has been postulated to be critical in shaping the unique character of human sociality (e.g., Washburn and Lancaster 1968; Isaac 1978; Lancaster 1978; Kithara-Frisch 1982; Zihlman 1983).

The Ache share food throughout the band. Women who share vegetable items are usually praised, and young children are taught that stinginess is the worst trait a person can have. All hunters, regardless of status or hunting success, give up their kills to be distributed by others, and they almost never eat from their own kill. Nevertheless, there is some interesting variation in the way different resources are shared.

Although about 75% of all food consumed in an Ache band is acquired by a person outside the consumer's nuclear family, different resources are not all shared to the same extent (Kaplan et al. 1984). Game items are shared most, with more than 90% of the meat a hunter acquires being consumed by individuals not in his immediate family. Honey is shared somewhat less, and plant and insect foods least (Kaplan and Hill 1985).

Statistical analyses show that wives, children, and siblings receive no more of the meat or honey acquired by a man (their husband, father, or brother) than would

be predicted by random chance if ail the food were simply divided up among band members. This clearly contradicts a common assumption that food is always shared preferentially with close kin. However, the husband, children, and siblings of a woman were found to consume more of the food she collected than would be predicted by chance (Kapian et al. 1984).

Further analyses suggest food-sharing among the Ache may serve to reduce daily variance in consumption. Food-sharing should be most beneficial if, by their own foraging, individuals acquire more than they can eat on some days and nothing on other days-a pattern that, indeed, characterizes Ache men's hunting returns (Hill and Hawkes 1983; Kaplan et al. 1989). If sharing is a strategy to reduce daily variance in food intake, and if different types of food (e.g., vegetables and meat) are not interchangeable, we should find a correlation between the daily variance in acquisition of a type of food and the extent to which it is shared. Our data from the Ache confirm this relationship. Moreover, the absolute reduction in variance of daily food intake is high enough to be biologically significant. During the time of our study, the average nuclear family reduced its daily variance from 13,243 cal to 4,563 cal by sharing food. A simple model suggests that food-sharing may lead to an 80% increase in nutritional status (Kaplan and Hill 1985).

Differences in observed patterns of food-sharing across modem foragers may therefore be partially due to differences in the daily variance of major food types acquired. This hypothesis leads to useful predictions: for example, among foragers that are able to store food, we might expect very little sharing, because storage reduces variance in the availability of food. Additionally, the data suggest that food-sharing and associated social patterns may not have arisen in hominid history until our ancestors began to use subsistence strategies that produced a high daily variance in food acquisition.

The division of labor

One of the major issues in the study of modem foragers has been just what determines how much time they spend in different activities. Some researchers see foragers as members of an original "affluent society" (e.g., Sahlins 1972), in which work effort is low because "needs" are few and easily met. Others (for example, Hawkes et al. 1985) have questioned this generalization. Early quantitative work with the !Kung San of Africa (Lee 1968) tended to support the low-effort model (which was partially derived from !Kung data) and has led more recent workers to monitor carefully how much time is spent in subsistence work and what other activities are important throughout the day. In addition, because a marked division of labor along sexual lines is an important characteristic distinguishing humans from other primates, it is of interest to desaibe the range of activities specifically for men and for women.

Our collected data-some 63 days' worth of focal

Figure 3. The division of labor along sexual lines is clearly marked among the Ache. with men spending almost 7 hours per day in hunting and in processing both meat and other foods. Resting, socializing, and light work together account for about another 4.5 hours per day. (Photo by K. Hill.)

studies each on men and women and 1,055 person-days of subsistence studies-show that in the forest Ache men spend about 6.7 h/day in subsistence activities (searching, acquiring resources, and processing food) and another 0.6 h/day working on the tools used in subsistence activities. Men also spend about 4.5 h resting, socializing, or in light activities each day (Hill et al. 1985). Women spend about 1.9 h in subsistence activities, 1.9 h moving camp, and about 8 h in light work or childcare (Hurtado et al. 1985). The contrast between the genders may not be surprising in light of the finding that men provide 87% of the energy supplied in the Ache diet and close to 100% of the protein and iipid consumed.

These data contradict the simple generalization that foragers spend little time in subsistence work. The Ache spend more than twice as much time in procuring,

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processing, and transporting food as !Kung men and women, who take 3.1 and 1.8 h/day, respectively, for such activities (Lee 1979). We developed a model which assumes that foragers will spend time in those activities which lower the mortality rates of their children and increase their own reproductive rates (Hawkes et al. 1985; Hill 1983; Hurtado 1985). This model explicitly rejects the notion, based on a concept of "limited needs" (Hawkes et al. 1985), that foragers work few hours per day because they do not need or want any more food.

Among the Ache, who eat much better than most foragers who have been studied, there is still evidence that the acquisition of more food than usual results in higher rates of successful reproduction (Hill and Kaplan 1988). In virtually all primitive, peasant, and economically underdeveloped populations studied, it has been shown that a greater intake of food than usual leads to lower rates of child mortality (Behm 1983; Chen 1983). Many of these populations spend little time each day in work, relative to well-nourished modem Americans (e.g., Minge-Klevana 1980). Given the severe effects of dietary, stress, however, it is unlikely that these populations simply choose to spend little time in subsistence work. More plausibly, they limit the hours they spend in food acquisition because opportunities are poor or entail at times an increased risk of injury or death, or because time spent in alternate activities has a greater effect on reproduction and children's survival.

The Ache patterns of time allocation provide some support for these generalizations. Both sexes work less on days when opportunities for food acquisition are poor. Men hunt fewest hours on days of poor weather (Hill et al. 1985), and women forage for fewer hours when no highquality fruits are in season (Hurtado et al. 1985). Both sexes also reduce the time spent in subsistence activities when other important needs arise. Men spend fewer hours hunting when they have children to take care of (Hill et al. 1985), and women spend less time

Figure 4. Women spend about 8 hours per day in light work, childcare, or a combination of the two, as with the woman here shown weaving a basket while her son looks on. Women also spend almost 2 hours per day moving camp, transporting their family's possessions in a basket of this kind. (Photo by K. Hawkes.)

in foraging when they are nursing and caring for an infant than do women without an infant (Hurtado 1985; Hurtado et al. 1985). These data suggest that the sexual division of labor in hominids may have arisen when opportunities for obtaining new foods were ignored by females because they resulted in higher rates of child mortalitv.

Mortality and fertility

Until Howell's study of !Kung demography, very little was known about mortality and fertility in foraging sodeties. Howell (1979) suggests that mortality rates among the !Kung are not significantly different from those observed currently in underdeveloped countries: high in infancy and early childhod and low in middle age, with about a third of the popuiation surviving to old age. However, as compared with other populations that do not practice contraception, fertility rates are low among the !Kung, with a mean of 4.7 live births to each woman, owing primarily to an interval between live births that is close to four years. Our major goal in studying the demography of the Ache, and later the Hiwi of Venezuela, was to determine how similar their patterns of mortality and fertility were to those reported for the !Kung and to examine some of the possibie determinants and implications of each. Comparison of the Ache with the !Kung is particularly interesting, because the !Kung are foragers in a dry desert, whereas the Ache live in the tropical forest, under very different ecological constraints.

Our data on mortality and reproduction come from interviews with all currently living Ache men and women. This gave us reproductive histories of 166 women, 65% ot which were cross-checked at least once. Preliminary demographic data on the Hiwi are based on reproductive interviews with 35 men and women.

Mortality rates for the Ache look surprisingly similar to those reported for the !Kung, except in the highest age classes (where the !Kung sample size is very small). For both populations, about 20% of all children die before reaching one year of age, and about 60% survive to the age of 15. By contrast, only 48% of Hiwi children survive to age 15. The major causes of death differ for children in the three populations. Whereas 90% of !Kung children's deaths were reported as due to illness, 62% of the Hiwi and only 32% of the Ache children die from illness. The single greatest cause of death among Ache children is homicide, which accounts for 31% of the mortality in the Ache and 14% in the Hiwi, but only 4% in the !Kung.

Differences in causes of adult mortality among Ache, Hiwi, and !Kung foragers show similar trends.

The opportunity to study humans as foragers has been disappearing extremely rapidly in the last 100 years

Among Ache adults, warfare and accidents (snakebite, fall out of tree, attack by jaguar, etc.) account for 73% of all adult deaths. Among the Hiwi, warfare and accidents account for 39%, and among the !Kung only 11%. For the !Kung, illness is the cause of 88% of adult mortality, whereas for the Hiwi the proportion is 56%, and for the Ache it is only 17%. The data show that although overall mortality rates are similar, the Ache and Hiwi are more prone to accidental and violent death, whereas !Kung foragers of all ages are most likely to die from illness.

Fertility rates also differ significantly. The mean total lifetime fertility (number of live births) for women who have completed their childbearing years is 4.7 among the !Kung, 5.1 among the Hiwi, and 7.2 among the Ache. The average interval between births is 48 months for the !Kung and 38 months for the Ache.

Three factors are important in explaining the variation in birth intervals among populations: first, nursing patterns may differ in ways that result in a longer period of nonreproductive cycling among some populations. Second, greater levels of activity may lower the fertility of some populations of women who work harder. Third, nutritional intake may vary, with some populations who eat better more likeiy to become pregnant even when nursing and activity patterns are the same. In particular, nutritional differences between the !Kung and the Ache may account for more of the observed difference in birth intervals than do nursing patterns. As for Hiwi women, preliminary data show them to be intermediate between the !Kung and Ache in their interval between births, as in their caloric consumption and body weight.

A top priority for research

Comparison of the Ache to other foragers reveals considerable variation between groups for most parameters. No single group of hunter-gatherers can be considered as typical, and no group can legitimately be used as an analogue for understanding our ancestors. Instead, careful testing of hypotheses should make it possible to explain the observed variation and eventually to reconstruct hominid behavioral patterns under a variety of conditions.

The amount of attention directed to hunter-gatherers around the world has increased dramatically in the past 20 years, but unfortunately the opportunities for

Figure 5. Like other foraging peoples throughout the world, the Ache face losing their way of lie as their territory is threatened by the development of the modem state within which they reside. Opportunities to study the rich variety of behavior associated with hunting and gathering may soon become scarce. (Photo by K. Hill.)

study are decreasing even more rapidly, despite new reports of full-time foragers in South America, Madagascar, New Guinea, and Indonesia. Studies on these groups and the remaining foragers in South America, Africa, Australia, and Asia should be given top priority if we hope to learn more before this opportunity disappears forever. Similarly, studies of groups that spend some time trekking nomadically, living mainly off wild resources, can give us important insights.

The increasing trend toward quantitative studies that pay careful attention to ecological constraints on the lives of foragers is not without its strong critics-those who believe that responsible anthropobgists should focus entirely on issues of political rather than scientific content. It is true that foraging peoples have lost their traditional territories at an alarming rate. They are almost universally incorporated into the lowest economic strata of the modem states in which which they reside, and often their health and weil-being deteriorate rapidly on contact with modem society. We have a responsibility to heip and protect these people, who have given us the opportunity to understand our origins better. However, we must not forget that we also owe it to our children, and to the children of the foragers who remain, to learn what we can about this once-universal human way of life in the short period left to us. Scientific and humanistic goals need not be mutually exclusive. Time spent residing with present-day foragers can be used productively both to help and to learn about the people who are so kind as to allow our presence as their guests. Let us hope that they remember us as having done all we could to improve their situation and preserve the knowledge of .-their rapidly disappearing way of life.

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