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Why Hunter-Gatherers Work

An Ancient Version of the Problem of Public Goods[1]

by Kristen Hawkes

People who hunt and gather for a living share some resources more widely than others. A favored hypothesis to explain the differential sharing is that giving up portions of large, unpredictable resources obligates others to return shares of them later, reducing everyone's variance in consumption. I show that this insurance argument is not empirically supported for !Kung, Ache, and Hadza foragers. An alternative hypothesis is that the cost of *not* sharing these resources is too high to pay. If exclusion costs are high, then these resources are like public goods. If so, why does anyone provide them? I briefly review treatments of the problem of public goods by economists and use a simple model to show why self-interested actors will rarely find the consumption value they place on collective goods sufficient reason to supply them. The model underlines the obvious corollary that individuals get more to consume if *others* provide collective goods. This is a reason to prefer neighbors and associates who are suppliers. Such a preference may itself be a benefit worth seeking. I construct another simple model to explore this. Taken together the models suggest two competing foraging goals: feeding one's family and gaining social benefits instead. This highlights conflicts of economic interest among family members. It is a direct challenge to influential scenarios of human evolution built on the assumption that men are primarily paternal investors who hunt to support their spouses and offspring.

KRISTEN HAWKES is Professor of Anthropology at the University of Utah (Salt Lake City, Utah 84112). She was educated at Iowa State University (B.S., 1968) and the University of Washington (M.A., 1970; Ph.D., 1976) and has done fieldwork with the Binumarien of the eastern highlands of Papua New Guinea, the Ache of eastern Paraguay, and the Hadza of northern Tanzania. Her publications include (with H. Kaplan, K. Hill, and A. M. Hurtado) "Ache at the Settlement: Contrasts between Farming and Foraging" (*Human Ecology* 15:133–61), (with J. F. O'Connell and N. G. Blurton Jones) "Hunting Income Patterns among the Hadza" (*Philosophical Transactions of the Royal Society* B 334:243–51), "Showing Off: Tests of an Hypothesis about Men's Foraging Goals" (*Ethology and Sociobiology* 12:29–54), and "Sharing and Collective Action," in *Ecology, Evolution, and Human Behavior*, edited by E. A. Smith and B. Winterhalder (New York: Aldine de Gruyter, 1992).

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Many anthropological questions turn on the assumption that hunter-gatherers work primarily to meet family needs. This assumption is used to contrast humans and other primates (Lancaster and Lancaster 1983), to develop hypotheses about the design of our cognitive and social propensities (Tooby and DeVore 1987, Cosmides and Tooby 1992), to construct scenarios of hominid evolution throughout the Plio/Pleistocene (Isaac 1978, Leakey and Lewin 1992), and to guide inquiry into the origins of agriculture (Cohen 1977). Anthropologists adopting many theoretical perspectives (e.g., Harris 1989, Sahlins 1972, Smith 1983) assume that foragers work to feed themselves and their families and that marked paternal investment is the key to a wide array of distinctive human patterns (Washburn and Lancaster 1968, Lovejoy 1981, Alexander 1990). I argue here that goals that compete with family provisioning shape the foraging strategies of contemporary people who depend directly on wild foods. Since these goals arise from opportunities and constraints imposed on subsistence foragers by the characteristics of wild resources, they would have played an important role in the ancestral past.

For some categories of foods, notably medium-sized and large game, there is little if any relationship between the amounts foragers acquire themselves and the amounts they and their families consume. This raises two questions. First, why don't they keep what they acquire? The proposition that foragers share to reduce the risks posed by exploiting unpredictable resources is widely favored but lacks empirical support. This gives the second question more force: Why do foragers ever target resources that will go mostly to others rather than to their spouses and children?

Widely shared resources are like public goods: they can be consumed by those who do not pay the acquisition costs. Economists have long noted that self-interested individuals will rarely contribute their fair share of the cost of any public good voluntarily (Samuelson 1954). This is the problem so influentially exposed by Hardin (1968) as "the tragedy of the commons." It is the logic of collective action (Olson 1965). A public good will be undersupplied by self-interested actors without some incentive distinct from the consumption value of the good itself.

If, as is argued below, unpredictably acquired large-package foods are public goods, then the supply of these foods poses a collective action problem at least as old as hunting or competitively scavenging large animals. Archaeological and ethnographic evidence shows that such goods have long been supplied in human foraging communities. An inquiry into the incentives for providing them should contribute to an understanding of other social patterns in both the present and the past.

I elaborate the hypothesis that the incentive for providing widely shared goods is favorable attention from other group members. If those who provide public goods are listened to and watched more closely than others and favored as neighbors and associates, they have a larger, readier pool of potential allies and mates. When this is so, foragers face a trade-off between increasing their families' food consumption and increasing the attention they get from other members of their group. Public goods will be provided when, for some individuals, the fitness value of the latter outweighs that of the former. This solution to the public-goods problem relies on identifying a fitness benefit that depends directly on the consumption value of the public good but is distinct from it.

An obvious gender difference is consistent with this argument. Under some circumstances foraging men may gain more fitness, as measured (say) in grandchildren, by seeking social attention because of the support and mating advantages they can use it to elicit. Women may more often leave greater numbers of grandchildren by foregoing this social attention and foraging for family consumption instead. From this perspective hunting or competitively scavenging large animals is more often done by men because they more often gain from pursuing goals *alternative* to family provisioning.

After a brief discussion of evolutionary ecology, which focuses attention on fitness-related costs and benefits to individuals and consequently on the conflicts of interest that arise among members of any social group, I review ethnographic data showing that foragers do not maximize the benefits they and their families receive in food consumption by targeting widely shared foods. The pattern is a challenge to long-standing views about nuclear families as basic units of production in human societies and to the associated notion that men hunt to feed their offspring. The data show wide and predictable variation in sharing of the resources that foragers exploit. Simplifying this variation in terms of two polar resource types ("private" vs. "collective" goods) and modeling the logic of collective action shows that foragers will usually maximize their own family consumption by targeting private goods. Other benefits—aside from consumption of the goods themselves—will be necessary to induce self-interested foragers to supply collective goods. A second model indicates how such "selective incentives" (Olson 1965) give that result. Taken together the models show that if foragers seek consumption benefits, they will target private goods; if they seek social benefits, they will target collective goods. By exploring how the values of these different kinds of benefits vary with foragers' age and sex and with local resource opportunities, we may explain variation in the kinds and amounts of work foragers do. The supply of other collective goods may depend on similar trade-offs.

Optimality

Evolutionary ecology poses problems in economic terms (Maynard Smith 1978, Parker and Maynard Smith 1990). Investigators cast questions about all aspects of individual organisms—developmental, morphological, physiological, behavioral—as allocation "decisions." In a world of limited time and materials, more of one thing means less of something else. Natural selection warrants the assumption that organisms are designed to make allocation decisions that generally serve their own fitness. Every allocation has a cost, the missed benefits of alternatives foregone. Paradoxically, perfect allocations are unlikely because the benefits of improvements may not outweigh their costs, hence the optimizer's epigram: "Nothing worth doing is worth doing perfectly." Alternatives that generally give higher *net* fitness benefits are nonetheless expected to predominate. This justifies the proposition that human evolution has shaped people to assess and then adjust to a wide array of circumstances according to cues that have been generally associated with their own fitness. No expectation that behavioral differences are due to genetic differences is required. Selection can result in tendencies to make fitness-enhancing adjustments to circumstances that produce wide phenotypic differences in a genetically homogeneous population. These assumptions provide the basis for asking questions about any aspect of human behavior (Smith and Winterhalder 1992), including questions about the amount or kind of work people learn to do.

Since there is always the opportunity cost of gains foregone from alternative activities, the optimal amount and kind of work will change with the array of possibilities. Trade-offs will differ with circumstances. Any work decision may involve many trade-offs, not only activities foregone but the profitability of different kinds of work, differences in the efficiency of "time-sharing" various other activities with different kinds of work, differences in payoffs if different kinds of work can be more efficiently done in different places or at different times, differences in the values of the products acquired, differences in the control workers have over the product, and differences in the way the products of work affect the behavior of others. The important question is whether there are a few (ideally measurable) costs and benefits that capture enough of the fitness trade-offs to account for a significant part of the variation (both synchronic and diachronic) that we hope to explain.

The cost of foraging is the benefits missed from alternative activities. The cost of choosing a resource is the gain foregone from others not sought instead. Widely used optimal foraging models (Stephens and Krebs 1986, Smith 1983, Kaplan and Hill 1992) focus on the trade-off between the mean acquisition rate (often measured as expected calories per unit time) gained from stopping to handle one resource and the expected rate from continuing to search for something better or between the mean acquisition rate gained from continuing to exploit one resource patch and the expected rate from traveling to and searching another. Alternatives are usually evaluated along one dimension of variation: the mean nutritional acquisition rates expected from particular resources or resource patches. The usual justification for focusing on acquisition rates is that they are correlated with foragers' consumption. For human foragers this hides a wide range of variation. Resources vary greatly in how much acquirers can expect to keep for their own or their families' consumption (Kaplan 1983, Kaplan and

Hill 1985*a*). For some resources, foragers' acquisition rates are closely related to their own or their families' consumption rates; for others, they are not. If foragers maximize family consumption and expect to keep different fractions of different resources, then the amounts they are likely to keep, *not* the amounts appropriated by others, should govern their choice of resources.

The Difference between Acquisition and Consumption

Data from three ethnographic cases show that some resources are so widely shared that the consumption payoff a forager can expect from acquiring them is lower than if he had taken others instead.

The !Kung of northwestern Botswana and adjacent parts of Namibia are the best-known hunter-gatherers in the world (Lee and DeVore 1976). Though the effects of colonial history in this area have recently been hotly debated (Solway and Lee 1990, Wilmsen and Denbow 1990), in the 1960s, when key quantitative observations were undertaken, most depended on foraging for their daily subsistence (Lee 1979). They took a diverse array of plant and animal resources, notably mongongo nuts but also various tubers, berries, baobab, tsin beans, and mammals ranging in size from small spring hares to giraffes. Women customarily exploited the plant foods. Marshall's (1956) film and Lee's descriptions have provided a lasting image of men stalking big game with small bows and poisoned arrows, but men also set snares for smaller prey and collected plant foods. Lee emphasized the sharing in !Kung camps but noted that vegetable foods tended to stay at the fire of the collector and, by contrast, cited Lorna Marshall's report that large animals were treated differently. Whereas small animals and plant foods were shared only with one's "immediate family or with others as he or she chooses," large animals were shared by all (Marshall 1976:357).

During a four-week period of the dry season in 1964, most of the game taken was small animals captured with snares. The only large prey were four warthogs, all killed by one hunter "with his excellent dogs" (p. 265). These represented 75% of the game by weight during the observation period. The hunter responsible spent 16 days hunting for estimated earnings of 28,200 Cal/day (p. 268).[2] Six other men who hunted killed only small animals, earning an average of 2,719 Cal/day each. Men provided 19% of the vegetable food during this period, earning 12,000 Cal/day of gathering (p. 262). Combined with the observations on sharing patterns, these data show the family consumption rates that foragers can expect from different resources. If the meat of large animals were shared by all in a camp, the big-game hunter's consumption fraction would vary with the number of camp residents. Lee reported 25 adult residents in the camp he monitored, including 11 men. If each of these men represented a family, a hunter who acquired 28,200 Cal/day from large animals might have expected to keep 1/11 for his family's share, 2,564 Cal/day. By setting snares and targeting small game to keep at his own hearth he would have done slightly better, 2,719 Cal/day, and by collecting plant foods instead he would have done much better, 12,000 Cal/day. Even counting the heavy processing required by some plant resources (Hawkes and O'Connell 1981, 1985) returns would still have been high: one to two days spent processing would still have meant 4,000–6,000 Cal/day for gathered foods, nearly twice the amount of consumption earned from hunting. Under these circumstances, a man who chose to hunt large animals contributed *more to others* (in this case an order of magnitude more than he kept, 25,640 Cal/day) and *less to himself and his own family* than when he gathered or hunted and snared small game.

The Ache of eastern Paraguay (Hill 1983) inhabit the well-watered forest just south of the Amazon basin. During the 1970s all began to spend at least part of their time in agricultural settlements (Hawkes et al. 1987), devoting substantial amounts of time to foraging trips away from these bases through the early 1980s. Participation in a sample of these foraging trips has allowed us to accumulate a quantitative record of foraging strategies, time allocation, and food sharing (Hawkes, Hill, and O'Connell 1982; Hill and Hawkes 1983; Hill et al. 1984, 1985, 1987; Kaplan et al. 1984; Hurtado et al. 1985; Kaplan and Hill 1985*a*). Ache foragers exploit the starch, fruit, and "heart" of a palm ubiquitous in their forest, as well as an array of seasonal fruits. Insects provide several kinds of honey and larvae. Many species of vertebrates are hunted, some with bows and arrows and some with sticks or by hand. Common prey range in size from capuchin monkeys to white-lipped peccaries and occasionally tapirs.

As with the !Kung, acquisition and consumption rates are more closely related for some resources than for others. A man acquires about 1,340 Cal/hr. (Hill et al. 1987) targeting largely meat and honey. About 13% of that is consumed by his own family (Kaplan 1983, Kaplan and Hill 1985*a*). Men also gather all the resources women do, but because women do not hunt their acquisition rates suggest the rates men might earn if they focused on gathering. Women earn from 1,220 to 2,800 Cal/hr., depending on whether their travel is counted as foraging time (Hill et al. 1987). Of this 47.5% is consumed by their own families (Kaplan 1983, Kaplan and Hill 1985*a*). The differences in sharing depend on the resources themselves. Food types show the same distinctive shar-

2. This is a notably high rate. Lee elsewhere (1979:242) estimates that hunters average two or three large animals a year and then says that even this may be "on the high side" (p. 243), citing Wilmsen's estimate of 0.6 large animal per man per year at /Xai/xai. If the 11 men monitored during Lee's period of observation had acquired his estimated 2.5 large animals per year each, the long-term average for the camp would have been 2.3/month. Counting only the 7 men who did any hunting during that period, the expected rate for the camp would still have been 1.4/month. Just one such catch could have more than doubled the meat consumed during July 1964. The failure of any hunter to kill a large antelope with poisoned arrows that month as well as ≠Toma's remarkable success with his dogs indicate the huge short-term variation characteristic of big-game hunting (noted by Lee 1979:243).

ing patterns whether they are acquired by men or women, and men preferentially target the ones that are more widely shared (Hawkes 1991). The expected contribution to the foragers' own families' consumption is 174 Cal/hr. (that is, 13% of the acquisition rate) for targeting game and honey and 580 to 1,330 Cal/hr. (47.5% of the acquisition rate) for targeting plant foods and larvae. Men get less for their own families by taking game and honey than they would by gathering plant foods and larvae instead.

The Hadza live in the wooded savannah south and east of Lake Eyasi, northern Tanzania (Woodburn 1968, Blurton Jones et al. 1992). In the past few decades they have been much less isolated than the Dobe !Kung or the Ache before the 1970s. In spite of the proximity of neighbors and repeated governmental and missionary attempts to settle them, many have continued to depend on hunting and gathering. Some have avoided settlements altogether, and many people have repeatedly returned to full-time foraging (Woodburn 1988, Blurton Jones et al. 1992). Since the mid-1980s, quantitative data have been collected on an array of topics including foraging strategies and time allocation (e.g., O'Connell, Hawkes, and Blurton Jones 1988; Blurton Jones, Hawkes, and O'Connell 1989; Hawkes, O'Connell, and Blurton Jones 1989, 1991). Local resources are similar to those available to the !Kung but more abundant. Hadza women collect tubers, berries, baobab, and tamarind and cooperate seasonally with men in pursuit of honey. Unlike the !Kung, Hadza men are also specialized big-game hunters, taking prey ranging in size from impala to giraffe with bows and metal-tipped poisoned arrows to earn an average of 4.9 kg/day (Hawkes, O'Connell, and Blurton Jones 1991). Although the technology is known to them, they make little use of snares or traps and generally pass by the small animals frequently seen in this environment.

The meat of large animals is very widely shared not only in the hunter's own camp but with other camps as well. Assuming conservatively that a camp defines the sharing limits and that each hunter represents a family, then the mean of about eight men in a Hadza camp leaves the hunter with an average 1/8 of his acquisition or about 900 Cal/day. Tubers and berries are not so widely shared. Women earn averages of about 4.5 kg/day from these resources (Hawkes, O'Connell, and Blurton Jones 1989) or about 3,900 and 10,000 Cal/day respectively.[3] If collected resources are consumed by the family of the gatherer, then as with the preceding cases men earn substantially less for themselves and their families to consume when they hunt than if they had gathered.

The Hadza data illustrate a related dimension of contrast along which resources vary: predictability. For a Hadza hunter, the probability of killing or scavenging a large animal on any given day is ~0.03, meaning that he faces a 0.97 risk of failure each day (Hawkes, O'Connell, and Blurton Jones 1991).[4] This makes hunting and scavenging large animals an especially poor choice of foraging strategies if the goal is to meet daily family consumption needs. Moreover, when a hunter does hit, most of his kill goes to those outside his family. By contrast, small-game hunting and trapping fail far less often, gathering never, and in each case most if not all of the product goes to the forager's own family.

These three cases illustrate a general pattern among hunter-gatherers: some resources are much more widely shared than others. In taking the widely shared foods, foragers contribute most of what they acquire to others in the community. Kaplan (1983; Kaplan and Hill 1985*a*) has demonstrated that for the Ache there is a correlation between sharing outside the nuclear family of the acquirer and two resource characteristics: predictability and package size. The relationship holds at least qualitatively for the !Kung and the Hadza as well.

Explaining Sharing: The Reciprocity Hypothesis

Why are unpredictable large-package resources so widely shared? A favorite hypothesis is that the fraction given up to others is repaid in future by the shares they return. This variance-reduction (Kaplan 1983, Kaplan and Hill 1985*a*, Winterhalder 1986), insurance (Cashdan 1985), or reciprocal-altruism (Trivers 1971) hypothesis proposes that individuals exchange short-term surplus to increase their own consumption payoff over time.

The resources most widely shared *are* the riskiest to pursue, those showing high variance in acquisition. Daily averaging does reduce consumption variance. The pattern has long been noted by anthropologists (e.g., Sahlins 1972, Gould 1982) and treated more formally by those drawing on behavioral ecology (Cashdan 1985, Winterhalder 1986, Smith 1988, Smith and Boyd 1990). If the first units of a large resource are worth more than additional units, then sharing not only reduces the variance but also raises the average consumption payoff for the sharers (Kaplan 1983, Kaplan and Hill 1985*a*).

Assuming a group of ten members, the gain curve for consuming additional units of a resource for any member takes the shape indicated in figure 1. If the resource is unpredictably acquired, then successes are uncorrelated. When one forager is successful and all ten group members consume one unit each from the lucky forager's score, then, since the payoff for the first unit is one consumption payoff point and each consumer's unit is that person's first, the total group payoff is ten. If, in

3. The daily rates come from observations during September and October 1985 and March and April 1986. Caloric values for the main species of tuber, *Vigna frutescens*, are 85 Cal/100 g, for the species of berry tabulated in Hawkes, O'Connell, and Blurton Jones (1989), *Grewia bicolor*, 223 Cal/100 g (Galvin et al. n.d.).

4. This is measured over 256 days of observation covering all seasons 1985–89, 2,072 hunter-days. It is a very low rate but substantially higher than the long-term big-game rate Lee estimates for the !Kung (2–3 animals/year). The difference in success rates can be related to differences in the work strategies men adopt (Hawkes 1990).

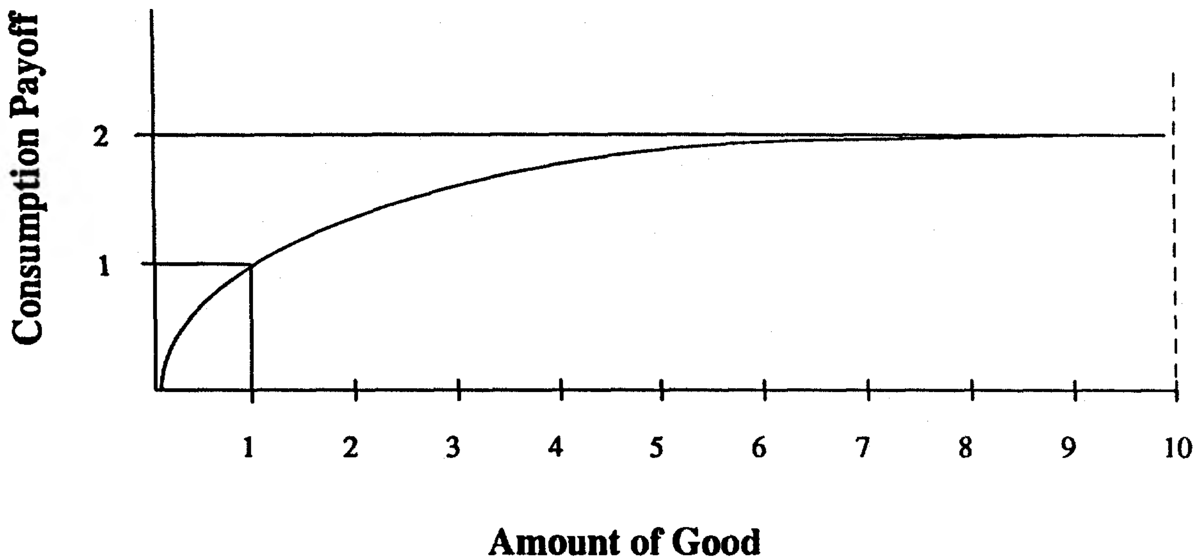

FIG. 1. *The* x-*axis represents the amount of a large, asynchronously acquired, divisible good. The* y-*axis represents the payoff to any individual for consuming portions of the good. The first unit consumed provides one payoff point; additional units are increasingly less valuable. A portion is worth less as the second unit consumed by one individual than it would be as the first portion consumed by another.*

contrast, only one member consumes it all, that member gets one point for the first unit but less for each additional unit, resulting in a total consumption payoff of only two. Clearly the *group* does better if the good is shared. But does that mean that individuals increase their own consumption by sharing?

For the values assumed here, the nine units of the good that others take are worth a total of only one consumption payoff point to the acquirer, once he has his first unit. If *in return* for giving up those nine units he obligates the others to pay him back when they are lucky and he is not, he will gain by sharing. This is the insurance or risk-reduction argument: one gives up something today in order to receive something of greater value in future. It must be the case, then, that those who do not give shares do not get them.

The empirical picture does not show that one must give to receive. In Lee's record of the !Kung, some foragers provided much more than others. One man acquired ~78% of the meat for the entire camp for a month. Of the other men, four did no hunting at all, but there is no indication that they were excluded. Marshall's characterization of meat sharing and Lee's endorsement indicate that shares go to all.

In the case of the Ache, Kaplan and Hill (1985*a*) report up to sixfold differences in the amounts of food acquired by families over periods less than two weeks. Individual men rank consistently from one year to the next in both their success rates and their acquisition totals. Those who acquire at a higher rate also spend more time hunting, increasing their disproportionate contribution to group consumption (Hill and Hawkes 1983). Yet there is no relationship between the amount a hunter acquires and the amount his family consumes (Kaplan and Hill 1985*a*).

Acquisition rates vary even more widely among Hadza hunters. For 14 men, each observed for 20 days or more in 1985–86, the range in daily acquisition rates is from 0 to about 1 animal a week, from 0 to 27.25 kg/day. The means are 0.046 ± 0.05 animals/day and 5.41 ± 7.58 kg/day. There is no comparable, let alone correlated, variance in consumption. Over a sample of 130 observation days, 52% of the meat in study camps was procured by two men, one present for 69 days, the other for 51. The meat any hunter acquired was eaten by all, including women, children, and men who never contributed any meat. People got shares whether or not they had been providing them.

In none of these cases is there evidence of repayment in kind to the providers. Two aspects of these patterns merit further comment: the duration of observations and the focus on repayment in kind. The absence of repayment is shown over limited time periods. Lee's work diaries covered a month. The data used on individual Hadza hunters cover only 130 days. The longest time period in the Ache data is the comparison of hunters' rankings between two periods within two years. The hypothesis that delays may be longer than those captured ethnographically cannot be falsified. Longer time frames might show repayment. Three considerations are relevant to this hypothesis. First, when Axelrod (1984; Axelrod and Hamilton 1981) used computer tournaments to investigate the success of strategies of cooperation in two-player sequences, he found that strategies in which a player's move was contingent only on the opponent's last play out-competed rivals with longer "memories." Those who quickly forgot the past were more successful because they avoided the costly sequences of reprisals that befell those who held grudges. Second, a consideration also emphasized by Axelrod, long delays between a benefit given and one returned make reciprocity difficult to sustain because of the sharp increases in discounting of future benefits with increasing delay. Empirical evidence of the high rate at which people discount the value of future benefits (e.g., Logue 1988) is consistent with this general point. Third, the hypothesis that benefits are returned after delays of longer duration leaves continuing contributions from those who have not been repaid unexplained. If foragers gave up shares to ensure repayment, then no one would have reason to continue to give to those already in his debt.

Repayment in kind is the test of the variance-reduction hypothesis because sharing is proposed to be the hedge against probable failure to capture unpredictably acquired resources. If, as others have suggested (e.g., Kaplan and Hill 1985*a*, Winterhalder 1986), those who provide shares are compensated in some other form, the advantage *to the share givers* is not reduced variance in their consumption of the risky resource. Improvements for the "average group member" can hide differences in costs and benefits for different members. All may do better if they all share than if none do, but some may do better not to share if others do.

Sharing as "Tolerated Theft"

If what ethnologists label "reciprocity" is rarely literally reciprocal (Sahlins 1965) the question remains: if one need not give to receive, why give? Building on Maynard Smith and Parker's work on contests over resources, Blurton Jones (1984, 1987) has suggested a model of "tolerated theft." He points out that if resources are large and asynchronously acquired, then one forager's successful capture will be of potential consumption value to many. If the acquirer tries to consume it all, the consumption payoff gained from each additional unit consumed will be less than the consumption payoff hungry others would get from those same units (as in figure 1). If individuals can afford to invest more in a contest when they have more to gain from winning, those who have consumed less can afford to fight harder. If acquirers cannot afford to fight as hard for additional portions, they will do better not to contest the claims of others at all. The resources are "shared" because the cost to an acquirer of *not* sharing is too high.

Kaplan and Hill (1985*a*) and Kaplan, Hill, and Hurtado (1990) have argued that if the physical contest were decisive, then differences in resource-holding potential (i.e., differences in the cost of a fight to different individuals) would determine the distribution. Yet size and strength, which usually determine resource-holding potential in other animals, have no effect on the shares people get. In none of the ethnographic cases do the biggest and strongest men take everything. Women, small children, old people, and even people not present at the time get shares. Some of this may still relate to physical costs. People may choose to avoid the rage they could anticipate if a strong neighbor returned to find nothing but the evidence of a finished meal. When a child is relieved of a desirable share of honey in a Hadza camp, wails of protest can quickly draw the child's mother and others as well. Blurton Jones (1987) suggests that because people can apply lethal force against each other, differences in "overkill capacity" may not matter. Deadly weapons may have a long history as "equalizers." This would make resource-holding potential more generally similar among humans than among other primates. Are there other costs as well?

Ethnologists have long used contrasts in patterns of "exchange" to distinguish traditional kinship communities from those of modern states. Mauss (1967 [1925]) noted that in archaic societies there are no neutral strangers; people are either friends or enemies. Friends give gifts; giving gifts maintains friendly relationships. White (1959) suggested that there are two kinds of economies, those in which the value of items exchanged governs transfers and those in which the social relationship between the parties to the transfer governs. Polanyi (1957) described transfers in marketless societies as embedded in social relationships. These scholars, none directly influenced by the others, argued that in traditional societies the transfer of valuable items depends on social relationships. To refuse or interfere with transfers is to deny the social relationships and the common interest they represent.

These ideas point to a cost distinct from physical injury that, though elusive, could have substantial fitness consequences. When one person tries to exclude another from using something that is of greater value to that other he incites hostility and aggression or at least passive enmity. When goods come unpredictably in large amounts, many are drawn to the rich resource patches created by the acquisitions of a few. The cost of interfering with transfers to those with less could be overt conflict.

Recently hunter-gatherer ethnographers have characterized the transfers they observe (and participate in) as "demand" sharing (Ingold, Riches, and Woodburn 1988). Bird-David (1990, 1992) notes the framing of demands in terms not of repayment for past generosity but of current inequities: "Give to me because I have none," "Give to me because I am needier than you," "Give to me because you have so much." This suggests calculation in terms of the costs and benefits noted by Blurton Jones (1984, 1987), who recalls the edge of hostility common in ethnographic accounts of sharing. The transfers he labels tolerated theft occur only when there are marked disparities in holdings. If resources are acquired by many in synchrony, if everybody has coincident luck, good or bad, there is no basis for demanding transfers. If resources come in small lumps, there will be little extra that one values less than another. No one's acquisition presents a valuable patch for others to exploit.

The label "tolerated theft" should not be taken to imply that goods *belong* to the acquirer. The model addresses the trade-offs individuals face in the absence of well-defined property rights. A good is held for consumption only to the extent that the holder can exclude other users. Potential contestants determine the cost of exclusion, which can multiply with the number of competitors. In the absence of well-defined property rights, the value of the things one can accumulate depends on what everyone else has.

Public Goods and the Logic of Collective Action

Goods that are large and acquired asynchronously create patches of high relative value. Because the alternative to getting some is having none, they have high exclusion costs. If the exclusion costs are high enough, the goods are effectively public goods; they can be consumed by those who do not pay the cost of acquiring them directly, and individuals serve their own interest by allocating their foraging time to other resources while consuming them for free. Influential treatments of the public-goods problem have a history of several centuries, mostly associated with the origin and proper role of the state. Formal treatments begin with Samuelson (1954), who assumed two categories of goods, "private" and "collective." He emphasized the distinction between goods that can be "parcelled out among two or more persons, with one man having a loaf less if another gets a loaf more," and those in which each person can consume the whole thing—bread vs. circuses (Samuelson 1955). Much discussion has ensued about the defining characteristics of public goods. Two are "jointness of supply" (as in Samuelson's initial discussion, the same unit can be consumed by all) and "nonexcludability" (consumers cannot be excluded from the good whether or not they pay). Food is often cited as the classic illustration of a private good. But if one person bakes a loaf of bread and the cost of refusing a slice to another is too high to be worth paying, then the loaf is not a perfectly private good. Paradoxically, certain kinds of foods present a kind of public-goods problem of great antiquity in human experience, greater than that of the common pasture used as an illustration by Hardin (1968). If the cost of excluding others from shares of large, unpredictably acquired animals is too high to pay, the problem is as old as the hunting or competitive scavenging of big game.

In 1965 Olson demonstrated that the logic of collective action was extremely general, arising whenever members of a group have a common goal. This development in economics paralleled events in evolutionary biology, where at the same time Williams (1966) was showing the importance of distinguishing group and individual interests. Economists also recognized the general importance of distinguishing costs and benefits external to the accounts of a decision maker and the determining effects these externalities can have on social outcomes.

If some resources will be collective goods, the consumption payoffs foragers can expect depend not only on which resources they target but also on which resources others choose. When the costs and benefits for a pattern of behavior depend on how many others do the same thing, the payoffs are said to be "frequency-dependent." Evolutionary game theory (Maynard Smith 1982, Parker and Maynard Smith 1990) provides the analytical tools for identifying optimal strategies when payoffs are frequency-dependent. Games can be symmetric (all players confronting the same payoffs) or asymmetric. They can involve two or more players and two or more possible strategies, and the strategies themselves may or may not be contingent on anything about the game. The contests may be "one-shot games" or repeated sequences with winnings evaluated over a series of plays.

A very simple model of the consumption trade-offs foragers might face can be modeled as a symmetric n-person game with two alternative strategies: foragers can target either collective goods (those of which others will successfully demand shares) or private goods (those not widely demanded by others). Because the topic here is food resources, the goods are divisible, and a unit of the good can be used by only one consumer (in contrast, for example, to the situation with community defense, which is jointly supplied and would be modeled differently).

In the payoff matrix of table 1, B is the value of collective good one forager can acquire, b is the value of private good, and n is the number of foragers in the group. The matrix depicts the boundary conditions. The left column shows the payoffs to row when all others target the collective good; the right column shows row's payoffs when all others target private goods. If row targets the collective good and all others do too (the upper left cell), row gets $1/n$ of the nB provided. Taking the private good instead (the lower left cell), row gets $1/n$ of the $(n - 1)B$ provided by the others plus the private good. If row is the only one to target collective goods (the upper right cell), then nothing comes from the others and row keeps $1/n$ of the B. If no one targets collective goods, row gets only the private good. In this model, the dominant or evolutionarily stable (Maynard Smith 1982) strategy depends on the relationship between B/n and b. If $B/n > b$, then row does better to target the collective good whatever the others do; targeting the collective good is the evolutionarily stable strategy. But if $B/n < b$, then the evolutionarily stable strategy is targeting the private good. The situation in which $B/n < b$ and $B > b$ is the well-known "prisoner's dilemma" (Luce and Raiffa 1957).

The prisoner's dilemma illustrates what Olson called the logic of collective action. Under most circumstances the members of a group will not provide the amount of

TABLE 1
Consumption Payoffs of Alternative Strategies

	All Others Target Collective Good	All Others Target Private Good
Target collective good	nB/n	B/n
Target private good	$(n - 1)B/n + b$	b

a good common to all that would be in the best interest of the members collectively. Only where the acquisition rates for collective goods *are* n *times higher than for private goods* (where foragers' own $1/n$ of the collective good is greater than they could get from targeting the private good) will foragers maximize their consumption payoff by procuring the collective good.

The payoff matrix shows in general form the trade-offs indicated in the data assembled above from the !Kung, Ache, and Hadza. In each of these cases, foragers earn more for their own family consumption by pursuing private goods on their own and claiming shares of any collective goods provided by others.

In the !Kung case, a man who gathers can expect a family consumption rate of 4,000–6,000 Cal/day for that work plus 2,564 Cal on average from every big-game hunter (if ≠Toma's performance in July 1964 is representative). The big-game hunter can expect only 2,564 Cal/day for his own family plus his family's share from every other big-game hunter.

An Ache man who targets plant foods will get 580–1,330 Cal/hr. for his family (47.5% of his acquisition) plus a bit from other collectors (his family's share of the 52.5% shared out by each) and his family's share of the 1,166 Cal/hr. shared out by each hunter. By contrast a hunter, though he gets the bit shared out by collectors and the shares from other hunters, foregoes the 580–1,330 Cal/hr. from his own gathering for the 174 Cal/hr. that is his own share of the game he bags.

A Hadza man will get 3,900–10,000 Cal/day for his family from gathering plant foods and can claim about 900 Cal/day from every hunter. If he hunted himself, he could expect to keep about 900 Cal from his own kills plus his 900 Cal share from each other hunter. In each of these cases, if men sought the foraging alternative that gave them the highest family consumption, they would gather rather than hunt, targeting private instead of collective goods.

Measuring Nutritional Payoffs

Energy can be a poor measure of nutritional utility when comparing resources with very different nutrient compositions (Hill et al. 1987, Hill 1988). Gathered resources usually have small fractions of fats and proteins, though nuts (like mongongos) are a notable exception. Hunted resources are almost entirely composed of fats and proteins. If the nutritional value of an additional unit of these nutrients varies both with the total amount of food available and with the nutrient composition of that total (Hill 1988), the relative consumption payoffs for a hunter's fraction of his score may be underestimated.

Hill (1988) makes the usual assumptions—the ones under question here—that acquisition choices are motivated by consumption goals and that acquisition approximately equals consumption. They allow him to use data on acquisition rates for different resources and the composition of forager diets to infer differing marginal rates of substitution for these macronutrients. He argues that if an Ache man could earn 2,800 Cal/hr. gathering but hunts and stops for honey to get 1,340 Cal/hr. instead, then he must value the second kind of calories at more than twice the first. If we consider his rate for hunting only, then he chooses 910 Cal/hr. of meat over 2,800 Cal/hour of gathered food, valuing meat more than three times as much as gathered resources. If the multiplier is large enough, then for the model of table 1, $1/n$ of the B may be greater than b. This will make the collective action problem disappear because foragers maximize their own nutritional gains by targeting the collective goods. For the Ache, the protein and fat multiplier (P) would have to be large enough to satisfy the inequality $13\% \ (910P + 430) > 47.5\% \ (2{,}800)$—greater than 10.77. For the !Kung, the macronutrient composition of both mongongo nuts and meat is fat and protein. This ought to inflate the value of rare carbohydrates but suggests no multipliers for the alternatives considered here. For the Hadza, for B/n to be greater than b, assuming n to be 8 (a number of families), P would have to satisfy $P\ 900 > 3{,}900–10{,}000$. P would have to be greater than 4.3 and sometimes greater than 11.

The complexity introduced by comparing foods with different macronutrients can be avoided where both collective and private goods are composed of the same macronutrients, perhaps mongongo nuts and meat for the !Kung, more certainly large and small game. Among the Ache, men and women take the same nongame resources. Within this set, carbohydrates only, some resources are more widely shared (Kaplan 1983, Kaplan and Hill 1985*a*). If there were no differences in return rates, foragers seeking to maximize their family consumption should target the private goods, those less widely shared. Women do, but men take more of the collective resources (Hawkes 1991). This suggests that, as when they hunt, men do not gather to maximize their family's consumption but target collective goods instead.

In the case of the Hadza, macronutrients can be held constant by comparing meat acquisition strategies, one targeting collective and the other private goods. Unlike the !Kung or the Ache, Hadza hunters are big-game specialists; only about 1% of the weight of game taken comes from small animals (Hawkes, O'Connell, and Blurton Jones 1991). Yet small game is abundant in their habitat, and on rare occasions men set snares. Hawkes et al. report an experiment in which a sample of Hadza men agreed to hunt small animals and set snares for a sequence of days to see what incomes they could earn this way. When small animals *are* taken they are not widely shared. Results showed that mean earnings were much lower than for big game but that failure rates were much lower as well. A model based on these measurements showed that, as in the payoff matrix of table 1, if men sought to maximize their chances of feeding meat to their children they would hunt or trap small animals instead of targeting large animals only. That model attended to the variance in returns ignored in the model here. The high long-term mean daily rate for Hadza big-game hunters (a function of the enormous size of their prey) obscures many days of failure. This extreme variance could have especially large effects on children. Continuing research on nutritional payoffs for different food types and on the effects of different consumption schedules is clearly in order. We need to know what difference it makes for a consumer to receive a large portion of meat rarely (e.g., 2 kg every three weeks) or a small amount more frequently (e.g., 50 g each day) and how this effect varies with age and sex.

These considerations show that in at least some cases a higher value placed on the macronutrients in a shared good could make the public-goods problem disappear. Yet a very robust pattern in resource choice would remain even if large multipliers were justified. Foraging men tend to target widely shared resources. !Kung, Ache, and Hadza men all spend substantial (though quite different) amounts of time supplying collective goods. The conclusion supported by this analysis is that under a wide array of circumstances they would not target these resources if they sought to maximize their own or their family's consumption.

Selective Incentives

The payoff matrix of table 1 suggests possible benefits distinct from consumption of the good itself. With the payoffs represented in the matrix, individuals who acquire collective goods increase their neighbors' consumption instead of their own families'. Foragers do better to choose neighbors who provide collective goods. If there are advantages to being preferred as a neighbor, individuals can gain them by trading off the consumption advantages from targeting private goods and supplying collective goods instead. Advantages may include deference in decisions about travel, support in disputes (or at least reluctance on the part of others to side against them), and enhanced mating opportunities. Preferences in association will be likely to have fitness consequences for any social animal—the more intensely social, the stronger the effect.

The social benefits to be gained from providing collective goods will be frequency-dependent, the amount of benefits one can capture depending on how many others supply collective goods. This can be modeled by assuming that no matter what others do, each individual spends an amount of social attention worth S to those receiving it, and further, that (1) all serve their own interests by paying a similar amount of social attention, (2) each individual allocates his or her social attention preferentially to those who target collective goods, (3) receiving social attention is a fitness benefit, and (4) more attention is better than less.

A very simple scenario provides a rationale for the first two assumptions. If individuals monitor cues in their environment to alert them to both opportunities and dangers (e.g., food and predators), then the behavior of others like themselves can provide an important set of cues. Individuals find it in their interest to pay some amount of social attention. If some of those they watch are more often associated with opportunities for consumption, then individuals will find it in their interest to distribute their attention accordingly.

The second two assumptions rely on an argument about the use of signals. If signaling plays a role in gaining mates and allies and in adjusting the behavior of competitors, then there can be an advantage in having one's signals heard earlier and more widely. Those who receive preferential attention are (other things the same) followed more and responded to more quickly. Associates are thus more readily available to them as allies and mates and less likely to side against them in disputes.

The boundaries of a symmetrical n-person game illustrating these payoffs appear in the payoff matrix of table 2. Here the benefit is not family consumption but social attention. As in the previous game, n is the number of individuals in the group. Here S is the benefit of all the attention from one group member. Entries show the social payoffs to row. If row targets collective goods and all others do too (the upper left cell), row gets a $1/n$ share of the S from all other $(n - 1)$ group members. If row is the only one to provide the collective good, row gets all the attention (the upper right cell). If row targets the private good and all others target the collective good (the lower left cell), then all the attention goes to others. If no one targets the collective good, then the social attention is equally or randomly distributed (the lower right cell). Since social attention is the only benefit counted in this game, no matter how small S is, as long as it is positive, row does better to target the collective good. Even though row earns no more social attention when all target the collective good than when none do, entries in the top row are always higher. The evolutionarily stable strategy is targeting the collective good.

Olson (1965:60–61) noted that in small groups social incentives could readily solve the public-goods problem, but he did not go on to ask why individuals should respond to social pressure by contributing collective goods. The treatment here points in the direction of an evolutionary basis for that social pressure and its effects. Those who prefer companions likely to provide collective goods accrue consumption advantages for this preference. The fitness advantage to collective-good providers is the attention they get as a consequence. Those who happen to be present to consume the collective good cannot continue to free-ride on the attention paid by others as long as the collective good appears unpredictably. Only by paying attention to the location and activity of the collective-good suppliers do they con-

TABLE 2
Social Attention Payoffs of Alternative Strategies

	All Others Target Collective Good	All Others Target Private Good
Target collective good	$(n - 1)\,S/n$	$(n - 1)\,S$
Target private good	0	$(n - 1)\,S/n$

tinue their good fortune. If the model is complicated slightly to distinguish strategies of supplying more or less of a collective good as well as none at all, and individuals who are expected to supply more get more attention, then the evolutionarily stable strategy for those seeking attention is providing more of the collective good.

Second-order public-goods problems often lurk in apparent solutions. Since incentives to collective-good providers must themselves be private goods (i.e., benefits that only providers get), supplying the *incentives* can engage the logic of collective action. If some award the attention that motivates the suppliers but others can regularly consume the collective good without paying the price of attention, then attention will be underprovided. This model avoids that problem by assuming that those who pay attention to suppliers are more often around to consume what they supply. There is then no incentive to "cheat." Connor (1986) has suggested the label "pseudo-reciprocity" to distinguish cases such as these from the trading of delayed benefits.

The assumption that suppliers get real benefits from attention alone because it makes their signals and invitations heard first more often by more others is quite general. Anyone might seek these benefits. Whether the actual value of such a signaling advantage could be very large remains to be investigated. The model is very sensitive to the assumptions about private benefits to all parties. If consumers got the same amount of collective good whether or not they paid attention to providers, then those not paying attention could free-ride. If consumers were around to get shares more often when they paid attention but were no more likely to respond to invitations and directions of suppliers even though they heard them first, then the incentives to collective-good providers would disappear. In a less general model of some of the same trade-offs, I used an asymmetric game with gender differences and two strategies available for men and two for women (Hawkes 1990). Private benefits to collective-good providers (who were called "showoffs") were mating opportunities, and private benefits to mating-opportunity providers were survival advantages to their children fathered by showoffs. The treatment here has the advantage of greater simplicity and generality, but the private benefits are less readily illustrated with empirical examples.

The models are of course too simple to capture what actually goes on in foraging communities. Yet even the few variables in the general models are enough to show that two kinds of payoffs, family consumption and social attention, can trade off against each other. If so, those whose goal is to maximize their family's food consumption should choose private goods and those whose goal is to maximize their social benefits should not. As with all trade-off problems, the optimal solution may be to provide only private or only collective goods or some mix of the two. Particular solutions will depend on the relative values of the two kinds of benefits—the marginal costs and benefits of additional units of time allocated one way or the other. These depend in turn on an individual's own characteristics and on local ecology.

Implications

The most general implication of the data and argument presented here is that hunters often do not get the food consumption benefits from their work that have generally been assumed. This has special relevance to three issues arising in scenarios of human evolution, at least two of which are also relevant to the study of public-goods problems. First, the analysis challenges the view that hunting or competitive scavenging is generally a kind of paternal investment among human foragers. Second, data reviewed do not support the proposition that variance reduction or delayed-return reciprocity explains sharing in foraging communities. Third, characteristics of the resources foragers exploit combined with small-community social life impose trade-offs between consumption benefits and social benefits. These trade-offs are not unique to modern circumstances, suggesting a link between features of subsistence resources and selection pressures on the character of human social behavior.

A striking implication of this argument involves differences in foraging behavior by sex. If the fitness values of social attention and family food consumption differ for men and women and if these are competing benefits, then men and women ought to prefer different trade-offs and choose to forage for different resources. Gender differences in foraging strategies are of course the usual pattern among ethnographically known hunter-gatherers, but this sexual division of labor is generally assumed to arise because it efficiently serves family production goals. One striking difference between humans and other primates is that men contribute to group food consumption, but I have argued that, in spite of authoritative contrary assertions (Washburn and Lancaster 1968, Lovejoy 1981, Lancaster and Lancaster 1983, Alexander 1990), much of this contribution is not paternal investment. The material reviewed shows that men often choose the very resources least likely to give consumption advantages to their own nuclear families. This choice can neither depend on nor reinforce either marriage or confidence of paternity. Anthropologists have long noted that women make trade-offs with child care that men do not (Brown 1970, Murdock and Provost 1973, Hurtado 1985, Hurtado et al. 1985). The argument here is that an additional trade-off plays an important role in foraging strategies. Family nutrition as compared with alliance and mating advantages will often give different relative fitness payoffs by sex because of the same fundamental asymmetries that lead women to invest more in child care than do men.

These asymmetries may sometimes be subtle. Consumption and socal benefits will be valuable to both men and women, but marginal fitness gains for investment in each will often differ. The food that a woman, her young children, and her reproductive daughter consume day by day will have a large impact on her reproductive success through effects on her fecundability and the survivorship and fertility of her offspring. At the same time, women have less to gain (or lose) in disputing other women over mating access to men than men have to gain (or lose) in contests over access to women.

This difference is especially great where property rights are poorly defined and therefore mates are not valued for their wealth. Still, under some circumstances, women may use social attention to gain assistance in child care from other women.

Offspring survivorship will affect a man's reproductive success as well as a woman's, and his own general nutritional status will affect his fitness. Under some ecological circumstances family provisioning may be his best bet, but under many others the number of his mating opportunities and his success in disputes with other men over mating will likely have larger effects. Men will usually have more to gain from additional mates than will women. Since any man who gets more paternity than other men subtracts directly from his competitors' reproductive success, arms races in mating competition among men can readily develop. It is consistent with the simple models here that if social attention can be gained from supplying collective goods and if it gives higher fitness returns than family provisioning, then when one man seeks social attention, others must follow suit or lose out. The correlation between hunting-success rank and measures of reproductive success among the Ache men (Kaplan and Hill 1985*b*) is consistent with this argument.

Because of the association between sharing and resource predictability, anthropologists have postulated risk reduction as an explanation for sharing. This explanation requires not only that those who provide shares for others receive shares themselves but also that those who do not provide shares do not receive them. This contingency is not observed empirically. In fact, it is the lack of quid pro quo in sharing patterns that has long drawn the attention of ethnologists (Lee 1979; Sahlins 1965, 1972; Hawkes 1992*b*). Some have considered the opening such sharing gives to "freeloaders" and have suggested that sanctions such as witchcraft accusations (more likely to fall on anyone of deviant laziness) keep people working (e.g., Harris 1989). Aside from the public-goods problems this poses (e.g., Boyd and Richerson 1992), it leaves salient aspects of the empirical reports unexplained. These show "most people" working some, some people (often the most efficient) working relatively hard (e.g., Hill and Hawkes 1983, Hawkes et al. 1985, Hawkes 1987). If people worked only hard enough to meet a minimum requirement set by the amount others worked, the frequency-dependent standard would be prone to slide lower and lower as any working harder than the current average reduced their effort.

Some have suggested that repayment to those who work harder and give more may be very long delayed, even indirect (e.g., Alexander 1987). Formal modeling so far shows indirect reciprocity to be at least as fragile (Boyd and Richerson 1989) as the direct exchange of delayed benefits (e.g., Boyd and Richerson 1988, Martinez Coll and Hirshleifer 1991, Hawkes 1992*a*). Perhaps more important, a model of indirect reciprocity fails to supply any explanatory links between particular resource characteristics, predictable differences in the extent to which resources are shared, and associated patterns in resource choice.

The tolerated-theft model shows how the economics of defensibility can make "ownership" negotiable. When large animals are procured unpredictably, excluding claimants from access may be too expensive. The hunter himself cannot afford to exclude others, nor can anyone else. If the hunter or another tried to channel a large fraction to favor a friend, the friend would face demands for shares in turn. With property rights under such continuing negotiation, large asynchronously acquired resources are collective goods. Like that of any collective good, the consumption value of the resource is rarely sufficient reason to procure it. However, selective incentives will motivate suppliers.

Some aspects of the lives of contemporary foragers can be linked to special circumstances of the modern world. The environments people exploit now differ from those of the past; regional histories often involve complex interdependencies between ethnographic subjects and their neighbors. People observed as foragers may have ancestors who made their livings in other ways. This can lead investigators to be suspicious of the relevance of hunter-gatherer ethnography to an understanding of our evolutionary history. But some of the limits and choices that people confront from day to day when they make their living by hunting and gathering exemplify constraints and trade-offs of great antiquity. This provides an opportunity to evaluate theoretically motivated hypotheses and may stimulate the development of new ones.

If the trade-off between family consumption and social attention underlies the resource choices of modern foragers, it is a trade-off with a long history. Paradoxically, this very "materialist" evolutionary economics anticipates the problem that not all incentives are "material." Modeling and measuring both social and family-consumption benefits will help us understand not only variation in resource choice among foragers but also variation in cooperation and tendencies to supply other collective goods in these and other human communities.

Comments

JON ALTMAN
Centre for Aboriginal Economic Policy Research. Faculty of Arts, The Australian National University, Canberra, A.C.T. 0200, Australia. 31 III 93

Hawkes seeks to replace the orthodox reciprocity model of hunter-gatherer sharing of game with a public-goods model which postulates that medium-sized and large game are regarded as common property in the sense that they are owned and consumed by all. This comment uses Australian data to argue that large game has characteristics of a private good, that the sharing of game is an effective risk-minimising strategy, and that ecological constraints regularly limit the choice of hunting strategy. The data were collected in western Arnhem Land among contemporary Gunwinggu hunter-gatherers (Altman 1987) and among Gidjingali people in coastal central Arnhem Land (Meehan 1982). Some of these data have been used to argue that rights in large game constitute a form of property—the opposite of Hawkes's position (Altman and Peterson 1988).

Among Gunwinggu, sharing of game is an extremely complicated process, and at best fieldworkers can trace only first-round distribution. Even such distribution is complicated by a range of factors including the ritual status of the hunter, the kin relations of fellow hunters and coresidents, the size of the residential group, and seasonal and ritual consumption restrictions. There is certainly a cultural expectation that large game will be widely shared, but in practice this may not occur because of competing obligations. The only sure way of guaranteeing game to one's immediate family is to be the successful hunter. Paradoxically, at times, ritual restrictions may result in the successful hunter's being excluded from consumption, but his immediate family, usually residing in the same household or household cluster, will partake of his share. In short, there is a material incentive to succeed. This view is supported by quantitative data collected among Gunwinggu: successful hunters received more game (Altman 1987:129–50).

There are opporunities for the successful to restrict wider distribution by, for example, consuming large game where hunted, and such action can be observed (by fieldworkers, at any rate), but this is counter to cultural norms. As one generally coresides with kin, there is little reason to exclude these people from access to game. Furthermore, in tropical Australia large game has a very limited life: it must be consumed quickly or it rots. The fact that game is not a public good is very evident when hunters competitively bid for a share of hunted game. At times, people go to extraordinary lengths to deliver an immediate surplus to kin rather than merely allowing camp coresidents to share in consumption.

Hawkes alludes to longitudinal data demonstrating that sharing does not result in balanced reciprocity in the long term, but I find this unconvincing. I am not aware of any ethnography that includes quantitative data for a group over a long enough period to assess whether the distribution of game balances over time. Quantitative data collected with Gunwinggu over one seasonal cycle indicated not only that sharing greatly ameliorated household variations in production but also that resources flowed in a predictable direction: from households with young, dynamic, and productive hunters to those with older, more ritually senior and less productive men.

Hawkes assumes that hunters face a simple choice of resources to target; she accepts as unproblematic the common and somewhat oversimplified view in hunter-gatherer studies that gathered resources are both predictable and available while the hunting of game is both unpredictable and high-risk. Such a view overlooks ecological factors that greatly constrain resource choice during some seasons. For example, among Gunwinggu, large game was the subsistence staple during the wet season, heavily supplemented, in the contemporary context, by store-bought carbohydrates. It is unclear how "the carbohydrate gap" would have been bridged under traditional conditions, when seasonality and flooding greatly restricted the availability of almost all gathered foods. This was, without doubt, a time of relative dietary hardship (Altman 1987, Meehan 1982). A collective hunting strategy may have been essential to meet a group's minimum dietary requirements, but even at this time game was not necessarily a collective resource.

Hawkes presents nonproducing consumers as freeloaders, but this view very much depends on cultural perceptions of who should produce, restrictions on potential producers, people's other recognised specialities, and so on. There is no doubt that freeloaders can be a source of extreme contention and disputation among hunter-gatherers, but in such circumstances effective strategies are adopted: subgroups may collude to consume game where slaughtered, or people may lie about their returns, sneaking game into camp late at night. Eventually disputes may erupt that result in changes in the composition of coresiding groups and the temporary abandonment or expulsion of freeloaders.

Ultimately, Hawkes ends with a conundrum. A materialist model grounded in the neoclassical-economic concept of public goods concludes with the cultural explanation that social benefits accrue to successful hunters. Hawkes provides no empirical support for the hypothesis that success in hunting game as a public good converts to accumulated individual social benefit, presumably as a private good. This is a hypothesis with which "mainstream" social anthropologists and hunter-gatherer specialists would be very comforable, but it is immaterial to the argument whether game is or is not a public good.

STEPHEN BECKERMAN
Anthropology Department, Pennsylvania State University, University Park, Pa. 16802, U.S.A. I III 93

Hawkes has taken her customary hard look at familiar anthropological assumptions and come up with a typically provocative reinterpretation. Salutary as the exercise is, two cautions are in order.

The first: The variance-reduction hypothesis for sharing of unpredictable large-package resources should not be discarded hastily. Variance reduction is not incompatible with using sharing for the acquisition of social benefits; the argument must be that the latter is a stronger influence on sharing behavior, not that the latter logically excludes the former. The argument for the relative unimportance of variance reduction has some soft spots. The Ache, Hadza, and !Kung data runs failing to verify food repayment are all short with respect to the life-span of the organism. Axelrod's computer tournaments, in which immediate tit-for-tat strategies outcompeted strategies with longer memories, provided no opportunity for the sort of pleading and haranguing prominent in the ethnographic literature about hunter-gatherer sharing. (While description of current inequities may be prominent in demands for sharing, it strains credulity to argue that memories of past generosity are unimportant to those on whom the demands are made. The literature bursts with accounts of the weight of reciprocity in egalitarian societies.) The trade-off between increasing or regularizing the food consumption of the adult male's own family and increasing or regularizing that of other families (for social attention payoffs) is rudimentarily posed. If (as will often be the case in hunting-and-gathering societies) many of the other families are those of ego's brothers, sisters, and brothers-in-law and their offspring are nieces and nephews, then ego has a fitness interest in the food consumption of all these people. It is an interest that may be served not only by giving them game to eat but also by giving them game to give away in turn, so that their generosity may influence the future behavior of others toward them. Adding these considerations to the nutritional payoffs (particularly to children) of the high-quality nutrients often supplied by the large game favored by men leads to a less than robust rejection of the variance-reduction hypothesis. The major point of Hawkes's article, that variance reduction alone is probably insufficient to explain the foraging options pursued by men, remains.

The second: The idea of social attention, a partible "private good" with ego's allotment going to him alone, may not be the only way (or the best way) to think about the nonfood benefits accruing to a provider of collective goods in food. One likely result of ego's targeting of big game in his foraging is his holding a lot of other men around him to partake of his largesse in shared meat. Ego's (and everyone else's) major benefit from the presence of these other men may be in common defense against wife raiding. Common defense is a public good. Strangely, it may not be true that this public good permits freeloading. If men in the raided group have no choice but to fight together, then cheating (consuming the food without paying the "price" of common defense) is impossible.

Moving out of the realm of public goods and into the slippery terrain between the fully public and the strictly private, another plausible benefit of conspicuous sharing is the political clout to acquire additional wives for ego's sons. While the fitness benefits to ego (in grandchildren) are obvious, these benefits can accrue only by virtue of benefits to his sons' mother(s) and to the sons themselves. These kinds of inherently familial benefits appear (maybe I'm wrong here) to violate the spirit of Hawkes's emphasis on fitness benefits to ego that are alternative to those realized within the family.

Another potential glitch is the possibility that the big-game hunters are deceived and exploited by the beneficiaries of their efforts. Admiring glances, easy deference, and coy insinuations of trysts in the moonlight may feed those more dedicated to acquiring private goods and nourish a big-game hunter's ego for years—only to end in a realization in Nimrod's old age that all that public admiration produced little in the way of effective support in tough disputes and none of those whispered flirtations ever culminated in a biologically significant assignation.

As is her habit, Hawkes has reformulated the conventional wisdom as a testable hypothesis requiring more and more detailed field data. I look forward to the round of research kicked off by her latest questions.

ROY RICHARD GRINKER
Department of Anthropology, The George Washington University, Washington, D.C. 20052, U.S.A. 26 II 93

This is a well-crafted paper with a sound and coherent methodology. It addresses important questions in the study of sharing in foraging societies. One reason for its coherence is that its author is concerned with reproductive fitness and thus operates within the narrow confines of a cost-benefit explanatory scheme. In so doing, she perpetuates a functionalist logic that is by now dismissed by the majority of cultural anthropologists. That this paper's theoretical foundations seem anachronistic is ironic, since Hawkes pursues another anachronism in taking hunter-gatherers out of their proper or historical time and treating them as ethnographic analogies for the distant past. I will leave the problems of biological perspective to be addressed by others and focus instead on the separation of hunter-gatherers from the social contexts in which they live.

What is especially shocking, although consistent with Hawkes's intentions, is the dismissal, in just a few sentences, of "the special circumstances of the modern world." One of these "special circumstances" is the relationships hunter-gatherers have with nonforaging neighbors. The groups represented in her analysis are treated in virtual isolation from their contemporary or past social relationships and regional histories. The Lese farmers and Efe (Pygmy) foragers of Zaire with whom I work are an interesting case because the foragers cannot be understood apart from their relations with the farmers and because the sharing of food between these groups illustrates some faults in Hawkes's scheme.

Lese-Efe relations are organized primarily at the Lese house. Each house ideally consists of a man, his wife or wives, their children, and an Efe partner (although the Efe partner does not reside in the Lese house). Both the Lese and the Efe define their partnership as a beneficial division of labor in which the Lese partner shares cultivated foods in return for meat and honey. Partners say that they give things to get things, but this economistic model conflicts with both the practice of Lese-Efe relationships and the conceptual schemes and vocabulary Lese and Efe use to represent them.

My informants consistently articulated an economistic ideology in which they identified themselves either as foragers (Efe) or farmers (Lese) and defined Lese-Efe relations in terms of the exchange of meat and honey for cultivated foods. But, as I have shown (Grinker n.d.), the Lese obtain most of their meat by themselves or from other Lese, and the Efe obtain many cultivated foods from people other than their partners. Indeed, during 1985–87, exchanges between partners were rare. Lese and Efe seldom mention the variety of activities they share, especially in Lese villages; among other things, the Efe provide labor in the Lese gardens, serve as the main participants in many Lese rituals, and assist in Lese chores. The relationships that constitute everyday practice are thus dissociated from the ideology of practice; they are conceived as residual to economics. This separation seems at odds with a conventional notion of the gift economy—that people spend great time and effort elaborating kinship, clientship, and other moral relations to mask their self-interested and economic behavior. The Lese and the Efe frame their relationship, including their identities as farmers and foragers, in an idiom of the economy; in other words, the division of labor is an ethnic process, with "forager" and "farmer" as ethnic identities. What may appear to the anthropologist to be a fairly simple cost-benefit relation is far more complex when one considers the conceptual scheme in which economics are embedded. Neither sharing nor interethnic social relations determine the other; rather, they are mutually constitutive.

Following Hawkes, one could argue that the Lese-Efe relationship is functional because, through sharing, the Efe receive social attention from the Lese, that is, those outside their families. The point I want to stress here is that it is circular reasoning to say that the Efe give meat to those outside their families in order to establish social relations with the Lese, because it is the Lese-Efe relationship itself that defines the giving of meat. Regarding Hawkes's concerns with fitness, the partnerships do not significantly influence the wealth or marriageability of Efe; people with or without partners marry and reproduce, and physically and mentally handicapped Efe men, though often bachelors, can and do have partnerships.

Lese and Efe do not believe that sharing between partners lies outside of the family, and they use the term *oki*, meaning the division or distribution of foods within the house, to denote the transfer of foods between partners. As members of the same house, partners are "family" and have rights in one another's foods. The Efe do not "exchange" foods any more than fathers or mothers exchange food with their children. In contrast, transfers of food outside the partnership are construed as either *oka* (purchase) or *iregi* (exchange). These observations have two important implications. First, when we analyze sharing we must identify the specific social relationships involved. Second, comparative studies of sharing must provide culturally specific definitions of the "family." Although Hawkes is concerned with family consumption, it is not clear what constitutes the family in the various societies she discusses. The undefined term "family" is juxtaposed to "others," with others, I assume, representing those less than a certain fraction of relatedness away from a given ego.

HENRY HARPENDING
Department of Anthropology, Pennsylvania State University, University Park, Pa. 16802, U.S.A. 3 III 93

The amount of time men spend hunting large animals in foraging societies is an embarrassment to cultural ecologists and sociobiologists because it does not maximize energy capture for either the group, the family, or the individual. Hawkes offers several explanations.

The most interesting is one that she does not pursue—that there is some critical nutrient or set of nutrients that has not yet been discovered. If there were such a megamammal nutrient, then there would be no problem understanding why men hunt the way they do.

Her other suggestion is that "social attention" is the payoff to good hunters. This social attention must enhance the fitness of the recipient. There are suggestions that in some groups it may be sexual access to females, but we knew paternity among the !Kung in the sixties and there was no evidence at all of greater sexual access for good hunters.

Hunting large animals is not the only puzzling inefficiency in human subsistence. Farmers who don't produce very much grain eat the grain, but farmers who produce a lot feed the grain to chickens and then eat eggs (Clark and Haswell 1966). Why convert ten calories of wheat into one calorie of egg?

We have a deep belief in mystery nutrients that are found only in certain foods; this is why we think that we need "balanced diets." Protein was the leading candidate for being the critical mystery nutrient for decades, but its prominence seems to have declined, perhaps in parallel with the political impact of the American dairy industry. All this may, however, reflect an ancient runaway process. Our preferences for meat over nuts and eggs over porridge may make little more adaptive sense than the lion's mane or the peacock's tail. I don't know how to test this hypothesis, but without tests we are left with just another version of the *sequitur* that culture makes us do it.

ROBERT J. JESKE
Department of Sociology and Anthropology, Indiana–Purdue University Fort Wayne, Fort Wayne, Ind. 46805-1499, U.S.A. 22 II 93

This article is a sound contribution to the growing body of literature that examines optimal behaviors in humans from a perspective beyond merely counting calories. Many have argued against viewing humans as *Homo economicus*, and indeed, many models that link human behavior to a rational energy-input/energy-yield strategy are poorly validated by empirical data. Hawkes does a credible job of showing that neither energy-optimization nor the more sophisticated risk-minimization models necessarily explain big-game hunting and meat sharing among foragers. Since men reduce short-term family nutritional intake by hunting and apparently get no demonstrable long-term caloric reward through reciprocity, she argues that they get increased reproductive success through "social attention." At heart, she proposes that males will hunt and share meat in order to gain sexual favors from multiple women, thereby increasing their reproductive success. Women, in contrast, will maximize their reproductive success by getting as much high-yield nutritional material for themselves and their children as possible through gathering and sharing meat from males who hunt, presumably mating with males who provide meat. Males who might otherwise freeload on other men's hunting are pressured into hunting in order to keep good hunters from co-opting all of the women. It appears that men can either be efficient calorie collectors with low social attention or inefficient calorie collectors with high social attention.

This model sets up a social economy with several implications that are potentially testable. First, reproductive success in males who are successful hunters/sharers (hence receive high social attention) should be demonstrably higher than in males who are less successful hunters. Second, young males in need of social attention should be the most active hunters; successful males who already have access to females, however, should not be able to taper off hunting and begin to enjoy the fruits of others' hunting. There should be a correlation between reduction in a man's hunting success and reduction in his siring of children. In light of Hawkes's dismissal of delayed-reciprocity models, we should see a tight fit between meat income and sexual activity. Unfortunately, she does not provide the data to show that there is a strong connection between hunting success and reproductive success. Until there are good data to support the connection between the two, her model provides no more explanation than any of the others offered to date.

There are, however, additional questions that arise from Hawkes's model. In order for a man's reproductive success to increase as a result of his hunting prowess, women must have an incentive to have sex with successful hunters. If all are sharing equally in the hunter's success, there is no incentive for a woman to provide more children for the meat supplier than for the nonsupplier. How, then, does the hunter increase his reproductive success, unless women increase their reproductive success by offering sex for meat? What is it about meat, if not nutrition, that makes it the chosen medium for this postulated social exchange?

A further interesting question is, If there is an evolutionary explanation for males' hunting big game, then why don't more do it? Hawkes's own examples suggest that relatively few men attain the big-game/social-attention payoff. Why do many if not most men seem to go for the energy-return, low-hunting payoff? Is there an age factor involved? What other factors enhance or degrade the social attention men may get from hunting? I believe that asking these kinds of questions and conducting more sophisticated investigations into aspects of nutrition and risk reduction will provide us with increasingly better insights into why foragers work and share.

NICOLAS PETERSON
Department of Archaeology and Anthropology, The Australian National University, Canberra, A.C.T. 2601, Australia. 31 III 93

The problem with much of the writing by evolutionary ecologists is not that it is wrong but that it is sociologically impoverished. Working with a series of simple contrasts between individual and society, biology and culture, and selfishness and altruism provides for great clarity in the definition of problems and their analysis but does not do justice to the complexity of social reality and frequently leads to banal conclusions. Thus this paper concludes that, "Paradoxically, this very 'materialist' evolutionary economics anticipates the problem that not all incentives are 'material.'" Who ever thought they were?

Hawkes invokes the selfishness-altruism dichotomy to ask why foragers ever target resources that will go mostly to others rather than to their spouses and children. A commonly heard justification for polarising problems in this way is that it leads to testable hypotheses. The first that Hawkes considers is that sharing is a means of risk reduction. This is set aside, however, because it "lacks empirical support." The implication that sharing does not reduce risk in some situations seems unlikely. What is wrong here is the idea that sharing is *only* a means of risk reduction. Sharing is a complex behaviour which cannot be reduced to a single consequence or significance.

The second hypothesis is that "the incentive for providing widely shared goods is favorable attention from other group members," which gives the male sharers a mating advantage. On the basis of Australian ethnography (which has to be encompassed by the generalisation if it is valid) it can be said that hunters do receive attention (even if it is often marked negatively by their being deliberately ignored) in that they confirm their potential as good sons-in-law by providing meat to their future wives' parents; they enhance their access to religious knowledge by gifts to the older men of their descent group; they enhance their status more generally; and, in long-delayed reciprocity, they nurture those who nurtured them when they were young. Providing meat to in-laws is something all young men have to do in order to secure a bride. Thus there is no doubt that supplying meat is related to mating—but this is mating by all men, and it is not the sole or even the most important determinant of how many wives a man may have or how many children.

The third hypothesis is that sharing takes place as tolerated theft in situations in which the cost of defending a resource is greater than the benefits to be had by doing so. The evidence adduced for tolerated theft is so-called demand sharing. But to construe demand sharing as tolerated theft (that is, taking without right or obligation) is to misunderstand the nature of interpersonal sociality in egalitarian societies. Demand sharing is testing, asserting, and substantiating behaviour, not evidence for large game's being a public good.

The conclusion to be drawn from the foregoing is well stated by Hawkes: "The models are . . . too simple to capture what actually goes on in foraging communities." For social anthropologists part of the problem is that much of the dialogue of the evolutionary ecologists is in an evolutionary time frame, which means that some of the complexities of present-day social behaviour may be noise even when they are vital to social life and social reproduction. More concern with the present would help break down the binary contrasts that vitiate so much of their work. It might also lead them to provide more relevant data. Despite the emphasis on the conferral of a mating advantage, we have no demographic information at all. By now the effective hunters that Richard Lee was writing about in the sixties must have grandchildren: have they been propagating their genes more effectively than the rest? Doubtless nothing statistically significant could be said from what is likely to be a small sample, but asking the question might well prompt more social analysis.

ERIC ALDEN SMITH
Department of Anthropology, University of Washington, Seattle, Wash. 98195, U.S.A. 15 III 93

This article offers a critique of the received wisdom concerning hunter-gatherer food sharing and proposes an alternative explanation for same. The critique seems to me fairly effective, if not definitive, but I do not find the alternative compelling or even comprehensible.

The critique has two elements, one theoretical and the other empirical. The theoretical point is that a collective benefit from food sharing such as risk (variance) reduction does not mean that rational choice or natural selection will favor its provision by self-interested individuals. This point has been recognized for some time by anthropologists with an evolutionary-ecology orientation (Kaplan and Hill 1985*a*, Blurton Jones 1984) and modeled explicitly as a "prisoner's dilemma" (Smith 1988, Smith and Boyd 1990). This article articulates this point for a broader anthropological audience. But what is unstable in a one-shot prisoner's-dilemma game is not necessarily so in a repeated one (Taylor 1987), and an ongoing pattern of food sharing is certainly not a one-shot interaction (Smith 1988). The empirical critique consists of demonstrating that for the few cases where we have the requisite data, contributions to collective goods (shared game) are not balanced: some hunters consistently bring in the lioness's share of the harvest, and poorer hunters gain by sharing in such largesse. Furthermore, those who contribute little to the collective harvest by voluntary failure to try hard are (allegedly) not therefore excluded from their share. But I read the ethnographic data from a number of other cases (such as Inuit) to contradict the notion that slackers will not face any sanctions or loss of collective benefits, and three ethnographic cases are not a particularly robust basis on which to rest the case against the risk-reduction explanation. Hence my conclusion that this critique of the conventional wisdom is to be taken seriously but not accepted as definitive.

Turning to the proposed alternative, I will grant that the mathematical derivation of results is done correctly and with exemplary clarity, but I question the logical connection between this particular model (table 2) and the real (or even ideal-type) world. The formulation begins with "social attention" as a simple function of proximity: individuals pay attention to good hunters because doing so will bring them a larger share of the catch simply by their being nearby when it is brought in. This in turn is assumed to benefit the providers, because "preferences in association" will have fitness benefits in any social animal. There is no temptation to underprovide attention (to "free-ride"), because there is a direct link between proximity, attention, and getting better shares.

If I have represented the argument correctly, here are my objections: First, I do not read the ethnographic literature as indicating that proximity is usually required for receipt of a share. Sharing is often ritualized, as in the seal-sharing partnerships of many Inuit (van de Velde 1956), or in any case does not necessarily appear to favor those who hang around the provider. Second, proximity or other forms of "social attention" can be costly to the recipients, exposing them to "tolerated theft" (Blurton Jones 1984). If proximity is the key to getting a bigger share, good foragers may find their movements, their very foraging success impeded by followers eager to partake of their catch. Hawkes may reply that it is not proximity that is implicated in "social attention" but such particulars as "deference in decisions about travel, support in disputes . . . and enhanced mating opportunities." Fine, but then we are in a situation of *delayed reciprocity.* This raises all the issues of collective action, sanctioning, free-riding, and so on, posed in the original risk-reduction formulation of the conventional wisdom. Instantiated as exchange of food for social goods (mating, deference, support), the proposed solution solves the collective action problem of risk reduction simply by deferring it to the second-order collective action problem of social exchange.

In sum, I do not see how the magic of "social attention" solves the sharing conundrum. Either the attention is too diffuse and problematic to motivate share givers or it is a collective good that will not motivate share takers (at least not any more effectively than the collective good of sharing-as-risk-reduction). I consider the received view of sharing challenged but not defeated and certainly not replaced by a stronger contender.

GEORGE W. WENZEL
Department of Geography, McGill University, Montreal, Que., Canada H3A 2K6. 17 III 93

This paper represents a substantial contribution to the long-running discussion in anthropology concerning hunter-gatherer strategies of resource exploitation and resource sharing. Indeed, Hawkes's central question—Why do hunter-gatherers work?—can be so interpreted as to provide an important lead into the much larger question of the social dynamic(s) and meaning of subsistence as a culturally organized set of activities.

More specifically, however, this article has two elements that are of immediate interest. The first is that it explicitly links the choices hunters make about the kind of prey they exploit to decisions regarding resource allocation within the larger population of which they are a part. While it has been some time since the behavioral dimension of what hunters do has been limited to the actual capture of prey (see Laughlin 1968, Altman 1987), it is still rather infrequent for researchers to explore the direct connection between these two decision sets.

Second, Hawkes, while working squarely within the framework of socioecology, successfully expands the overall perspective in which resource sharing is generally cast by proponents of optimal foraging theory. In general, optimal foragers have taken the view that (1) immediate sharing provides a hunter with insurance against a future time when less success may be enjoyed (variance reduction) and (2) sharing reduces the uncertainty inherent in the pursuit of scarce big game. Hawkes leans strongly toward a third, less frequently articulated view, namely, that sharing represents a form of tolerated theft through which harvest resources are projected from the realm of private into that of public goods as individuals eschew short-term consumption returns so that they may accumulate social capital and, ultimately, reproductive advantage.

This, however, appears to me not to represent the whole explanation for why hunters share and how resources become public. A critical element of wildlife harvesting is that it is an activity not easily carried out with great success by lone producers. Rather, most forms of large-game procurement require the coordinated action of several individuals. Thus, harvesting begins, in terms of the time and energy investment required, as a shared activity complex. Among Inuit of the Eastern Canadian Arctic, the hunting of most forms of interesting game almost always involves the coordinated action of from two to five or six harvesters. It would appear from ethnological evidence that there is an aspect to northern food sharing that recognizes the substantial energy and time contributions of all participants of a hunt group to the success enjoyed by one or two members. In winter sea-ice sealing, for instance, each hunter makes a contribution to group success by, at the very least, denying the use of a breathing hole to seals (Nelson 1969, Wenzel 1991), thus aiding in the capture of a seal by an associated hunter waiting at another station. The fact that hunters A, B, and C do not capture seals while X and Z succeed does not negate the former's contribution to overall group success. In other words, there is no transformation of "goods" from private to public because harvesting is premised on collective/cooperative action. Indeed, virtually all forms of Inuit pursuit of large animals begin with an acknowledgment of the wide social contextualization of harvesting, and this contextualization or embeddedness has broad implications for the substance of subsistence relations.

JOHN E. YELLEN
National Science Foundation, 1800 G St. N.W., Washington, D.C. 20550, U.S.A. 5 III 93

In a study of faunal remains from abandoned !Kung San camps (Yellen 1986) I analyzed change in meat diet over a 32-year period which covered the transition from hunting and gathering to a mixed strategy incorporating cattle and goats as well as wild game. The data indicated that cattle, in essence, directly replaced large ungulates and that goats likewise came to fill the same niche and assume the same relative importance as hunted animals of about the same size. At the time I found it difficult to understand why replacement rather than addition took place, since young boys herd livestock and adult hunters still had the time to maintain traditional pursuits. Why not use this opportunity to add to the amount of meat obtained? I concluded that this pattern was best understood not in immediate subsistence terms and adopted the suggestion by Alison Brooks that "hunters in the successful pursuit of large animals benefit more from the long-term reinforcement of social ties than short-term nutritional returns" (p. 774). Data such as these support the general approach which Hawkes adopts and suggest that it should be examined and developed in a systematic way. The strength of Hawkes's paper lies in her presentation of a formal model which attempts to interpret subsistence activities within a broader social and evolutionary context. The implications for the understanding of sexual division of labor are also significant.

Hawkes clearly recognizes how complex the world can be, and several !Kung San examples serve to illustrate this. In most instances it is a poisoned arrow fired by a single individual which results in an animal's death, and therefore it is that man, in Hawkes's terms, who qualifies as the "successful hunter." However, this obscures the extent to which large-game hunting is a communal effort. In the Kalahari, for example, large animals are highly mobile and hard to locate. The information about game movement derived from animal tracks observed by unsuccessful hunters and by woman gatherers and then shared across the group can set the stage for the one successful individual on the following day. Hawkes's model, as I understand it, assumes that the hunter can rightly claim that success derives 100% from his own efforts, and one can question how often in reality it holds.

A second issue involves delayed reciprocity. How does one know that a hunter does not give meat away today with the expectation that it will be returned at some future date when the ethnographer is no longer there to record it? Hawkes is clearly aware of this problem and uses both data-oriented and theoretical approaches to deal with it. There is one caution, however, which might be noted: Hunting ability varies over the course of an individual lifetime, increasing with experience and then tailing off as physical strength and eyesight decline. !Kung know, for example, that old men are not good hunters, and one might wonder if younger men are not in effect banking against old age. In such a hypothetical case, reciprocity is long delayed, and the question is difficult to examine directly.

Hawkes presents the hunter-gatherer world in terms of a dichotomy: there is food and the nutrition it provides, and then there is essentially everything else, lumped together as "social attention." This strikes me as an appropriate first step, since models, by definition, simplify reality and simple formulations precede more complex ones. What happens, however, if one recognizes that among the !Kung good trance dancers are rare and that the medicine that passes from their hands is also a good which can be conceptualized in the same way as meat from a large game animal? I would ask—as a question, rather than a criticism—what happens to a "public-goods approach" when a number of public goods and multiple actors with differential control over them may be involved. Is the entire approach undermined, or can refinements deal with the issue?

Finally, it is worth considering the hunting/social-attention model in a broader ecological context as Hawkes agrees one should. Where meat is hard to come by, the model might apply, but what happens as this resource becomes successively easier to obtain? Does this approach fall apart, or do other public goods (or combinations of them) come to the fore? It might be interesting to see what would happen if one attempted to apply this basic view of human behavior to a pastoralist group.

Reply

KRISTEN HAWKES
Salt Lake City, Utah, U.S.A. 26 IV 93

Grinker makes the most general objections to my argument: (1) that it uses functionalist logic, (2) that it treats contemporary hunter-gatherers as analogs for the distant past, and (3) that it isolates groups from their regional temporal and social contexts. These are important because they mark a boundary of understanding between theoretical orientations. (Can those from one understand "the other"?) Behavioral ecologists try to explain why organisms do one thing rather than another by examining the fitness-related costs and benefits of feasible alternatives. Features of interest are explained in terms of their adaptive "function," that is, their effects on the survival and reproduction (more generally, inclusive fitness) of the individuals displaying them because natural selection designs features by way of these effects. In social and cultural anthropology "functionalism" (*pace* Malinowski) sought to explain social patterns by their effects on the survival or reproduction of a metaphorical superorganism. Various devastating problems with group-level functionalism have been recognized not only by evolutionary biologists, critical of the explanation of patterns by their effects on group or species survival (e.g., Williams 1966), but also by social scientists (e.g., Elster 1989), who nevertheless seek to explain social outcomes as the result of *individuals'* making "functional" choices, that is, preferring alternatives that better serve their own goals.

As to the use of modern foragers as analogs for the distant past, it is a central evolutionary proposition that contemporary organisms have been designed by their evolutionary history: we are the richest source of evidence about our evolutionary past. At the same time, every moment, every event differs from every other and is itself as multiple as its participants. Probably neither of these propositions is actually in dispute. The question is how we proceed in light of them. Patterns (let alone their recognition) are possible only if some of the variables and some of the values they take make more difference than others. What we disagree about is *which* variables are likely to make the most difference. On the basis of his Efe experience, Grinker suspects that relationships with neighboring ethnic groups play a more important role in resource choice and patterns of sharing in the ethnographic cases I cite than characteristics of the available wild food resources. That is an empirical question. The descriptive records of !Kung-speakers in the Dobe area in the sixties, of the Ache around Chupa Pou in the early eighties, and of the Hadza in Tli'ika from the mideighties to the present show that local resource characteristics have systemic effects on foraging strategies. This is not a general argument against the importance of other variables. If complex social arrangements can be explained as the outcome of individuals' mutually adjusting their own behavior according to their available options, then the character and value of those options continually matter. Changing dangers of attack from enemies, changing alternatives to trade with, mate with, or work for neighbors might have important effects on the choices people make. Posing and testing contrary hypotheses about these effects could be illuminating (see, e.g., Blurton Jones, Hawkes, and O'Connell n.d.).

Grinker and especially Peterson are critical of the readiness with which evolutionary ecologists focus on a small number of ecological and behavioral dimensions at a time. Again, this focus does not arise from an assumption that *only* these variables matter. Instead, the proposition is that something can be learned from how they matter in the case at hand that adds to our understanding of how they matter generally. Variables expected to be important on theoretical grounds and measurable across cases are more attractive candidates for study. I *am* ripping subjects out of their regional contexts. Whether or not that is useful turns on the questions of interest and on the empirical patterns showing how the variables under study are related.

The strong appeal of variance-reduction explanations for sharing is impressive. I reiterate the central (and paradoxically not so contentious) point that no matter how great the "group benefits," they are rarely enough for self-interested actors to provide a collective good. Harpending rates it an embarrassment to sociobiology that hunting does not maximize energy acquisition for "the group, the family, or the individual," but sociobiologists should expect conflicts of interest within groups, with "inefficiencies" a common result. Smith notes that many have shown how iterated games produce different solutions than one-shot prisoner's dilemmas. True, but stimulated by Axelrod's influential argument to the contrary, they have also shown that an evolutionarily stable pattern of reciprocity is not often one of them. The model Smith cites (Smith and Boyd 1990) is an illustration. He explored the circumstances in which neighboring groups may do better to allow access to each other's foraging territory. According to the model, they do better to allow the use of their territory only when the costs of defending it outweigh the benefits of keeping others out. The relatively immediate costs of not sharing (tolerated theft instead of reciprocity) determine whether allowing access is the dominant strategy.

As Beckerman says, "the literature bursts with accounts of the weight of reciprocity in egalitarian societies." The label is ubiquitous, but it is used in ethnology for patterns in which quid pro quo is explicitly denied and the obligations of the social relationship are said to govern instead. I cited the classic ethnological review (Sahlins 1965; 1972: chap. 5) enumerating examples in which transfers are not literally reciprocal and more recent arguments consistent with this (Ingold, Riches, and Woodburn 1988, Bird-David 1990). Peterson's comment that in Australia one of the reasons young men hunt is to pay back the old men who nurtured them in "long-delayed reciprocity" is an example of common usage. This pattern does not involve repeated exchanges with each party's current costs compensated by delayed benefits returned. An old man cannot withhold his previous nurturing "next time" if a young man does not give. As Peterson notes, young men may have other things to gain from old men, but *that is a different argument.* Notions of debt and repayment shape many of my own actions and seem to shape those of others I observe both in the "field" and out. Surely reciprocity must fit some of it, but there is a great deal that it does not fit. The delays are too long, the flows too consistently one-way, the punishment for cheaters too mild or absent altogether. If something besides kin effects and reciprocity makes a big difference in patterns of social behavior in small-scale communities dependent on wild food, the same thing may, as Yellen says, be important in other social settings.

I picked the three cases because of biases in my own experience but might easily have added the Gunwinngu because of Altman's rich ethnography. His case descriptions and quantitative data (Altman 1987, Altman and Peterson 1988) show (1) the wider sharing of larger, more unpredictably acquired resources, (2) the importance of current inequities over returns for past favors in the distribution of shares, and (3) persistent biases in the contribution of these widely shared resources. My argument is that the first two patterns make large, unpredictably acquired resources like public goods and that the third pattern implies that something other than shares returned (and so reduced variance in their own consumption) must motivate suppliers. Altman and Peterson both note that sharing does reduce risk, so I repeat that my argument is *not* that sharing fails to reduce consumption variance but that such an outcome is insufficient to explain why people do it. People fail to supply all kinds of collective goods. Yet in each of these cases men spend substantial amounts of time trying to acquire resources which will be consumed by others.

My presentation has led Jeske to surmise incorrectly that only a few men hunt. Among the Ache and !Kung (Hawkes et al. 1985) more successful hunters spend more time hunting (we have not yet done the analysis for the Hadza), but men who are less successful spend time hunting as well. Yellen's observation about the complexities of assigning credit when many are involved and Wenzel's point about cooperative sealing should be underlined, but big-game hunting is often *not* cooperative (Yellen 1977: appendix B; Lee 1979: chap. 8). Hadza men usually hunt alone.

As Jeske says, more data are needed. I agree with Peterson that data on the reproductive success of !Kung hunters would be of great interest. Publication of the records Harpending mentions would be most welcome. A variety of questions could, however, be asked. In some discussions of evolutionary approaches, the use of variables other than an actual count of descendants in a future generation is described as an unfortunate necessity. Proxy variables for fitness are seen as poor but inevitable substitutes because "the real thing" cannot actually be measured in the present. But most of the time it is the current trade-offs that are of central interest. If more successful hunters do have more grandchildren, that will not tell us *how* successful hunting and numbers of grandchildren are linked. If they do not have grandchildren, then sample size (and so other characteristics of those particular men or that particular time slice), other unmeasured fitness components (such as sisters' grandchildren), or mixed strategies (in which, for example, poor big-game hunters spend more time acquiring private goods and so gain comparable fitness payoffs) could all be implicated. The *assumption* that individuals have been designed by their evolutionary history to act in their own fitness interest is a powerful one. Given it, the question is not whether but *how* individuals can be serving their probable fitness better by doing what they do rather than things they could do instead. Modeling can clarify requirements implicit in our favorite guesses and also specify hypotheses about the constraints and trade-offs that we need to find ways to test.

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