# Food Sharing at Meals

## Kinship, Reciprocity, and Clustering in the Taimyr Autonomous Okrug, Northern Russia

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The presence of a kinship link between nuclear families is the strongest predictor of interhousehold sharing in an indigenous, predominantly Dolgan food-sharing network in northern Russia. Attributes such as the summed number of hunters in paired households also account for much of the variation in sharing between nuclear families. Differences in the number of hunters in partner households, as well as proximity and producer/consumer ratios of households, were investigated with regard to cost-benefit models. The subset of households involved in reciprocal meal sharing is 26 of 84 household host-guest pairs. The frequency of reciprocal meal sharing between families in this subset is positively correlated with average household relatedness. The evolution of cooperation through clustering may illuminate the relationship between kinship and reciprocity at this most intimate level of food sharing.

KEY WORDS: Costly signaling; Evolution of cooperation; Hunter-gatherers; Inclusive fitness; Parental investment; Reciprocal altruism; Siberia; Tolerated scrounging

Interhousehold food sharing at meals is common cross-culturally and across ecological zones, oftentimes including members of more than one nuclear family.[1] To the extent that this type of food sharing is widespread, it may have been a significant contributor to the evolution of the human family, life history, and economies of scale. Discerning how and when meals include members of more than one nuclear family should take into account the effects of ecological and social variables on sharing. Such variable effects may be com-

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Received September 2, 2003; accepted October 23, 2003; final version received August 16, 2004

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*Human Nature*, Summer 2005, Vol. 16, No. 2, pp.178-211. 1045-6767/98/$6.00 = .15

parable in other social contexts and times, enabling testing of hypotheses on the evolution of cooperation.

Ethnographic study among the Dolgan and Nganasan during the 1990s (Ziker 2002a) described the increased importance of the local subsistence economy after the collapse of the Soviet planned economy in indigenous Arctic communities in the Taimyr Autonomous Okrug (region), northern Russia. From the late 1960s through the early 1990s, the indigenous Dolgan and Nganasan populations of the central Taimyr were integrated into the Soviet economy. With the collapse of that economy in the early 1990s and the dissolution of state farms in 1992, traditional practices such as food sharing regained importance.

Three significant patterns emerged from a previous analysis (Ziker 2002b) of meal-composition patterns and menu items present at 1,150 meals, including those considered here. First, in remote communities, the use of non-local proteins and fats decreased tenfold from 1994 to 1997. Overall, carbohydrate consumption levels in bush and village meals are lower than at meals documented in the city. Relatively more protein and fat are consumed as one moves farther from the city, demonstrating the importance of subsistence production in the village and bush. Second, the use and diversity of preparation techniques varies according to season and gender. There is also more variation in the male diet, particularly in the consumption of raw meat and fish during the hunting and fishing seasons. This sex differentiation is consistent with historically documented task groups and division of labor patterns for the local population, and it is heightened by settlement in the villages. Third, there is significant gender differentiation in the types of foods prepared and consumed: as the ratio of women to men at meals increases, a wider variety of menu items is observed. This finding demonstrates the importance of women’s contribution to the diet, even in this Arctic environment where big game and fish provide most of the calories and essential nutrients in the diet. Just as menu-item selection at meals varies according to ecological and social variables, so should the degree of interhousehold sharing at meals vary according to measurable variables.

Additional evidence of the increasing importance of the subsistence economy in the Taimyr includes a decreasing variety and quantity of carbohydrate foods available for sale in indigenous villages in the 1990s. By the mid-1990s the cost of basic carbohydrate foods, such as a loaf of bread, had increased more than an order of magnitude in comparison with the cost in the years prior to the breakup of the Soviet Union (Ziker 1998). Transportation costs increased similarly.

Dolgan and Nganasan community members have pointed out that food sharing at meals is an integral part of their traditions and an important part of daily life. “Hosts” can be offended if “guests” refuse tea and food. For example, a foreign film crew that visited in the early 1990s brought their own food and purchased canned fish in the store, while refusing locally procured fish and meat. This behavior is discussed to this day in a negative light; the visitor who shares in a meal is better respected. Beyond this, informants agree that the food consumed at meals is more valuable than the same amount of raw food. Some of this additional value originates from the time and labor invested in processing and cooking, as well as any supplemental ingredients that enhance taste. Providing food at meals projects an atmosphere of care. The greater number of menu items present at meals prepared by women may be related to the social expectations of caregiving in a set of related nuclear families and friends. Interhousehold sharing at meals may turn out to be a venue for leveling resource variation, as well as facilitating division of labor, information exchange, and tool sharing.

## ETHNOGRAPHIC BACKGROUND

The Dolgan and Nganasan are two of Russia's indigenous minorities living in the Taimyr Autonomous Okrug in north-central Siberia. The Dolgan language is similar to Sakha (Yakut), the northernmost branch of the Turkic language family. The Dolgan population is close to 6,000 people and includes Sakha, Evenk, and Russian "tundra peasant" ancestries (Dolgikh 1963; Popov 1934). Dolgan families traditionally practiced reindeer pastoralism, mostly in combination with big-game hunting, fishing, trapping, and mercantile trading (Popov 1937, 1964). A minority of families traveled by dog sled.

Nganasan is one of six languages in the Samoyedic branch of the Uralic language family (Dolgikh 1962). The Nganasan traditionally hunted wild reindeer, fished and trapped while traveling by dog sled, and maintained small domestic reindeer herds, but, unlike the Dolgan, rejected Russian Orthodox missionaries (Popov 1936, 1963, 1966). Currently, the majority of the approximately 1,000 Nganasan live alongside the Dolgan in three permanent settlements, one of which is Ust'-Avam—the focal community for this research.

Ust'-Avam, a majority Dolgan and Nganasan community of 670 people in the central Taimyr lowlands, is more than 400 km by river (250 km by air) from Norilsk, the region's nickel-mining complex. From Norilsk, one travels north (downstream) along the Piasina River, then upstream along the Dudypta River to its confluence with the Avam River. The village is 13 km upstream from the Avam-Dudypta confluence. The village is far enough from Norilsk that the impact of pollution is unapparent. Additional ethnographic work was done in Khantaiskoe Ozero, a Dolgan and Evenk community 200 km south of Norilsk, on the south shore of Lake Khantaiskoe, the second-deepest lake in Siberia. This community has had to deal with the devastating environmental impacts of Norilsk's development.[2] Additional observations were made among native families in Dudinka, the capital of the Taimyr Region, and Khatanga, in the eastern Taimyr Region, but the interhousehold analysis provided below focuses solely on Ust'-Avam.

After 250 years as subjects of czarist Russia, the Dolgan and Nganasan were incorporated into the planned economy under the Soviets beginning in the early 1930s. The transformation, operating through the collectivization of property, was severe at its inception, and the Dolgan and Nganasan in Ust'-Avam and other nearby communities lost all their domestic reindeer by the mid- to late 1970s after they were settled into permanent villages. At the collapse of the USSR in 1991, most adult Dolgan and Nganasan were working for state-managed rural enterprises, hunting caribou, fishing, and trapping, and producing crafts. These activities were important before 1930, but during the Soviet era the Dolgan and Nganasan, as well as other indigenous peoples of Siberia, were provided occupational training and jobs to perform such "traditional activities."

Dolgan and Nganasan cultural norms encourage cooperation in food production, distribution, and land use. For example, it is widely accepted that the tundra requires hunters to share their catch, or else the hunt will not be successful in the future (cf. Anderson 2000; Bird-David 1990). A belief in sacred places is also widespread. Symbolic sacrifices are made to the tundra when one is traveling to a new hunting spot. Details on such traditions, their logic, and challenges to them, as well as their relevance to collective-action issues on resource use, are discussed elsewhere (Ziker 2003a).

Living in remote Arctic villages, the Dolgan and Nganasan have been surviving since the collapse of the Soviet Union through subsistence production and minimal participation in the greater Russian market and the global economy. Unlike hunters, herders, and peasants in more accessible parts of Siberia, where roads facilitate sales of meat and fish to outsiders, the Dolgan and Nganasan in Ust'-Avam have minimal opportunity for trade or barter. As a result, the ability of individuals to purchase goods and services became increasingly limited in the 1990s. While such isolation from markets is likely to have been experienced at times by hunter-gatherers worldwide, the contemporary trend is toward more rather than less involvement in global markets (Spielmann and Eder 1994:311). Thus, this case material on food sharing from Ust'-Avam provides a point of comparison for hunter-gatherer food sharing under subsistence big-game hunting, fishing, and gathering regimes.

The Dolgan and Nganasan meal data provide an opportunity to describe the patterning of food sharing among subsistence big-game-hunter-fisher-gatherers living in an ecological context of marked seasonality and high latitudes. The ecological conditions and resources approximate those exploited by Eurasian hunter-gatherers in the late Pleistocene/early Holocene (Pitul'ko 2000), well within the range of human environments of evolutionary adaptedness. Their reliance on local resources for the bulk of subsistence requirements makes this study relevant to discussions about human and primate food sharing and the evolution of cooperation.

## HYPOTHESES

A range of models has been proposed to investigate the evolutionary mechanisms and circumstances that favor food sharing among human foragers. The prominent models include kin selection, reciprocal altruism, tolerated scrounging, and costly signaling. The evolutionary logic behind these cost-benefit models has been considered in many recent publications on food sharing (e.g., Winterhalder 1997, 2001). The operational correlates of the models are not as well understood. Gurven (2004) advocates a serious of indicators (breadth, depth, balance, and equality) with which the four models of food sharing can be operationalized. We suggest the following predictions for these indicators and models (Table 1).

### *Kin Selection*

In anthropological terms, generalized reciprocity, the most altruistic and personal form of exchange, is arguably related to human systems of kinship cooperation (Alexander 1979; Sahlins 1972). The kinship model implies that nepotistic behavior should be stronger and more frequent as genealogical relatedness increases. Studies of extraparental nepotism raise the question of what kind of benefit is received for the effort (Batson 1991; Pope 1994; Sober and Wilson 1998). Evolutionarily, benefits would accrue indirectly through the greater reproductive success of offspring or co-descendants, following inclusive fitness theory (Hamilton 1964) or group models for nepotism (Jones 2000). Further, kin selection implies evolved psychological mechanisms, enabling the identification of kin and the favoring of certain types of kin (Euler and Weitzel 1996; Euler et al. 2001). These psychological mechanisms operate on proxies for relatedness that entail a degree of ontogenetic flexibility (Alexander 1991).

*Table 1.* Food-Sharing Models and Predictions for Four Indicators (following Gurven 2004)

| *Models* | *Depth (percentage of meals shared)* | *Breadth (number of families hosted)* | *Equality (disparity in meals shared )* | *Balance (long-term differences in amounts given and received)* |
|---|---|---|---|---|
| Kin Selection | Increases with proportion of young kin in other households | Close kin favored over distant and non-kin | Increases with relatedness and age differences | Sizable |
| Reciprocal Altruism | Similar means, high variance, and asynchrony in production | Specific cooperative individuals favored | Contingent on previous transfer | Negligible; with recipients, long- term benefits outweigh costs of giving |
| Tolerated Scrounging | Marginal units transferred | Little producer control | Increases with non-possessor's need | Moderate |
| Costly Signaling | Increases with higher cost hunting | Wide audience | Decreases with package size | Sizable; anyone in the audience returns a benefit |

At least one empirical study (Betzig and Turke 1986) has shown food sharing to be consistent with predictions derived from inclusive fitness theory.[3] The strength of kin-selected food sharing may be most apparent when the provisioning of young kin is an issue. It follows that the percentage of food transferred (depth) would be correlated positively with the number of young descendents or co-descendants in the giving and recipient families. Similarly, under kin selection, the families given food (sharing breadth) should show a bias toward close kin over distant kin and non-kin, rather than being contingent on previous giving. Under kin-selected sharing, one might expect one-way flow of resources from producers to non-producers who are closely related, independent of household location. Disparity in the amounts given to others could be high, but controls for relatedness and age of recipients should account for most of the disparity. One would expect it to be in the interest of parents to give equally to their children, even if each child wants more for him- or herself (Trivers 1974). In the long term, one might expect little balance in food sharing under a kin-selection model, as the expected resource transfer would be from producing adults to children, grandchildren, nieces and nephews, and the very elderly.

### *Reciprocal Altruism*

Unlike the kinship model, reciprocal altruism makes no prediction about the genealogical relatedness of the cooperators. Returns are delayed, and the value of the item being exchanged is what is important, with benefits of cooperation accruing directly to individuals (Axelrod 1984; Axelrod and Hamilton 1981; Trivers 1971). Costs should continue to be paid under the condition that benefits are received, when needed and available (Bleige Bird et al. 2002; Gurven et al. 2000).

Reciprocal food sharing has been postulated as a mechanism that reduces variance in daily food intake among cooperating members of a community through delayed returns (Cashdan 1985; Halstead and O'Shea 1989; Lee 1968; Smith 1991). By contributing to the subsistence needs of a set of regularly cooperating individuals, risk buffering is adaptive for individuals in terms of gaining predictable food supplies when variance in daily hunting returns is high (Kaplan and Hill 1985b:239). The sharing pool should be relatively small and composed of regular cooperators (Wilkinson 1988; Winterhalder 1997).

Reciprocal altruism posits an individual benefit to offset the cost of supporting others; for example, reduction in the risk of going without food owing to patchiness in the environment or to variance in foraging returns has been suggested as a possible offsetting benefit (Smith 1988, 1991). Proximate-level mechanisms necessary for reciprocal altruism, such as detecting and punishing cheaters (Cosmides 1985, 1989; Cosmides and Tooby 1992; Richerson and Boyd 1998) and monitoring the cooperative attitude of partners (de Waal and Berger 2000), have been identified.

It follows from the reciprocal-altruism hypothesis that the percentage of food given (sharing depth) is associated with similarity of production means, high variance in acquisition, and asynchrony in acquisition (Gurven et al. 2000; Kaplan and Hill 1985a), rather than relative proportions of young kin in families or the cost of defense of the resources. As in the kin-selection model, producers exhibit control over the resource and target specific individuals as recipients. Unlike in the kin-selection model, however, the expectation for future food transfer is based on who has delivered such favors previously. One-way flows of resources are not anticipated. The disparity in amounts given to various households also would be contingent on previous cooperation: those who get more food from other households would give more to those households when they had it. Over the long term, the expectation from reciprocal altruism is that differences in the amounts given and received would balance out so that the benefits to givers offset the original cost of giving. Investigations of food-sharing behavior among contemporary hunter-gatherers focusing on distribution of the products of hunted game have questioned the importance of tit-for-tat reciprocity in food sharing in favor of band-level pooling (e.g., Kaplan and Hill 1985a, 1985b), public/collective goods (Hawkes 1993), tolerated theft (Bliege Bird and Bird 1997), and handicap (or costly) signaling (Hawkes and Bliege Bird 2002; Smith et al. 2003). Gurven and colleagues (2000) demonstrate that the percentage of food received by a Hiwi nuclear family is a strong predictor of the percentage given to other nuclear families. However, they also state that reciprocal altruism is difficult to measure because of its scale-dependent properties. Bliege Bird et al. (2002) find that those who share more often and generously do not receive more in return, that free riders are not discriminated against, and that most sharing involves one-way flows.

### *Tolerated Scrounging*

When the consumption of food stores exhibits declining marginal value to the producer, then marginal portions are worth more to other individuals who have no food. As a result, there may be a cost associated with defending these food reserves. Thus, producer control is a cost-benefit calculation under the tolerated-scrounging model, and not necessarily contingent on previous cooperation: a producer should relinquish marginal portions to other individuals if the price of defense is greater than the additional value gained by others (Blurton Jones 1987). Continuing this logic, the disparity in amounts given should be low since portions are given out until the marginal consumption value or utility is equal for all potential recipients (Winterhalder 1996). Long-term balance is also not a prediction of tolerated scrounging. "If a producer can control who receives and how much, or if marginal value is linear or increasing (as a result of trade for example), then tolerated scrounging is unlikely to explain food transfers" (Gurven 2004). Like reciprocal altruism, tolerated scrounging is expected with medium to large-sized prey acquired asynchronously. A benefit to the hunter in allowing tolerated scrounging is avoiding the cost of defense of marginal portions of a large, asynchronously acquired resource.

Peterson's (1993) concept of demand sharing emphasizes the social and symbolic significance of requests for food and other resources. While acknowledging its correspondence to the tolerated-scrounging model, Peterson views demand sharing as part of a wider "testing behavior" which is used to establish relationships by incurring "debt." The concept has been used widely in anthropology to describe such food transfers, linking this debate to the literature on exchange (Mauss 1967).

### *Costly Signaling*

The costly signaling model proposes that big-game hunting evolved as part of men's competitive display rather than as part of provisioning relatives, compensating for short-term variation in food procurement, or avoidance of defense costs. Instead, big-game hunting provides reliable information about a hunter's skill, resilience, or strength. The costly signaling model posits a benefit to the hunter's reputation resulting in positive political, social, or reproductive consequences (Hawkes and Bliege Bird 2002; Smith et al. 2003; Zahavi 1975). Because the cost of a signal presumably guarantees its honesty, the hunter hypothetically endures the risks of big-game hunting to encourage others to choose him as a social partner.

Unlike in tolerated scrounging and reciprocal altruism, resource package size and synchrony in procurement are not important determinants of sharing depth in costly signaling models. Sharing is not contingent on previous giving because the benefit to the giver is that others will choose him or her as a mate, ally, or other social partner. Food given in return is unlikely to be of sufficient benefit to cover costs. Rather, with costly signaling, sharing depth is likely to increase with the cost of the hunt. The breadth of sharing expected under costly signaling is wide—the benefit of the signal is greatest when it is carried to the widest audience possible. Equality in sharing is predicted under the costly signaling hypothesis, other things being equal, since the need of the recipients is not what drives distribution. The potential of the recipients to provide political support or future spouses may bias distribution, however. Because other things are not often equal, benefits to the hunter could come from any others in the audience according to the costly signaling model. These benefits should outweigh the costs, but the benefits might be presented in a form other than food, such as shared defense or marriage.

## METHODS

Participant observation of meals utilized the snowball method—beginning with a focal actor or set of actors with their sharing partners and extending to the partners of partners until the observation period ended. The snowball method can be particularly useful for tracking down "special" populations (cooperative networks of people mixed in with large numbers of others).[4] The household was defined using the village registry (*pokhoziaistvennaia kniga*) and checked against results from structured interviews. "Nuclear family" is synonymous with "household" for the purposes of this study. This definition should recognize that Soviet housing policy focused on nuclear families and small apartments and houses, even in the bush, where duplex and quadraplex cabins were built in a number of locations. By using a consistent definition of "household"—those sharing an apartment or hearth (Goody 1976)—one can make a consistent appraisal of the importance of food-sharing behavior across different apartments and bush camps, where the particular arrays of resources and information are likely to vary. Alternative definitions of "household" would likely result in different outcomes.

A meal was defined as a customary or social occasion of taking food, especially at a fixed time of the day or fixed place, such as the kitchen table or around the campfire. Snacks were not included. The 466 shared meals discussed below were selected from a total of 814 observations, which were made in December 1993 and January 1994, December 1995 and January 1996, March through June 1996, and September through December 1996, with participants' permission. The 268 meals excluded from the social analysis below consist of meals with only one native participant ($n$ = 265) and meals with participants not known to me ($n$ = 3). Meals observed in the city ($n$ = 80) are excluded from the analysis. Additional meals observed in 1997 ($n$ = 336) were not included in the social analysis because of a change in ID numbers with the 1997 census. Elsewhere, these 684 cases are included in the analysis of meal composition (Ziker 2002b).

In Ust'-Avam, observations began with Household A and Household E and extended to people with whom they associated. Twenty-four households were observed hosting meals with members of other nuclear families. The distribution of these observations is listed in Table 2. Five Nganasan families and two non-native families are included as hosts in these data, with the remainder being ethnically Dolgan. The small number of meals observed at Nganasan households ($n$ = 8) precludes comparisons by ethnicity. A sociodemographic and genealogical investigation conducted conjointly provided information on the relationships of individuals participating in the meals. The genealogical information for each household participating in observed meals was analyzed using the KINDEMCOM program (Chagnon and Bryant 1984), which calculates Wright's relatedness coefficient by comparing each individual in the community with every other individual. The Ust'-Avam community has 164 households, most of which are concentrated in the settlement. As Ziker found in his community-wide work in 1997, average consanguineal relatedness in Ust'-Avam was in the third-cousin range ($r$ = 0.007) (Chagnon et al. 1997).

Interhousehold relatedness was calculated using the individual relatedness figures generated by KINDEMCOM, summed for each pair of individuals in each household and averaged.

Two teams of research assistants consolidated information on meals and social relationships of meal participants. Data were cross-checked at each stage. Meals in tundra locations, including hunting base camps and fishing camps, were coded "bush." Meals in settlements were coded "village." Meals in the city were coded "city." Frequencies, exploratory statistics, and two-sample *t*-tests were used to describe the individual dyadic relationships for the three location categories (Appendix).

After the data were limited to Ust'-Avam and the Avam tundra, meals with individuals representing more than one nuclear family were identified. Household pairs were derived from the individual data, and the frequency of each household dyad was tabulated and converted to an asymmetric matrix. The meal count matrix was converted to a matrix of percentages of total meals shared with other households. These two matrices were used as dependent variables. Independent relational and attribute variables for households in the food-sharing network, such as kinship, shared neighborhood, and comparative number of hunters, were converted to matrix format using UCINET (Borgatti

*Table 2.* Number of Meal Observations for Each Host

| *Household Code* | *Number of Observations* |
|---|---|
| A | 164 |
| E | 48 |
| C | 29 |
| B | 15 |
| P | 10 |
| L | 7 |
| Y | 7 |
| Vsh | 7 |
| Alb | 4 |
| Dul | 3 |
| Bnd | 1 |
| D | 1 |
| Nin | 1 |
| Khr | 1 |
| Z | 1 |
| Lod | 1 |
| Bdk | 1 |
| G | 1 |
| Pav | 1 |
| Yc | 1 |
| X | 1 |
| U | 1 |
| J | 1 |
| S | 1 |

et al. 1999), which was also used for the matrix correlations and regressions. The UCINET program can also identify a core and periphery in social networks, based on the numbers of connections between actors.

## INTERHOUSEHOLD SHARING

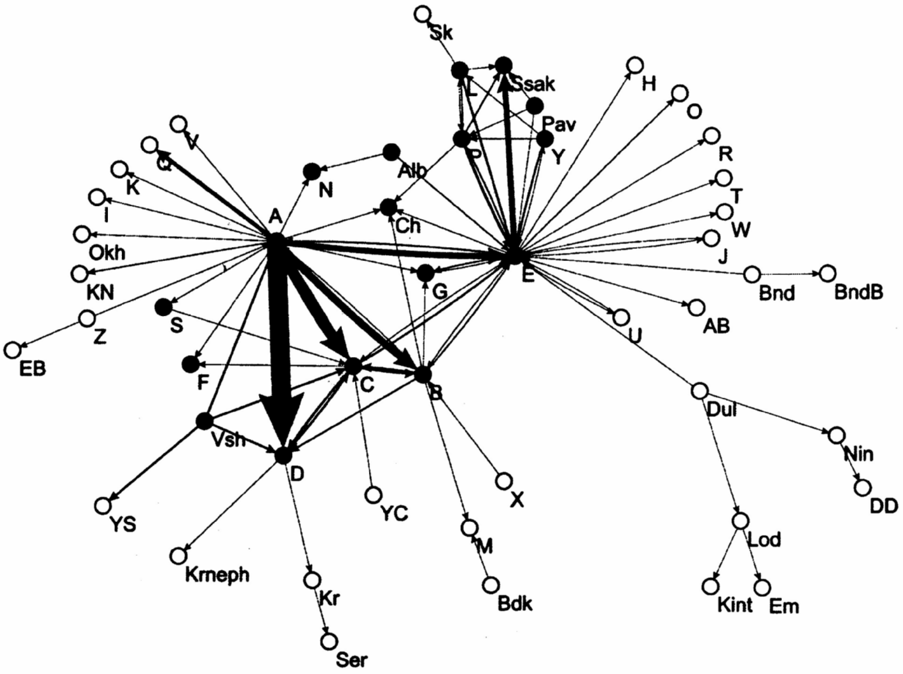
The following analysis of sharing between nuclear families is limited to the 466 meals in Ust'-Avam village and the Avam tundra. In 302 of the 466 meals, the participants represented more than one nuclear family—this despite the low average number of participants in meals and a good number of individual meals.[5] A high frequency of interhousehold cooperation is found in meals at Ust'-Avam. In the remaining 164 cases, participants at meals consisted of members of the same household. Similarly, Kishigami (2000:178) noted that guests from one or more nuclear families were involved in 56 of 62 meals observed in Akulivik, Canada, over a three-month period.

Within the 302 multihousehold meals there are 439 dyadic "observations" (coded household pairs derived from individual ID numbers) documented in a meals database. Guests from a single household account for 219 of the dyads recorded at meals. In other words, some or all of the members of two nuclear families ate together. Guests representing multiple households at meals account for 220 of the 439 household dyads recorded. In these cases, people from three or more nuclear families ate together. The practice of feeding guests from multiple households underscores the organizational flexibility present in this community and noted for hunter-gatherers in diverse contexts (Barnard 1999). Because half of the dyadic nuclear-family relationships (XY, YZ, etc.) in the data pool are drawn from meals wherein at least three nuclear families are represented, a question about dependency in the sample arose. In order to rule out the effect of dependent sampling, analyses of single- and multiple-guest meals were conducted separately and jointly and yielded no significant differences; the results of the combined analysis of the 439 dyads are reported below.

Among the 439 raw dyadic observations (302 interhousehold meals), members of 50 households are represented as hosts and/or guests. A core-periphery analysis of this sample (Figure 1) shows a well-connected core comprising 17 households, not all hosts. The arrows in this figure point to the guest households. Within the core, households are connected to others in the network through multiple links. These multiple links indicate that the loss of a particular household does not cut off other members of the core. The periphery of the network (33 households) reflects more infrequent partners of the central households in the sample, and the loss of a connecting household might isolate that actor from the rest of the network. Much of the statistical analyses below are limited to the core meal-sharing families.

An analysis of the raw 50-household data matrix by factions shows two main groups, one centering on Households A, B, C, and D and the other cen-

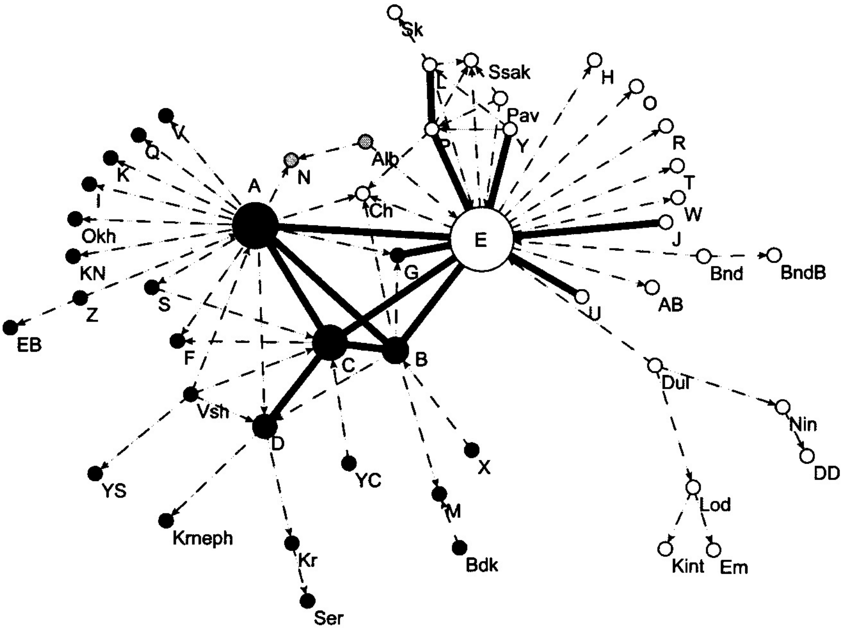
*Figure 1.* A social network graph showing the relative numbers of meals shared between nuclear families in Ust' Avam. The arrows point to the guest household. Core households are shaded rings; periphery households are open rings. This graph and Figure 2 drawn using Pajek: Program for Large Network Analysis (V. Batagelj and A. Mrvar, 2005, http://vlado.fmf.uni-lj.si/pub/networks/pajek/).



tering on Household E (Figure 2). Both factions have 24 households, but the households in the second faction are more centrally tied to Houeshold E, which has the largest number of partners. Most of the households in the second faction are related directly to Household E as either hosts or guests. In the first faction, Households A, B, C, and D are all important actors. Only two households (N and Alb) do not fit into either faction. This makes sense ethnographically since Households N and Alb are infrequent visitors to either Household A or Household E and are cognatically related both to Households A and E and to each other. The analysis by factions shows two sub-networks within the sample, centering on Households A and E, which are prominent nuclear families within two large sets of kin. Analysis by core and periphery shows the interconnections between these two extended families and their social partners.

This network sample does not purport to describe meal sharing on a community-wide basis. Controlling for the number of observations, there still are some significant biases within the network. The following sections describe some significant trends found in the arena of partner selection and both asymmetrical and reciprocal meal hosting in the network.

*Figure 2.* A social network graph based on factions within the sample. The thick lines indicate reciprocal hosting of meals.



## *Partner Selection*

With members of 50 households represented as hosts and/or guests in the sample, the meal-sharing network is fairly broad within this community of 164 households. Even though only five households were observed as hosting interhousehold meals 10 times or more, guests from a fairly broad range of the community are represented. Nevertheless, this broad network is sparse. Of the 2,450 possible meal-sharing pairs among the 50 households, only 84 household-pair combinations (3%) are present. (The total possible number of permutations considers each of the 50 households in combination with the 49 other households.) We documented 148 consanguineal kinship links of a possible 2,450 in this same set of 50 households. Despite the greater preponderance of kinship links, the number of families related by kinship that were observed eating together was far below the maximum number of possible combinations. The density of the network is fairly low, which means that food sharing at meals is directed to specific partners.

Of the 84 documented interhousehold meal-sharing relationships, slightly more than half (44) of these household pairs are characterized by a consanguineal link. Some degree of sharing between families extends beyond kin. Forty of the meal-sharing links exhibit no close kinship between the corresponding households; these are generally friends, hunting partners, and other visitors. The 44 "kin" household pairs account for 331 of 439 dyadic observations at meals. The 40 "non-kin" households account for 108 of those tallied. Kin are more common visitors than non-kin, and the frequency of meal sharing among kin is triple that of sharing among non-kin.

Household A has 17 household partners that shared meals. In eight of Household A's meal-sharing relationships, kinship links are found between households, half of which are close relationships. Seven of Household A's meal-sharing links are associated with friendships between at least one resident of each house. Two pairs are other sorts of links, such as a visit by the settlement administrator. Household E is observed in 20 interhousehold meal-sharing pairs: 10 are related through kinship, 7 through friendship, and 3 with other sorts of relationships, such as hunters passing through the area. Both households seem to follow the general trend found in my 1997 structured-interview results (Ziker 1998, 2003b) whereby sharing breadth is biased toward kin in different households—the most common visitors—followed by friends and other people. These interviews were based on a random sample of 79 Dolgan, Nganasan, and ethnically mixed households in the community.

In order to test the influence of independent variables on partner choice in the interhousehold food-sharing data set, a series of matrix correlations and regressions was conducted. The food-sharing matrix was used as the dependent variable. Both matrices of raw dyadic tallies and percentages of each host's total sharing were tested. Table 3 summarizes the results of several of these matrix correlations (2,500 permutations, random seed). The matrix correlation takes each element *i,j* of matrix A, pairs it with the same element *i,j* of matrix B, and calculates measures of association. The standard correlation across cells of the two matrices is computed and compared with a correlation from matrices with randomly permuted rows and columns. The large number of permutations improves estimates of standard error and "significance." The significance is the proportion of times that the random correlation is larger than or equal to the observed correlation. A low proportion (<0.05) suggests a strong relationship between the matrices that is unlikely to have occurred by chance. This "best-fit" method is suitable for this sample despite the biases that would be problematic for standard statistical approaches. Both the presence and absence of cooperative links are tested against independent relational and attribute variables.

In these data, the kinship matrix—a relational variable dichotomized to 1 and 0—has the most significant correlation. The presence or absence of a socially acknowledged kinship link between households was correlated with the entire 50-household meal-sharing matrix at a highly significant level. The remaining correlations were limited to the 17-household core to reduce the bias created by households observed only once. Within the core alone, kinship relationships between households remain highly correlated with the pattern of food sharing at meals.

*Table 3.* QAP Matrix Correlations of Interhousehold Food Sharing with Independent Variables

| | *Pearson correlation* | *Significance* |
|---|---|---|
| Kinship: all | 0.143 | 0.000 *** |
| Kinship: core | 0.250 | 0.000 *** |
| Hunters (*n* sum): core | 0.265 | 0.001 * |
| Average age difference: core | 0.200 | 0.037 * |
| Neighborhood: core | 0.138 | 0.040 * |
| Shared building: core | 0.081 | 0.076 † |
| Hunters (*n* difference): core | 0.118 | 0.098 † |

*** $p < 0.0001$, ** $p < 0.001$, * $p < 0.05$, † $p < 0.10$

The number of hunters living in each household was converted to similarity and dissimilarity matrices in order to measure the productive potential of nuclear families. The sum of the number of hunters in core households sharing meals was compared with the sharing pattern using a QAP matrix correlation, which yielded a correlation at a highly significant level. The difference in the number of hunters in households, however, was only weakly correlated with the food-sharing pattern and at a statistically insignificant level. Differences in average age of each household were weakly correlated with the food-sharing pattern. In addition, matrices of the difference in total number of members of paired households and the difference in producer/consumer ratio of households were uncorrelated with the food-sharing matrix. This suggests that differences in productive capacity and the producer/consumer ratio are less important to predicting interhousehold sharing at meals than the combined productive power of the sharing households. The importance of the sum of the number of hunters in households sharing food at meals supports theoretical assumptions for tit-for-tat reciprocity in food sharing (Kaplan and Hill 1985b:239).

Similarity matrices were generated for households living in the same apartment block in the village, as well as within the same neighborhood, and compared with the food-sharing pattern using the QAP matrix correlation. The similarity matrix of households living in the same apartment block was weakly correlated with the core food-sharing pattern at a nonsignificant level. Shared neighborhood, however, was a marginally significant factor.

Table 4 shows the results of three QAP multiple matrix regressions (1,999 permutations, random seed) with different combinations of independent variables. As with the QAP correlation, a standard regression across cells is computed and compared with random permutations of the dependent matrix. For each coefficient, the proportion of random permutations that yielded a coefficient as extreme as the one computed by the standard regression generates the significance level. Kinship is highly significant in each model, explaining more than 20% of the variation in the food-sharing pattern. While shared neighborhood and average age differences of households were significantly correlated with the sharing pattern, when paired with kinship and other independent variables both become insignificant in matrix regressions. After including kinship and sum-of-hunters matrices, Model 4 explains more than 40% of the variation in sharing within the network core.

### *Host-Guest Asymmetry*

A number of households appear more active as hosts than others in the network. The thickness of the arrow in Figure 1 represents the number of meals observed for a given host-guest pair. The varying activity of the hosts can be measured as host-guest asymmetry. Asymmetry is defined as the difference between the number of times Household X hosted a member of Household Y minus the number of times Household Y hosted a member of Household X. For example, Household A hosts Households B, C, D, E, and Q more frequently than the reverse for each partner. Households B, C, and D included the adult offspring of the heads of Household A. Household D also includes the youngest offspring of Household A, along with the offspring's spouse and newborn child. Household D members were guests at their parents' house 93 times, but Household D was not observed hosting their parents, even though Ziker visited their house frequently. Households B and C are more established than Household D but are also busy with young children. Many of the meals hosted by Household A included the young children from Households B, C,

*Table 4.* Summary of Matrix Regressions of Percentages of Meals Going to Other Nuclear Families

| | *Independent Variables* | *Unstandardized Coefficient* | *Standardized Coefficient* | *Significance* |
|---|---|---|---|---|
| Model 1 | Kinship | 0.084 | 0.264 | 0.000 *** |
| | Neighborhood | –0.008 | –0.018 | 0.411 †† |
| Model 2 | Kinship | 0.074 | 0.231 | 0.001 * |
| | Hunters (*n* sum) | 0.036 | 0.194 | 0.022 * |
| | Neighborhood | –0.019 | –0.046 | 0.235 †† |
| Model 3 | Kinship | 0.073 | 0.227 | 0.002 * |
| | Age (average difference) | 0.002 | 0.142 | 0.077 † |
| Model 4 | Kinship | 0.074 | 0.231 | 0.003 * |
| | Hunters (*n* sum) | 0.034 | 0.187 | 0.030 * |

*** $p < 0.0001$, ** $p < 0.001$, * $p < 0.05$, † $p < 0.10$, †† $p \geq 0.010$

and D (their grandchildren). Grandparental investment thus may account for much of the asymmetry.

Members of Household E are rather distant cousins of Household A, and they are also neighbors in the same apartment block. Household E also participates in hunting trips with members of Household A, and they are generally on good terms with Household A, as well as with A's independent children and their families, but Household A ate at Household E less often than vice versa. The members of Household A do not host all their neighbors. In fact, one of their neighbors is a close cousin and a single mother, but she was never observed sharing a meal at Household A. Instead, Households A, B, C, and E regularly gave her uncooked meat and fish. Household Q was an unrelated visitor from the city, a friend of Household A's. As a result, Household Q was in large part dependent on Household A for food during the one-week visit when shared meals were observed. In sum, Household A shares meals asymmetrically with their recently married children and grandchildren most often, but also with more distant relatives and friends.

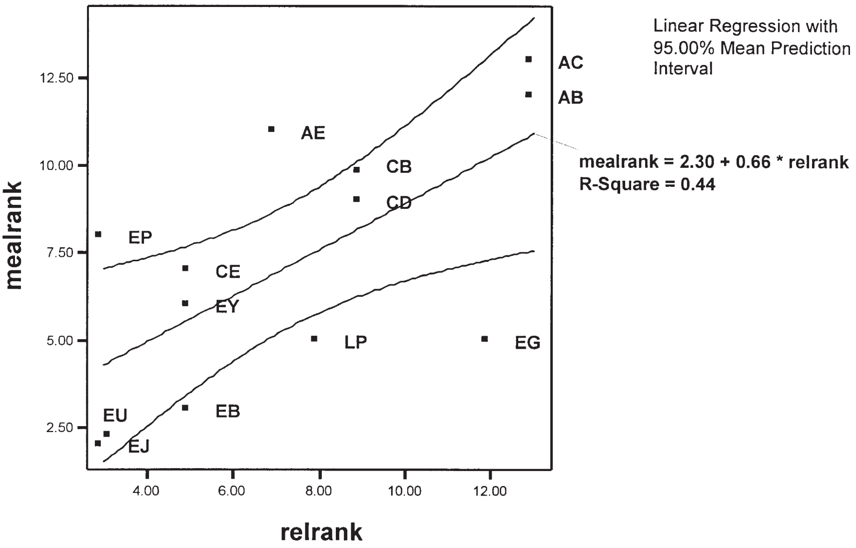
Household E hosted Household Ssak most asymmetrically (25 meals) because a member of Household Ssak was an apprentice (*pomoshchnik*) at Household E's hunting cabin for an extended period when observations were made. Household Ssak had no opportunity to reciprocate at that time. Learning a trade—in this case, hunting, fishing, and trapping—entails a lot of helping out with mundane tasks. It is likely that Household Ssak will offer a good deal of returned cooperation at some point. Since this analysis focuses on one kind of resource transfer during the medium term, such long-term implications cannot be explored here.

When the 44 pairs of houses for which kinship links have been identified are compared, the range of asymmetrical meal sharing is greater than that between the 40 pairs for which no kinship is claimed. The range of asymmetry for dyadic observations where the households have a kinship relationship ($n$ = 331) is from 1 to 93 meals. The range of asymmetry for households where there is no kinship relationship ($n$ = 108) is from 1 to 25. When the subset matrix of kinship and food sharing is compared with the matrix of non-kinship and food sharing (including all 2,450 hypothetical relationships), there are significant differences in the means, standard deviations, and variances in the matrices. The mean number of meals for the entire kinship-and-food-sharing matrix is 0.135, the standard deviation is 2.335, and the variance is 5.450. The mean number of meals for the non-kinship-and-food-sharing matrix is 0.044, the standard deviation is 0.671, and the variance is 0.450. The classical $t$-test value is 1.854 (standard error of difference = 0.049). More significant results were found comparing kin and non-kin sharing in the core using percentages of sharing rather than the raw dyadic counts ($t$-statistic = 1.77, standard error = 0.008). These results suggest that when meals are shared between households of non-kin, there is more symmetry in the relationship (i.e., non-kin visit other households less often without hosting in return). There is less overall symmetry in the interhousehold food sharing between kin. These results follow expectations from kin-selection and reciprocal-altruism models.

## *Reciprocal and Non-Reciprocal Hosting*

Reciprocal meal hosting is rather limited in terms of partners and overlaps considerably with kinship between households. Of the 84 interhousehold pairs, 26 are reciprocal. This means that 13 households are involved in mutual hosting and visiting. Ten of these nuclear family pairs are also related by consanguineal kinship, which is greater than the overall proportion of kinship links in the entire 50-household network. In order to test the influence of kinship on reciprocity, average household relatedness ($r_{\text{ave}}$) was calculated by summing the $r$ of each pair of individuals in each household and dividing by the total number of household members. Average relatedness for the 13 reciprocal pairs ranged from 0.01 to 0.20, with a mean of 0.09. Three pairs of households with no kinship link were assigned a relatedness of 0.00. In Figure 3, household relatedness is rank-ordered, with the non-kin household pairs receiving the lowest rank. The depth of the sharing relationship, calculated as the sum of the total meals for each pair, is also ranked. These rank-order data were compared using SPSS and found to be positively related with a Pearson correlation of 0.648 ($p$ = 0.017, two-tailed). Controlling for the number of observations at host households increases the Pearson correlation to 0.672.

*Figure 3.* Linear regression for the intensity of reciprocal meal hosting (mealrank) on the ranked average household relatedness (relrank). The points on the graph are 13 unordered household pairs.



When the reciprocal sharing between nuclear families is analyzed in terms of the frequency of dyads observed at meals, then these rank-order results are reinforced. A total of 198 dyadic observations of the entire sample of 439 are reciprocal meals among the 13 household pairs (11 nuclear families). The frequency of reciprocal sharing among kindred families is 180 (91%), and non-kin reciprocal hosting is 18 (9%). A matrix regression of reciprocal hosting on two independent variable matrices (kinship and the sum of hunters in partner households) showed both independent variables to be statistically significant predictors of reciprocity.

Asymmetry in non-reciprocal meal sharing was greatest among kin, as expected under inclusive fitness theory. At the same time, the rank order, frequency, and matrix regression results indicate that reciprocal meal hosting is structured by kinship in the direction consistent with inclusive fitness theory. Mutual caregiving behavior occurs more often with close relatives in the reciprocal subset. The reciprocal meal-sharing relationships are not fully symmetric (i.e., there are differences in the amounts given and received among reciprocal hosts). In any case, those who share more often and generously do predictably receive more. The Pearson correlation of contingency for the reciprocal pairs is 0.369 ($p = 0.001$). These results are consistent with predictions for tit-for-tat reciprocity.

Members of non-kin households attended meals reciprocally with less frequency than members of households related by kinship in this sample period. Tit-for-tat meal sharing between non-kin households is relatively rare. Nevertheless, reciprocal meal hosting is fairly common in this network, favoring close kin in terms of range of partners and frequency of meals. The implications of the reciprocal meal-hosting results for the evolution of cooperation are discussed below.

For non-reciprocal meal hosting, the results indicate a wider range of asymmetric relationships for households related by kinship than among non-kin. Such heightened asymmetry is expected under kin selection. Twenty-four household pairs related through kinship were observed in non-reciprocal meals (151 dyadic observations). Thirty-four unrelated households were observed in non-reciprocal meals (90 dyadic observations). Both the average number of meals and the range of the asymmetry were significantly larger for kin in contrast to non-kin in these non-reciprocal relationships.

Examination of independent variables on the unreciprocated meals in the network core shows more nuances in the sharing pattern (Table 5). Average age difference is correlated most significantly with the non-reciprocal meal pattern among kin, followed by shared neighborhood and the number of hunters in the household pairs. The difference in the number of hunters was not correlated with non-reciprocal sharing among kin. In a matrix regression, adding the number of hunters causes all three variables to drop out of the statistically significant range, making it a marginal factor. Average age difference

*Table 5.* Results of QAP Matrix Correlations for Non-reciprocal Meals among Kin and Non-kin in the Core for Other Relational Matrices

| | *Pearson correlation* | *Significance* |
|---|---|---|
| Non-reciprocal Meals among Kin | | |
| Average age difference | 0.139 | 0.031 * |
| Shared neighborhood | 0.165 | 0.034 * |
| Hunters (*n* sum) | 0.110 | 0.044 * |
| Hunters (*n* difference) | 0.067 | 0.184 |
| Non-reciprocal Meals among Non-Kin | | |
| Hunters (*n* difference) | 0.113 | 0.024 * |
| Average age difference | 0.149 | 0.028 * |
| Hunters (*n* sum) | 0.091 | 0.143 |
| Shared neighborhood | –0.017 | 0.638 |

* $p < 0.05$

and shared neighborhood alone account for 30% of the variation (at $p < 0.05$) of non-reciprocal sharing between kin. This suggests that consumption needs and proximity cannot be ruled out as factors among kin.

With non-kin, on the other hand, the most significant correlate in the non-reciprocal meal-sharing pattern is the difference in the number of hunters, followed by the difference in average ages of the households. In a series of multiple regressions, these variables remain significant predictors of unreciprocated hosting of non-kin, suggesting economic need may be even more important for explaining partner selection in this subset. This subset is the only part of the network in which differences in the number of hunters was a significant predictor of partner selection and sharing depth. These results would be consistent with the tolerated-scrounging model.

## RELEVANCE TO THE PREDICTIONS

### *Depth*

*Prediction for kin selection.* The percentage of meals shared with other nuclear families increases with the proportion of young kin and average genealogical relatedness.

The relative percentages of meals shared with different types of households were examined to shed some light on Prediction 1. Raw tallies of sharing dyads were converted to percentages of total meals for each host. The relative number of meals given to different types of guests for Household A and Household E are discussed here. Household A shared food with kin in 89% of their interhousehold meals. Close kin ($r_{\text{ave}} \geq 0.125$) were guests at 76% of the meals, and the youngest child's family attended 41% of the meals provided by Household A to other nuclear families. The prediction holds for Household A's close relatives. Beyond close relatives, Household A hosted members of three families ($r_{ave} < 0.125$). The most distantly related family (Household E, $r_{ave} = 0.016$) attended 11% of Household A's meals, while the other two families (both with young children and more closely related) were guests at fewer than 1% of meals observed. Household E had no children, so the fact that Household A hosted them so often departs from the prediction. One possible explanation is that two members of Household E were key informants in my research, and they often visited Houeshold A to see me but would have visited less often under normal circumstances. During subsequent visits to the village (2001 and 2003), Ziker was told that Household E members had rarely been over to visit since my departure in 1997.

Household E shared food at meals with kin in 37% of observed meals and with non-kin in 63%. This appears to be a reversal of the predicted bias and a falsification of the model. However, almost half of the non-kin sharing was documented during a multiday hunting trip, when an adolescent from Household Ssak was living at Household E's bush camp. If this dyad (the only interhousehold dyad observed at their bush camp) is removed from the total, Household E shared with kin in 66.6% of the between-family cases and with non-kin in 33.3% of the cases. If Household E's kin are divided into close ($r_{ave} \geq 0.125$) and distant ($r_{ave} < 0.125$) kin, meals were shared with the same frequency: 33.3% in both cases. Household E hosted close and distant relatives and non-relatives equally (excluding the extended hunting trip with Ssak). Unlike Household A, Household E has no young children in the household or children with their own nuclear families living independently. Household E has a large extended family, and their close kin include nuclear families with children, many of whom are school-age. During subsequent observations (2001 and 2003 field seasons), Household E regularly donated large quantities of raw food to their close kin. The analysis of meals reflects an inflated proportion of distant kin in Household E's network, likely because of my presence at Household A early on in my research. Since there are no direct descendants of Household E, and friends and relatives visit their house quite often, the proportion of meals hosted with non-kin and distant kin is heightened in their faction.

*Other predictions regarding depth.* Since information on the synchrony and means of hunts was not combined with these data, it is not possible to determine the degree to which asynchrony and similar means influence reciprocal food transfers. Indirect evidence presented above on the sum of hunters in food-sharing households suggests that combined productive capacity is a factor in the meal-sharing pattern in reciprocal relationships. Since 13 households did share meals reciprocally, a degree of risk buffering may be occurring, in which similarity of productive means indicates an ability to share in a tit-for-tat manner.

The difference in the number of hunters in food-sharing households was not a significant factor until the non-kin, non-reciprocal subset was investigated. This finding suggests that productive differences may not be a factor in the food-sharing pattern, except with certain non-kin. The above discussion of partner selection indicates that producer control is significant. The "depth" predictions for tolerated scrounging (marginal units transferred) and costly signaling (more likely with high-cost hunts) remain incompletely tested with these data, however. Determining the marginal value of meals is impractical here, since information on visitors' food was largely unavailable. Costly signaling at meals is unlikely since there was no food sharing associated with high-cost hunting. Dolgan and Nganasan generally do not hunt bear, which likely would be the highest-ranked prey for an optimal forager and the most dangerous to hunt. Hunting bear is taboo for most people in the community (Ziker 2003a). If a bear had been killed and the meat distributed, this distribution might provide an opportunity to test the costly signaling model in this context.

### *Breadth*

*Prediction for kin selection.* The number of families given food shows a bias toward close kin over distant kin and non-kin.

As discussed above in the section on partner selection, more household pairs are kin than non-kin. A tally of Household A and Houeshold E guests shows that close-kin families represent half of all kin pairs. Considering that each household has many more distant kin than close kin, there appears to be a bias toward close kin and particular families of distant kin.

*Other predictions regarding breadth.* Reciprocal altruism requires that specific cooperative individuals will be favored in tit-for-tat sharing. This appears to be the case in this set of data for the 198 reciprocal observations. Not all close kin are fed reciprocally, so the arguments that reciprocal sharing may be caused by symmetrical relationships of other types (kinship or neighborhood) do not hold. There is a great deal of control over who is willfully admitted into houses and fed. People, even close kin, who are under the influence of alcohol are usually barred from entering or highly discouraged from staying. Since hosts exhibit a fairly restrictive selection of partners at meals, only a small proportion of meals appears to follow the tolerated-scrounging model. Similarly, since sharing does not occur in a setting with a wide audience, assumptions about the costly signaling model are not supported.

### *Equality*

*Prediction for kin selection.* The disparity in the amounts of food given and received increases as relatedness and average age differences increase.

The above discussion of asymmetry in the food-sharing pattern indicated that there was a wider disparity in amounts given and received in the kinship submatrix in comparison with the non-kinship matrix. High proportions of interhoushold meals were given to close kin without any evidence of reciprocity. This was also the case with a number of non-relatives, but the disparity was smaller in the non-kin matrix.

Average age difference between nuclear families was correlated with the food-sharing percentages in the core (Pearson's correlation = 0.200, $p = 0.037$). When combined with other variables in a multiple matrix regression, however, average age drops out of significance. Testing with larger data sets may be necessary to evaluate this proposition fully.

*Other predictions regarding equality.* With reciprocal altruism, the main prediction with regard to equality is that it is contingent on previous transfers. Gurven (2004) calculates contingency as the correlation between the amount or percentage of total production A gives B with the amount or percentage B gives A with a sample period ranging from several weeks to several months. When the 11 reciprocal meal-sharing households are arranged in 13 household pairs, the Pearson correlation of contingency is 0.369 ($p = 0.001$). This test makes it difficult to rule out the reciprocal-altruism model. The equality predictions for tolerated scrounging and costly signaling remain untested because information on non-possessors' needs and package size of hunts was not collected in conjunction with the meal data.

### *Balance*

*Prediction for kin selection.* The long-term differences in amounts given and received are predicted to be sizable under kin selection and negligible in reciprocal sharing.

In the above discussion of host-guest asymmetry, this appears to be the case: the range of asymmetrical meal hosting was wider among kin than among non-kin. In addition to sharing meals, there are likely other forms of benefits that outweigh the cost of giving, such as help on hunting trips, borrowing tools, etc., although those benefits cannot be tabulated for this sample of meals.

*Other predictions regarding balance.* With tolerated scrounging, moderate long-term inequalities are expected as families' economic needs vary. Again, there is limited support for this prediction, particularly for non-kin. Costly signaling may allow for sizable long-term differences as long as someone in the audience returns a benefit. Since the meal-sharing pool is limited, this appears to be unlikely at this phase of sharing.

## DISCUSSION

Sharing at meals may be an activity through which cooperative strategies are reinforced within subsets of small communities. Axelrod and Hamilton (1984) propose that when the number of interactions within a cluster is sufficiently high, clustering can be a means by which reciprocal cooperation can become viable in a community of noncooperators. However, Axelrod and Hamilton are vague about the relationship between kinship and reciprocal cooperation: "Clustering is often associated with kinship, and the two mechanisms can reinforce each other in promoting the initial viability of reciprocal cooperation. However, it is possible for clustering to be effective without kinship" (1984:98).

Two difficult issues are disentangling kinship and reciprocity, and determining how cooperative strategies are maintained and spread. The fact that reciprocal hosting is found more regularly between kin in separate nuclear families than between friends and non-kin raises serious questions about kinship and reciprocity. Does this mean that kinship is in large part characterized by reciprocity (Gurven et al. 2001:286)? On the contrary, the data show larger and more frequent asymmetrical transfers to kin. This is what might be expected, other things being equal, according to inclusive fitness theory, nepotism, and generalized reciprocity.

The evidence reviewed here supports the prediction that reciprocal cooperation is contingent. Kin may provide more predictable returns, especially when closely related families are feeding each other's young or the offspring of offspring. In this way, contingent cooperation at meals may facilitate an economy of scale for childrearing in a set of related families. Further investigation will examine this hypothesis. Although clustering among non-kin families occurs, other things being equal, people in this network prefer their kin.

Variability in the reciprocal sharing pattern is partially explained by the number of hunters in each family. There is also a strong relationship between the number of hunters and the meal-sharing pattern for the subset involved in reciprocal meal hosting. This suggests that the productive capacity of households engaged in reciprocal food sharing is combined. If reciprocal meal sharing is largely occurring for reasons associated with family provisioning, then combined productive capacity may improve the quality or the regularity of provisioning. This hypothesis also requires further investigation.

Combination of productive capacity is not necessarily the case for those households involved in non-reciprocal hosting. With non-reciprocal meal sharing among kin, the strongest associations are shared neighborhood and average age difference between households. Number of hunters is correlated with non-reciprocal sharing among kin, but the variable loses significance in multiple regressions with neighborhood and household age. The independent variables that are significant predictors of non-reciprocal sharing among kin suggest that economic considerations, proximity, and relative need may play a role in partner selection. This result does not, however, rule out kin selection. Most of the non-reciprocal sharing with kin occurred between established families and their close relatives in newly established nuclear families.

With non-reciprocal meal sharing among non-kin, the strongest associations are differences in the numbers of hunters and average age of the households. Shared neighborhood and number of hunters are not correlated with the non-kin, non-reciprocal sharing pattern. It is in this last subset of the network that tolerated scrounging would be most expected. The independent variables suggest that differences in productive capacity as well as household consumption needs may inform partner selection. In fact, the lion's share of the non-reciprocal, non-kin sharing was with unrelated teenagers visiting relatives of their friends.

If Dolgan and Nganasan families are including non-kin in reciprocal cooperation (to level out resource availability, for example), then one might expect sharing depth and breadth to show significant proportions of food going to non-kin. These data indicate that that the reciprocal cluster is primarily composed of kin. Such clustering may occur largely in accordance with the pooling of resources and labor. The labor pool may reflect cooperative acquisition as well as cooperative food preparation—a time-consuming task which requires skills in butchery and processing. It is not that the hunter does not own the catch (Hawkes 2002), but that the catch is converted to family property, which denotes an entitlement to the separate nuclear families within a set of related households. For example, in Ust'-Avam, first distributions of kills and catches are largely transferred to the household of the hunter's parents or to the hunter's wife, and they are redistributed from there, mainly to close kin.

Reciprocal sharing at meals provides empirical evidence of regular cooperation in a contingent, largely tit-for-tat manner, something which theoretical studies suggest may be rare in large groups (Richerson and Boyd 1998:75). In the food-sharing sample examined here, reciprocity is occurring largely within a limited core of actors connected through multiple links. Reciprocal cooperators are, thus, chosen out of a larger pool of nuclear families. This limitation of partners suggests that a large but indefinite number of opportunities to exchange exist within an individual's lifetime (Wilkinson 1988:86). Meal sharing, although a relatively low-cost behavior, still has certain altruistic costs since the food could be directed to different partners or solely to members of the nuclear family. The benefits are most likely delayed, as people reciprocate at different times. Non-reciprocal meals are more common among kin than among non-kin, suggesting that some means for identifying and favoring kin is in operation. The varying willingness of hosts to feed visitors is representative of this mechanism. Kin are willingly fed meals non-reciprocally, whereas non-kin, especially those not volved in reciprocal arrangements, are discouraged from visiting.

In the context of Ust'-Avam, sharing meals with people outside the nuclear family has the intangible benefit of adding variety to the diet and to meal-time conversation. Sharing at meals also spreads out the labor involved in food preparation for a relatively small set of regularly cooperating families. If these families are related, as they are in this sample, then caring for each other and each other's children makes sense on a number of levels. Caring for close relatives' offspring makes sense according to kin selection, as well as local understandings of kinship. Reciprocal cooperation among kin is more likely because the kinship link improves the likelihood of future cooperation. Non-kin are likely included in reciprocal meal clusters for other reasons (e.g., access to different kinds of resources, cooperative acquisition), and provisioning may be less important than it is among kin. Meal sharing at hunter-gatherer bush camps tends to include other persons present in the camp whether they are kin or not (e.g., among Ache, Inuit, San, and Aka; Kishigami 2003).

## SUMMARY

This paper has explored the final phase of food sharing: meals. Beyond food shared at or immediately after procurement, butchery, and transportation, analysis of shared meals opens up a new point of entry into the food-sharing debate. The effort and auxiliary ingredients added to the product during preparation increases the value, and thus, other things being equal, one would expect benefits returned to be commensurate. Provisioning of descendants and other relatives appears to be a major focus of interhousehold meals among the Dolgan and Nganasan. Highly asymmetrical relationships are most common among kin, following assumptions of inclusive fitness theory. In addition, reciprocal meal hosting was most common among kin in separate households. This cooperative clustering may reflect the division of meal preparation responsibilities and common ownership of locally procured food resources. Non-reciprocal hosting among non-kin exhibits the most evidence for tolerated scrounging. Costly signaling was not supported as an explanation for sharing meals.

Food sharing is a prominent aspect of contemporary hunting-and-gathering people's economies (e.g., Freeman et al. 1998) and has been a major focus of discussion in economic anthropology (e.g., Hunt 2000; Mauss 1967; Sahlins 1972; Woodburn 1982,). Big-game hunting and the benefits of large package sizes of meat are also assumed to have played a role in the evolution of human sociality (Darwin 1871) and the roles of men and women in social organization (Hawkes et al. 2001a, 2001b; Lee and Devore 1968; Lovejoy 1988; Tooby and Devore 1987; Wrangham et al. 1999; Zuk 2002). It follows that procurement, distribution, and consumption by modern-day hunter-gatherers are important behaviors to observe and document in order to explore benefits to hunters and others in variable environments and times (Blurton Jones 1987). Four major sets of hypotheses are examined in this paper: kin selection (inclusive fitness), in which transfers are biased by nepotism and provisioning of young; reciprocal altruism, in which transfers are contingent and function as risk buffering; tolerated scrounging, where there is little producer control and costs of defending a resource are considerable; and costly signaling, in which transfers are made so that others can see and know about the gifts with hypothesized reproductive benefits to the hunter.

The data explored in this article show that kinship explains most of the variation in meal sharing between households. Other independent variables, including number of hunters in the households and average age of household members, suggest that provisioning cannot be ruled out as a function of food sharing at meals. For some cases, particularly non-reciprocal sharing with nonkin, significant differences in economic ability (number of hunters) and consumption needs (average household age) suggest that tolerated scrounging cannot be ruled out. Within hunting-and-gathering bands in other geographic areas, the degree to which kinship, age, numbers of producers, and household location influence interhousehold sharing at meals remains to be seen. The extent to which the predictions of kin selection and reciprocal altruism obtain in Dolgan and Nganasan meals is a significant finding. Generalized sharing and balanced reciprocity are not alternatives here, as in Sahlins's schema of reciprocities (1972), but are combined within the cooperative cluster, a subset of the food-sharing network. It may be that the free-rider problem is less likely in the network core where interactions are most intensive, providing conditions under which a reciprocal cluster can develop.

This research was supported by a grant from the National Science Foundation's Arctic Social Science Program (OPP 9528936) and Title VIII research fellowships from the International Research & Exchanges Board and the American Council of Teachers of Russian, funded by the National Endowment for the Humanities and the U.S. Department of State, Program for Scientific Research in Russia, Eurasia, and Eastern Europe. The Wenner-Gren Foundation for Anthropological Research (Richard Carley Hunt Fellowship) sponsored the compilation of the meal records. A grant from the Leakey Foundation provided support to develop the analysis techniques, as well as additional research on food distribution in Ust'-Avam to be described in future publications. The statements and views expressed herein are those of the author and are not necessarily those of the Leakey Foundation, the Wenner-Gren Foundation, or any of the other funding agencies or the Max Planck Institute for Social Anthropology, which supported a two-day workshop on social network analysis with Michael Schnegg, August 1–2, 2002. Special thanks go to the research team at the University of Alaska Fairbanks: Jenny Newton, Britt Arnesen, and Tom Delaune. Comments from Ed Hagen, Robert Hunt, Robert Layton, Nobuhiru Kishigami, and Will Palmer helped to improve this paper, but we are responsible for the views presented.

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## APPENDIX

### *Analysis of Meals by Individual Dyad and Location*

Biases in the distribution of sexes (Table 6), consanguineal relationships at meals (Table 7), and affinal relationships and friendship relationships at meals (Table 8) across location categories are significant in these data. Elevated proportions of males who are close genealogical relatives characterize the participants at bush meals. Relatively high proportions of spouses, affines, and friends of both sexes characterize village meals, whereas high proportions of females and their relatives and friends characterize city meals. Village and bush were the most likely candidates for interhousehold food sharing based on the dyadic relationships present.

*Table 6.* Mean Proportion of Females in Meals at Three Types of Locations (between-group differences are significant: F = 262.77, $p < 0.0001$)

| *Location* | *Mean Proportion of Females* | *N* | *s.d.* |
|---|---|---|---|
| City | 0.69 | 80 | 0.24 |
| Village | 0.39 | 302 | 0.29 |
| Bush | 0.01 | 164 | 0.02 |
| Total | 0.32 | 546 | 0.33 |

*Table 7.* Distribution of Meals ($N = 546$) by Average Relatedness ($r$) of Participants and Meal Location

| | Relatedness at Meals ($r$) | | | | | |
|---|---|---|---|---|---|---|
| | $r = 0$ | | $0.0 < r < 0.5$ | | $r = 0.5$ | |
| *Location* | *N* | % | *N* | % | *N* | % |
| City | 16 | 10 | 54 | 23 | 10 | 7 |
| Village | 128 | 81 | 135 | 56 | 39 | 27 |
| Bush | 15 | 9 | 51 | 21 | 98 | 67 |

*Table 8.* Mean Proportion of Individual Dyad Categories at Meals by Location

| | *Individual Dyad Categories* | | | | | | |
|---|---|---|---|---|---|---|---|
| *Location* | *Cognate** | *Spouse* | *Affine1* | *Affine2* | *Friend1* | *Friend2* | *Other* |
| City | 0.62 | 0.03 | 0.02 | 0.03 | 0.10 | 0.13 | 0.07 |
| Village | 0.36 | 0.25 | 0.19 | 0.03 | 0.12 | 0.03 | 0.02 |
| Bush | 0.70 | 0.00 | 0.05 | 0.01 | 0.05 | 0.18 | 0.01 |

* Between-group differences (ANOVA) are highly significant (F = 44.606, $p < 0.0001$) for cognatic dyads.

## NOTES

1. Ichikawa (2004) describes three phases of sharing for hunter-gatherers: (*a*) obligatory sharing after the kill, (*b*) voluntary sharing of raw meat (large first-butchering portions) to those not participating in the kill, and (*c*) sharing portions prepared for consumption. Sharing at the third phase is reported worldwide (e.g., Bodenhorn 2000; Kishigami 2000; Turnbull 1987; Wenzel 2000).
2. Pollution is carried to Lake Khantaiskii by prevailing winds. Also, the construction of the Khantaiskii reservoir and power-generating station caused the fish stock in the lake to change from preferable whitefish and grayling to so-called black fish (i.e., burbot and pike). Reindeer pastures on the north side of the lake became inaccessible after the construction of the reservoir.
3. Alvard (2002, 2003) reports that lineage membership accounts for meat-sharing patterns to a greater degree than individual relatedness.
4. Two problems with the snowball method have been identified (Hanneman 2001). First, actors who are not connected to other actors are not located by this method. The presence and numbers of isolates can be important for some analytic purposes, but since this paper explores a particular sharing network and variables that explain its pattern, the number of isolates in the population is not presently of concern. Second, there is no guaranteed way of finding all of the connected individuals in the population. The length of the study and the number of observations help to minimize the effects of this problem.
5. Eighty-six percent of shared-meal observations have from two to four participants. The modal meal had two participants. The mean was just over three participants per meal, and the median was three participants. Communal meals attended by large numbers of people were relatively unusual in this sample—meals with six or more participants accounted for only 6% of meals.

## REFERENCES

Alexander, R. D.
1979 *Darwinism and Human Affairs*. Seattle: University of Washington Press.
1991 Epigenetic Rules and Darwinian Algorithms: The Adaptive Study of Learning and Development. *Ethology and Sociobiology* 11:241–303.
Alvard, M. S.
2002 Carcass Ownership and Meat Distribution by Big-Game Cooperative Hunters.*Social Dimensions in the Economic Process* 21:99–131.
2003 The Adaptive Nature of Culture. *Evolutionary Anthropology* 12:136–149.
Anderson, D. G.
2000 *Identity and Ecology in Arctic Siberia: The Number One Reindeer Herding Brgade.* Oxford: Oxford University Press.
Axelrod, R., and W. D. Hamilton
1981 The Evolution of Cooperation. *Science* 211:1390–1396.
1984 The Evolution of Cooperation in Biological Systems. In *The Evolution of Coopertion,* by R. Axelrod. Pp. 88–105. New York: Basic Books.

Barnard, A.
1999 Modern Hunter Gatherers and Early Symbolic Culture. In *The Evolution of Cuture*, R. Dunbar, C. Knight, and C. Power, eds. Pp. 50–68. New Brunswick, New Jersey: Routledge.
Batson, C. D.
1991 *The Altruism Question: Toward a Social Psychological Answer*. Hillsdale, New Jersey: Erlbaum.
Betzig, L., and P. Turke
1986 Food Sharing on Ifaluk. *Current Anthropology* 27:397–400.
Bird-David, N.
1990 The Giving Environment: Another Perspective on the Economic System of Gaterer-Hunters. *Current Anthropology* 31:189–196.
Bliege Bird, R. L., and D. W. Bird
1997 Delayed Reciprocity and Tolerated Theft: The Behavioral Ecology of Food-Sharing Strategies. *Current Anthropology* 38:49–78.
Bliege Bird, R., D. W. Bird, E. A. Smith, and G. C. Kushnick
2002 Risk and Reciprocity in Meriam Food Sharing. *Evolution and Human Behavior* 23:297–321.
Blurton Jones, N.
1987 Tolerated Theft: Suggestions about the Ecology and Evolution of Sharing, Hoaring, and Scrounging. *Social Science Information* 26:31–54.
Bodenhorn, B.
2000 It's Good To Know Who Your Relatives Are, But We Were Taught To Share with Everybody: Shares and Sharing among Inupiaq Households. In *The Social Economy of Sharing: Resource Allocation and Modern Hunter-Gatherers*, G. W. Wenzel, G. Hovelsrud-Broda, and N. Kishigami, eds. Pp. 27–60. Senri Ethnological Series 53. Osaka: National Museum of Ethnology.
Borgatti, S. P., M. G. Everett, and L. C. Freeman
1999 *UCINET 5.0 Version 1.00*. Natick: Analytic Technologies.
Cashdan, E.
1985 Coping with Risk: Reciprocity among the Basarwa of Nrthern Botswana. *Man*(n.s.) 20:454–474.
Chagnon, N. A., and J. Bryant
1984 KINDEMCOM: The Fourth Style in the Study of Human Kinship Relations. Ms. Department of Anthropology, University of California, Santa Barbara.
Chagnon, N. A., J. Ziker, B. Thompson, M. Price, and J. Eerkens
1997 The Density of Kinship in Tribal and Peasant Communities. Paper presented at the Ninth Annual Meeting of the Human Behavior and Evolution Society. University of Arizona, Tucson.
Cosmides, L.
1985 *Deduction or Darwinian Agorithms? An Explanation of the "Elusive" Content Effect on the Wason Selection Task.* Ph.D. dissertation, Department of Psychology, Harvard University. University Microfilms 86-02206.
1989 The Logic of Social Exchange: Has Natural Selection Shaped How Humans Reson? Studies with the Wason Selection Task. *Cognition* 31:187–276.
Cosmides, L., and J. Tooby
1992 Cognitive Adaptations for Social Exchange. In *The Adapted Mind*, J. Barkow, L. Cosmides, and J. Tooby, eds. Pp. 163–228. New York: Oxford University Press.
Darwin, C.
1871 *The Descent of Man and Selection in Relation to Sex*. New York: Appleton.
de Waal, F. B. M., and M. L. Berger
2000 Payment for Labour in Monkeys. *Nature* 404:563.
Dolgikh, B. O.
1962 The Origins of the Nganasans: Preliminary Remarks. In *Studies in Siberian Ethnogenesis*, H. N. Michael, ed. Pp. 220–299. Toronto: Arctic Institute of North America/ University of Toronto Press.
1963 Proiskhozhdenie Dolgan [Origin of the Dolgan]. In *Sibirskii Etnograficheskii Sbornik V*, Pp. 92–141. Trudy Instituta Etnografii im. N. N. Miklukho-Maklaia, Novaia Seriia 84. Moscow: Izdatel'stvo Akademii Nauk SSSR.

Euler, H. A., S. Hoier, and P. A. Rohde
2001 Relationship-Specific Closeness of Intergenerational Family Ties: Findings from Evolutionary Psychology and Implications for Models of Cultural Transmission. *Journal of Cross-Cultural Psychology* 32:147–158.
Euler, H. A., and B. Weitzel
1996 Discriminative Grandparental Solicitude as Reproductive Strategy. *Human Nature* 7:39–59.
Freeman, M. M. R., I. I. Krupnik, L. Bogoslovskaya, R. A. Caulfield, I. Egede, and M. G. Stevenson
1998 *Inuit, Whaling, and Sustainability*. Walnut Creek, California: AltaMira.
Goody, J.
1976 *Production and Reproduction: A Comparative Study of the Domestic Domain*. Cambridge: Cambridge University Press.
Gurven, M.
2004 To Give and To Give Not: The Behavioral Ecology of Human Food Transfers. *Behavioral and Brain Sciences* 27, in press.
Gurven, M., W. Allen-Arave, K. Hill, and A. M. Hurtado
2001 Reservation Food Sharing among the Ache of Paraguay. *Human Nature* 12:273–297.
Gurven, M., K. Hill, H. Kaplan, A. Hurtado, and R. Lyles
2000 Food Transfers among Hiwi Foragers of Venezuela: Tests of Reciprocity. *Human Ecology* 28:171–218.
Halstead, P., and J. O'Shea
1989 Introduction. In *Bad Year Economics: Cultural Responses to Risk and Uncertainty*,P. Halstead and J. O'Shea, eds. Pp. 1–7. New York: Cambridge University Press.
Hamilton, W. D.
1964 The Genetical Evolution of Social Behavior (I and II). *Journal of Theoretical Biology* 7:1–16, 17–52.
Hanneman, R. A.
2001 Introduction to Social Network Methods. Ms. Department of Sociology, Univesity of California, Riverside.
Hawkes, K.
1993 Why Hunter-Gatherers Work: An Ancient Version of the Problem of Public Goods. *Current Anthropology* 34:341–361.
2002 Is Meat the Hunter's Property? Big Game, Ownership, and Explanations of Huning and Sharing. In *Meat Eating and Human Evolution*, C. B. Stanford and H. T. Bunn, eds. Pp. 219–236. Oxford: Oxford University Press.
Hawkes, K., and R. Bleige Bird
2002 Showing Off, Handicap Signaling, and the Evolution of Men's Work. *Evolutionary Anthropology* 11:58–67.
Hawkes, K., J. F. O'Connell, and N. G. Blurton-Jones
2001a Hunting and Nuclear Families. *Current Anthropology* 42:681–709.
2001b Hadza Meat Sharing. *Evolution and Human Behavior* 22:113–142.
Hunt, R. C.
2000 Forager Food Sharing Economy: Transfers and Exchanges. In *The Social Economy of Sharing: Resource Allocation and Modern Hunter-Gatherers*, G. W. Wenzel, G. Hovelsrud-Broda, and N. Kishigami, eds. Pp. 7–26. Senri Ethnological Series 53. Osaka: National Museum of Ethnology.
Ichikawa, M.
2004 Food Sharing and Ownership among Central African Hunter-Gatherers: An Evolutionary Perspective. In *Property and Equality,* Vol. 1: *Ritualisation, Sharing, Egalitarianism,* T. Widlok and W. G. Tadesse, eds. Pp. 151–164. New York: Berghahn Books.
Jones, D.
2000 Group Nepotism and Human Kinship. *Current Anthropology* 41:779–809.
Kaplan, H., and K. Hill
1985a Hunting Ability and Reproductive Success among Male Ache Foragers: Prelimnary Results. *Current Anthropology* 26:131–133.
1985b Food Sharing among Ache Foragers: Tests of Explanatory Hypotheses. *Current Anthropology* 26:223–246.

Kishigami, N.

2000 Contemporary Inuit Food Sharing and Hunter Support Program of Nunavik, Canada. In *The Social Economy of Sharing: Resource Allocation and Modern Hunter-Gatherers*, G. W. Wenzel, G. Hovelsrud-Broda, and N. Kishigami, eds. Pp. 171–192. Senri Ethnological Series 53. Osaka: National Museum of Ethnology.

2003 Notes on Studies of Food Sharing in Hunter-Gatherer Societies (in Japanese).*Bulletin of the National Museum of Ethnology* 27(4):725–753.

Lee, R. B.

1968 What Hunters Do for a Living, or How to Make Out on Scarce Resources. In *Man the Hunter*, R. B. Lee and I. Devore, eds. Pp. 30–48. New York: Aldine.

Lee, R. B., and I. Devore, eds.

1968 *Man the Hunter.* New York: Aldine.

Lovejoy, O. C.

1988 The Origin of Man. *Science* 211:341–350.

Mauss, M.

1967 *The Gift*. New York: Norton.

Peterson, N.

1993 Demand Sharing: Reciprocity and the Pressure for Generosity among Foragers. *American Anthropologist* 95:860–874.

Pitul'ko, V.

2000 Terminal Pleistocene–Early Holocene Occupation in Northeast Asia and the Zhokov Assemblage. *Quaternary Science Reviews* 20:267–275.

Pope, S. J.

1994 *The Evolution of Altruism and the Ordering of Love*. Washington, D.C.: Georgetown University Press.

Popov, A. A.

1934 Zatrundrenskie Krest'iane (Russkie na R. Piacine) [Tundra Peasants (Russians on the Piasina River)]. *Sovietskaia Etnografiia* 3:77–86.

1936 *Tavgiitsy: Materialy po Etnografii Avamskikh i Vedeevskikh Tavgiitsev* [The Tavgi: Materials on the Ethnography of the Avam and Vadeev Tavgi]. Moscow: Izdatel'stvo Akademii Nauk SSSR.

1937 Okhota i Rybolovstvo u Dolgan [Hunting and Fishing among the Dolgan]. In *Pamiati V. G. Bogoraza (1865–1936) Sbornik Statei.* Pp. 147–206. Moscow: Izdatel'stvo Akademii Nauk SSSR.

1963 The "Kuoika," Guardian Spirits of Family and Clan among the Nganasan. *Arctic Anthropology* 1(2):122–130.

1964 The Dolgans. In *The Peoples of Siberia*, M. G. Levin and L. P. Potapov, eds. Pp. 655–669. Chicago: University of Chicago Press.

1966 *The Nganasan: The Material Culture of the Tavgi Samoyeds.* Bloomington: Indiana University Press.

Richerson, P. J., and R. Boyd

1998 The Evolution of Human Ultrasociality. In *Ethnic Conflict and Indoctrination: Altruism and Identity in Evolutionary Perspective*, I. Eibl-Eibesfeldt and F. K. Salter, eds. Pp. 71–96. New York: Berghahn Books.

Sahlins, M. D.

1972 *Stone Age Economics*. Chicago: Aldine Atherton.

Smith, E. A.

1988 Risk and Uncertainty in the "Original Affluent Society": Evolutionary Ecology of Resource Sharing and Land Tenure. In *Hunters and Gatherers,* Vol. I: *History, Evolution and Social Change*, T. Ingold, D. Riches, and J. Woodburn, eds. Pp. 222–251. New York: Berg.

1991 *Inujjuamiut Foraging Strategies: Evolutionary Ecology of an Arctic Hunting Economy*. New York: Aldine de Gruyter.

Smith, E. A., R. Bliege Bird, and D. W. Bird

2003 The Benefits of Costly Signaling: Meriam Turtle Hunters. *Behavioral Ecology* 14:116–126.

Sober, E., and D. S. Wilson

1998 *Unto Others: The Evolution and Psychology of Unselfish Behavior.* Cambridge: Harvard University Press.

Spielmann, K. A., and J. F. Eder
1994 Hunters and Farmers: Then and Now. *Annual Review of Anthropology* 23:303–323.
SSPS, Inc.
1999 *SPSS Base 10.0 Applications Guide*. Chicago.
Tooby, J., and I. Devore
1987 The Reconstruction of Hominid Behavioral Evolution through Strategic Modeling. In *The Evolution of Human Behavior: Primate Models*, W. G. Kinzey, ed. Pp. 183–237. Albany: SUNY Press.
Trivers, R. L.
1971 The Evolution of Reciprocal Altruism. *Quarterly Review of Biology* 46:35–57.
1974 Parent-Offspring Conflict. *American Zoologist* 14:249–264.
Turnbull, C.
1987 *The Forest People*. New York: Simon and Schuster. [Originally published in 1961]
Wenzel, G. W.
2000 Sharing, Money, and Modern Inuit Subsistence: Obligation and Reciprocity at Clyde River, Nunavut. In *The Social Economy of Sharing: Resource Allocation and Modern Hunter-Gatherers,* G. W. Wenzel, G. Hovelsrud-Broda, and N. Kishigami, eds. Pp.61–85. Senri Ethnological Series 53. Osaka: National Museum of Ethnology.
Wilkinson, G. S.
1988 Reciprocal Altruism in Bats and Other Mammals. *Ethology and Sociobiology* 9:85–100.
Winterhalder, B.
1996 A Marginal Model of Tolerated Theft. *Ethology and Sociobiology* 17:37–53.
1997 Gifts Given, Gifts Taken: The Behavioral Ecology of Nonmarket, Intragroup Exchange. *Journal of Archaeological Research* 5(2):121–168.
2001 The Behavioural Ecology of Hunter-Gatherers. In *Hunter-Gatherers: An Interdisciplinary Perspective,* C. Panter-Brick, R. H. Layton, and P. Rowley-Conwy, eds. Pp. 12–38. Cambridge: Cambridge University Press.
Wood, B., and K. Hill
2000 A Test of the "Showing-Off" Hypothesis with Ache Hunters. *Current Anthropology* 41:124–125.
Woodburn, J.
1982 Egalitarian Societies. *Man* (n.s.) 17:431–451.
Wrangham, R. W., J. H. Jones, G. Laden, D. Pilbeam, and N. Conklin-Brittain
1999 The Raw and the Stolen: Cooking and the Ecology of Human Origins. *Current Anthropology* 40:567–594.
Zahavi, A.
1975 Mate Selection: Selection for a Handicap. *Journal of Theoretical Biology* 53:205–214.
Ziker, J. P.
1998 Kinship and Exchange among the Dolgan and Nganasan of Northern Siberia. In *Research in Economic Anthropology,* Vol. 19, B. Isaac, ed. Pp. 191–238. Greenwich, Connecticut: JAI Press.
2002a *Peoples of the Tundra: Northern Siberians in the Post-Communist Transition*. Prospect Heights, Illinois: Waveland Press.
2002b Raw and Cooked in Arctic Siberia: Diet and Consumption Strategies in Socio-Ecological Perspective. *Nutritional Anthropology* 25(2):20–33.
2003a Assigned Territories, Family/Clan/Communal holdings, and Common-Pool Resources in the Taimyr Autonomous Region, Northern Russia. *Human Ecology* 31:331–368.
2003b Kinship and Friendship in the Taimyr Autonomous Region, Northern Russia. *Sozialer Sinn* 2003(1):59–80.
Zuk, Marlene
2002 *Sexual Selections: What We Can and Can't Learn about Sex from Animals*. Berkeley: University of California Press.