Garden Labor Exchange Among the Ye'kwana

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The Ye'kwana Indians of southern Venezuela engage in extensive garden labor exchange. Approximately 40% of a household's labor is committed to gardens owned by other households. Owing to a number of situational constraints inherent in Ye'kwana household organization and garden ownership, individuals are not free to benefit other individuals directly. For example, if an individuals labors in another household's garden he benefits all members of the household who feed from that garden. Knowledge of these constraints led to the formulation and successful testing of a simple inclusive fitness model that predicts that mean relatedness between households is correlated with the intensity and balance in exchange. In addition, it is argued that the Ye'kwana system of garden labor exchange is a form of reciprocity biased by kinship.

KEY WORDS: Labor; Reciprocity; Inclusive fitness; Ye'kwana Indians

INTRODUCTION

This article has a theoretical and descriptive goal. Theoretically I explore the utility of kin selection theory in developing hypotheses concerning patterns of garden labor exchange among the egalitarian Ye'kwana. Sahlins's model of the sociology of primitive exchange (1965) is evaluated and found to be essentially correct if his concept of kinship distance is measured genealogically by the coefficient of relationship (Wright 1929).

The descriptive goal of this article centers around what could be called economic integration. Again, Sahlins (1972) has led the way in this area with his concept of the "domestic mode of production" (DMP). Under the DMP households in egalitarian society are viewed as autonomous, self-sufficient, and not integrated into higher level economic units unless forced to by technical or environmental circumstances. If, through habitual cooperation, for example, economic integration occurs at levels higher than the domestic

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unit, Sahlins maintains (1972, p. 78) economic control is still vested in the domestic unit. Although I feel that Sahlins may be partially correct, two important issues are not addressed in his DMP model. First, anthropologists have made no thorough quantitative investigations of the degree to which households in egalitarian settlements are independent or interdependent. Recent studies of food exchange (Laughlin 1974; Kaplan et al. 1984; Aspelin 1979; Saffirio and Hames, 1983) have shown how utterly dependent domestic units are on one another and in some cases (Kaplan and Hill 1985) domestic autonomy is compromised. Recent research on garden labor exchange (Hawkes 1977; Dove 1985) has more precisely than ever before quantitatively described the patterning of exchange but has not measured its intensity or likely impact on domestic autonomy.

Reciprocity and Kinship

According to Sahlins (1965, pp. 147–148), kinship distance, which is locally or culturally defined, and, to a lesser extent, residential proximity, determine the form of reciprocity: close kinship leads to generalized reciprocity (altruism), distant kinship to balanced reciprocity (tit-for-tat), and lack of kinship relations between exchangers leads to negative reciprocity (theft or cheating). Alexander suggested (1974, 1979) that Sahlins's model of exchange is consistent kin selection theory (Hamilton 1964), which predicts that nepotism is, in large part, a function of genealogical relatedness. That is, holding costs and benefits constant, the more closely related two individuals are, the more likely they will behave altruistically towards one another, or, in Sahlins' parlance, engage in some form of generalized reciprocity. In his reply to Alexander, Sahlins (1978, p. 112) asserted:

> One of the basic objectives of this entire exercise in the ethnography of kinship has been to show that the categories of "near" and "distant" vary independently of consanguineal distance and that these categories organize actual social practice. I have underscored the basic point because sociobiologists, notably Alexander (1974), have taken the equally well known tendency of economic reciprocity to vary in sociability and "kinship distance" as cultural evidence of biological "nepotism," hence as a proof of kin selection. "Lineage" vs. "other lineage," upon which reciprocity is predicated do not correspond to coefficient of relationship, so the evidence cited in support of kin selection (e.g., Sahlins 1965) in fact contradicts it.

Sahlins seems to be suggesting that kinship has nothing to do with genealogical relatedness, a point of view that, to put it mildly, is not shared by all anthropological kinship experts (e.g., Lounsbury 1964; Murdock 1949; Scheffler 1974). The degree of correspondence between cultural concepts of near and distant kin and the coefficient of relationship is a testable proposition, and there is good reason to believe that inclusive fitness theory and knowledge of environmental constraints and opportunities can be used to make predictive models of cultural systems of kinship classification. At the

same time, one must not assume that systems of classification map directly onto behavior. There is mounting evidence (Barth 1966; Chagnon 1982) that individuals manipulate systems of classification toward their own selfish ends. Thus, the system of kinship classification that does emerge may be viewed as modal patterns resultant of cumulative attempts by many individuals within a local context to maximize inclusive fitness.

The notion that humans or any other organism attempt to maximize inclusive fitness through cooperation presupposes the existence of a number of psychological mechanisms designed toward this end (Symons 1979; Daly and Wilson 1983). For example, one must have the ability to discriminate among kin and nonkin, measure costs and benefits, detect cheating, and possess other abilities such as those described by Trivers (1971). Recently, Cosmides and Tooby (in press) have suggested that researchers have taken "a conceptual wrong turn" by applying evolutionary theory directly to overt behavior. Instead, they propose, evolutionary theory should be employed as a "guide for the discovery of innate psychological mechanisms." To some extent this criticism is valid. It rests on the idea that behavior is not what is selected for but rather the ability to generate the behavior under appropriate circumstances. For example, the behavior of a female committing infanticide is not an evolved trait. However, the *ability* to ascertain whether continued investment in an infant would have greater fitness payoff compared to killing the infant so as to provide greater investment in current or future offspring is an evolved trait. Still, I would argue, innate psychological mechanisms are selected for only insofar as they reliably generate behavior that has a net positive effect on fitness. Testing evolutionary hypotheses by naturalistically observing social behavior may sometimes be difficult. Field workers lack the control that psychologists can obtain in laboratory setting. But unless psychological mechanisms become behaviorally visible they will not be affected by the process of natural selection. Field workers are in a position to observe the probable fitness consequences of patterns of behavior. And they can provide insights into the possible psychological mechanisms that underlie behavior.

Some Problems in Formulating an Inclusive Fitness Model

In formulating an inclusive fitness model of Ye'kwana garden labor exchange one cannot blindly predict that since exchange is altruistic there will be a correlation, for example, between exchange frequency and relatedness. To formulate a revealing hypothesis one must have an idea of why exchange occurs, whether other forms of exchange affect labor exchange, and the ability of one individual to specifically favor another. I bring up these issues not so much because I can answer them all but because they commonly affect the patterning of altruism in egalitarian society.

Before an explicit inclusive fitness hypothesis can be formulated it is necessary to identify the problem a putatively altruistic behavior is designed

to overcome. For example, the exchange of meat, so common in Amazonian horticultural societies, may be an attempt to lower variance in meat consumption that results from large game whose capture is uncertain or highly variable through time (Hames 1983; Kaplan and Hill 1985). The adaptive consequence of this behavior is to permit the high protein content of game to be used by the body for tissue growth and maintenance instead of wastefully employing it as a calorie source, particularly in those societies that cultivate low-protein crops (e.g., manioc and plantains) for caloric needs. Garden crops, in contrast, are reliably gained at any time (they are simply harvested) and, as a result, they are rarely exchanged. In this example one would want to only extend meat-sharing partnerships to no more individuals than necessary to reduce variance in game consumption to a dietary optimum.[1] Thus, the adaptive rationale behind exchange can tell us how frequently, how far (i.e., among how many people), and among whom (i.e., kin or nonkin or a mixture of both) sharing should be extended only if one can reliably determine why it should occur in the first place. Altruistic interactions are responses to specific environmental problems, and it is the nature of these problems that partially determines the patterning of altruism. Tests of kin selection theory that fail to deal with this are inadequate (e.g. Hames, 1979a). The adaptive rationale behind Ye'kwana garden labor exchange is considered later.

Kurland (1979) has shown that although ego may be highly disposed to assist a particular alter he may not be able to do so directly. He calls this a "partitioning" problem. I refer to this problem as one of "targeting." In Ye'kwana gardening, for example, one cannot contribute labor to a garden without simultaneously benefiting many individuals. It is an important constraint in Ye'kwana garden labor exchange and is considered later.

Focusing on one kind of altruistic behavior over a short time period (e.g., garden labor exchange during a year) may be misleading. Humans interact in a variety of ways and exchanges between individuals frequently involve two different sorts of behavior. For example, among the Ye'kwana an old man may work in his son's garden and receive game in return. Since reciprocal altruism involves a time delay (Trivers 1971) and inclusive fitness involves a maximization strategy that extends over the entire lifetime of an individual, short-term field research may fail to record either long-term reciprocation or relate variability in exchange strategies to life historical changes of individuals.

Aside from these considerations, reciprocal altruism may interact with nepotism. In nepotism the benefit gained by an altruist is the increased probability that genes held in common with beneficiary will spread in the pop-

[1] It is obvious that variance could be steadily reduced by infinitely increasing the number of game sharing partners, but this would be subject to diminishing returns if the probability of cheating increases because of the difficulties in monitoring the honesty of a large group of reciprocators. It is perhaps because of this that strict rules of sharing (e.g., Netsilik seal-sharing partnerships described in Balikci 1970, p. 133*ff*) and associated sanctions have evolved in many hunting societies (see also Trivers 1980, pp. 62–64).

ulation while in reciprocal altruism the benefit gained by the altruist is an increased probability of being assisted by the beneficiary in the future. Among the Ye'kwana, as I later argue, garden labor exchange falls between the ends of this continuum.

Other factors that affect the formulation of an inclusive fitness model, such as reproductive value, reproductive variance, differential need, or ability to parlay investment, could be mentioned. I detailed some of the above factors because I can deal with them and to argue that inclusive fitness models cannot be applied without a clear understanding of local conditions and constraints.

THE YE'KWANA

There are approximately 1600 Carib-speaking Ye'kwana inhabiting the Venezuelan Federal Territory of Amazonas spread out over an area of 30,000 square kilometers in about 30 villages. These villages range in size from 7 to 193 people, with a modal population of 50. Villages are principally located on the banks of the major tributaries of the Upper Orinoco such as the Cunucunuma, Ventuari, Padamo, and Caura (Arvelo-Jimenez 1971). Research took place in the Ye'kwana village of Toki located on the lower middle portion of the Padamo River. This river basin serves as a frontier separating the southwesterly most extent of the Yanomamö population and the southeasterly most extent of the Ye'kwana population. On the Padamo there are 8 Yanomamo and 3 Ye'kwana villages within 1-day's motorized canoe trip from Toki.

The village of Toki contains 88 full-time Ye'kwana residents and 18 Yanomamö who are more or less fully integrated into various Ye'kwana households. Within the village, but occupying three separate houses (two of which are inside the village confines while the other is 10 minutes away) is the Yanomamö village of Toropo-teri, with a combined population of 35 full-time residents. Despite the close proximity of the Ye'kwana and Yanomamö, there is very little economic interaction between them, and the Yanomamö obtain nearly all of their industrial goods from the Salesian Mission at Ocamo.[2]

Nuclear and joint households are the most important social and economic groupings in a Ye'kwana village. They are the basic units of production, exchange, and consumption, and these two different household forms crystallize in the course of a basic domestic cycle. Joint households consist

[2] This situation is quite different from those reported by Arvelo-Jimenez (1971) on Ye'kwana and Yanomamö relations in the Ventuari and Cunucunuma, where Yanomamö clear fields, maintain villages, bury dead, carry heavy loads, and do other difficult tasks for the Ye'kwana. Perhaps the closeness of the Salesian Missions in the area, which allows the Yanomamö to gain trade goods cheaply, prevents the Yanomamö of the Padamo from being used as a labor force by the Ye'kwana.

of a senior founding couple, their subadult children, and one or more junior nuclear families of matrilocally married daughters. A joint household grows as the daughters of the senior couple marry, form junior families, and produce offspring. When the daughters of junior families marry and bring in husbands they and their parents hive-off from the joint family and found a new joint family of their own. Frequently, a junior family will separate from a joint family and form an independent nuclear household if a patrilocal marriage occurs or if the joint family consists of more than two junior families. Ties between the new nuclear household and the old joint household initially are strong but dissipate when the nuclear household later becomes a joint household. Death of the senior couple also leads to the dissolution of a joint household and formation of new nuclear households. In Toki there are three joint households and five nuclear households.

Structurally and functionally the economy exists at three different levels in a Ye'kwana village. The first level is that of the household, which may be a joint family or an independent nuclear family. A nuclear family, whether it is part of a joint household or an independent nuclear household, has its own gardens and hearth. Ideally, each should be able to feed and support its members independently. However, in joint households there is so much sharing of labor, gardens, food, and meals that the nuclear families that comprise it must be considered a dependent part of a single economic entity within itself and is viewed as such by other such entities. At the next level, groups of households are organized into help circles (*wewätänä*). These households, more frequently than other such groups, exchange labor and resources and are commonly united by close kinship bonds. In Toki there are three such groupings, with one composed of two independent nuclear households, another of two joint households, and the last of one joint household and three nuclear households. The last level of the economy is that of the village itself and is manifested when labor and resources are pooled to provide feasts for visiting villages or the construction of a communal ritual house.

The Ye'kwana subsistence economy is based on shifting cultivation, hunting, fishing, and gathering—the typical Amazonian pattern. Between 75% and 80% of all calories consumed are produced in gardens planted in manioc, plantains, and root crops, whereas hunting and fishing supply 75%–80% of the protein (Chagnon and Hames 1979; Hames 1979b). Some crops are sold or traded to the Salesian Missions in the area and, to a lesser extent, to the criollo population in the distant government cities of San Fernando de Atabapo and Puerto Ayacucho in exchange for industrial goods.

DATA COLLECTION

The data used here were gained through a behavioral sampling technique known as instantaneous scan sampling [see Altmann (1974) for a description

of this and other techniques] that is used frequently in primatological research [Dunbar (1975) and various contributors in Clutton-Brock and Harvey (1977)] and now ever more frequently in ethnography [Johnson (1975); see Gross (1985) and Borgerhoff Mulder and Caro (1985) for reviews of ethnographic applications]. Since my use of it has been detailed elsewhere (Hames 1979a) I only outline it here. I made sweeps through the village, at random hours of the day, and recorded the activity and location of all individuals the moment they were encountered. An attempt was made to gain a 100% sample of the village population during each sweep. If I was not able to observe an individual (e.g., because he was outside of the village gardening, hunting, fishing, or gathering) I inquired as to where he was, what he was doing, and whom he was with. For each individual encountered during a sweep the following information was recorded: (1) ego identification number; (2) date; (3) 24-hour clock time; (4) location; (5) activity; and (6) ego identification number of interactant(s)—if applicable.[3] Sampling was done for 216 days during an 11-month period, yielding approximately 27,000 records.

All gardens were measured, associated with the female owner (who was always a nuclear family head), and were given an identification code that was used in the location value in the scan sample. Twelve females were garden owners, with a total of 25 gardens. Seven of these females were nuclear family heads in one of the three joint households of Toki while the other five belonged to independent nuclear families. Once back from the field a computer program was devised to determine how frequently each individual and each household labored in all gardens. Finally, a computer program developed under the direction of Napoleon Chagnon (Chagnon and Bryant 1984) was used to calculate relatedness between all individuals and between the eight households.

RESULTS

Division of Labor and Organization of Work Groups

The division and organization of garden labor varies considerably between males and females. As Table 1 indicates, males are solely responsible for slashing and felling. Although both sexes engage in all other activities, such

[3] In the field, direct recording of interacting egos in variable 6 proved difficult, time consuming, and prone to recording errors in transcription. To cure this problem the following convention was observed during data processing: if two or more egos had the same date, time, location, and activity variable values then the computer was instructed to score interaction. In the field when I observed three individuals, for example, engaged in the same activity at the same time and place but only two of them were interacting while the third was not, I advanced the noninteractant's time variable value by 1 minute; thus the interacting dyad had the same date, time location, and activity while the noninteractant had an identical set of variable values except for the time variable value. Finally, it is obvious that some interactions were not symmetrical (e.g., a mother nursing her child) and these were handled differently from the above.

Table 1. Daily Agricultural Labor

Age Group[a]	Slash	Fell	Garden Activity Weed/Burn	Plant	Weed	Harvest	Total
Males: Minutes per day							
4–6 (4)	0	0	0	0	0	3.9	3.85
7–11 (7)	0	0	0	2.3	0	5.8	8.10
12–16 (4)	0	0	0	1.3	0	1.9	3.13
17–23 (6)	10.3	17.5	5.3	9.8	2.8	10.2	56.00
24–37 (6)	18.8	22.5	12.8	6.3	4.1	9.6	74.05
38–50 (3)	9.0	4.8	0	12.9	5.0	1.7	33.33
51+ (1)	0	0	0	38.6	45.4	30.2	114.2
Females: Minutes per day							
4–6 (5)	0	0	0	1.5	6.8	6.7	15.0
7–11 (65)	0	0	0	6.5	21.6	21.9	50.0
12–16 (6)	0	0	4.8	19.5	60.1	55.0	139.4
17–23 (7)	0	0	3.1	25.7	55.6	58.1	142.5
24–37 (5)	0	0	7.8	19.3	27.6	37.0	92.7
38–50 (6)	0	0	3.6	27.6	63.1	63.4	157.8
51+ (3)	0	0	19.0	2.4	21.9	16.5	59.8

[a] Figures in parentheses indicate number of individuals in age group.

activities are dominated by females. Husbands and wives cooperate in determining the site and size of a new garden, with the wife having the major deciding role. After a new site has been selected and a path blazed around it perimeter, to demarcate its extent, the work of slashing the undergrowth, felling trees, and burning the resulting debris is done entirely by men.[4] After clearing and burning females do most of the planting, weeding, and harvesting. Men engage in these distaff activities only at the request of their wives, usually when they feel especially pressed to complete one of these tasks. An exception to this pattern is found in the garden activities of the only male over 50 years of age: his garden activities are similar to that of a woman, as he is incapable of heavy work. Table 1 gives the age and sex breakdown of garden labor in terms minutes per day spent in each activity.

Compared to female cooperative work groups, the organization of male work groups is more formal, complex, and limited. Just prior to the dry season (November) the headman (*kahichana*) and his deputy (*ekune*) call a meeting of all male household heads (women can and do attend, albeit in limited numbers) so that each can announce publicly if he will make a garden and, if so, the number, size, and location. Then the headman, in concert with the assembled, decides the order in which all gardens will be cooperatively cleared. Before each day of cooperative clearing (in which all men are expected to participate) men are called together by the sound of drums, flutes, and conch shells and travel to the garden together while singing and

[4] The work category "burn/weed" in Table 1 indicates that women participate in this type of work. However, they do none of the burning but may weed several weeks after the garden is burned. This only occurs in gardens burned from secondary forest when the burn has failed to kill secondary forest weed seeds which sprout in dismaying profusion after burning (Hames 1983).

Table 2. Garden Labor Exchange by Age–Sex Group: Percent Time Observed to Work in "Own" Family Garden Compared to "Other" Family Garden

Age–Sex	Males			Females		
	N	Own	Other	*N*	Own	Other
7–16	—	—	—	10	70%	30%
17–37	7	45%	55%	9	70%	30%
38–50	2	35%	65%	7	78%	22%
51+	1	87%	13%	—	—	—
Mean		52%	48%		74%	26%

playing musical instruments. Clearing is competitive, with each individual and/or team of workers commenting on the ability and progress of themselves compared to others. The work is continuous until midday when women suddenly appear with cassava cakes and cassava gruel (*sukutäkä*) to feed the men. The woman whose garden is being cleared is in charge of supplying the food and organizing other women to help her bring it to the men.

For women, the organization of cooperative garden labor is much less formal and sizable, although its frequency is much greater.[5] Women form partnerships that are usually dyadic (commonly, sisters or sister-in-law/mother-in-law) in order to travel together to one or the other's garden to weed, plant, or harvest. Occasionally, a woman will send an able daughter to aid a partner in some task without coming herself, but usually a daughter accompanies her mother to a partner's garden. A man, unless he is a brother of a woman, will never accompany another woman in order to work in her garden unless he is accompanied by his own wife.

Patterns in the Allocation of Garden Labor Exchange

Although males spend much less time gardening than do females (Table 1), they allocate 48% of their garden labor to gardens other than their own, compared to 26% for females (Table 2). This difference is largely due to the fact that males are required to clear gardens in teams that incorporate all the able-bodied males in the village (even those males from households that do not plan to make new gardens). However, if we exclude clearing labor then men allocate but 8% of their labor to gardens other than their own. Compared to males, females spend proportionately less time working in gardens other than their own. In absolute terms, however, they spend 38% more time than males working in gardens other than their own. The absolute difference in time working in gardens other than one's own for females is a result of a division of labor in which women do 83% of the total labor (Table 1).

For both males and females there is no significant difference by age in

[5] Observations and informant data from members of the two more traditional up-river villages indicate that the women there are much more formal in the organization of cooperative work parties and such parties are larger and more frequent than in Toki.

the amount of garden labor exchange: young and old of the same sex allocate approximately the same proportion of time to their own and to other gardens (Table 2).This lack of proportional difference between subadults, young adults, and mature adults is interesting because it suggests that from an early age children socially learn to give and accept help from others who are outside of their households. This may be an important proximate cause of garden labor exchange among the Ye'kwana.

Returning to the issue raised by Sahlins about the autonomy of households and the lack of settlement-wide economic integration one is hard put to accept this proposition because females expend 26% of their total garden labor for others and males expend an even greater level—48%. If we convert the above-mentioned values to hours per year[6] the point is even more apparent; females spend 268 hours per year working in gardens other than their own and males 176 hours. The magnitude of these figures is ample evidence for economic integration above the level of the household. It should be noted that only one economic activity, gardening, is considered. Other economic activities such as hunting, house construction, fishing, and the like are also cooperative.

Tables 3A–3F depict the frequency of exchange between all households for each garden task and all garden tasks combined. The rows show the frequency at which each household was observed to give labor to itself and each other household; the columns indicate the amount of labor gained by a household from itself and from all other households. Casual inspection of the cells in these tables reveal that, depending on garden task, there is a great deal of variation in the amount of labor a household may give or receive from other households. In a number of instances there is no exchange between certain households for some gardening activities, for example, clearing (Table 3A) or burn/weed (Table 3B). However, in no case is there a lack of some exchange between any two households when all garden tasks are considered.

Column marginal percentages for the tables show how much labor a household invested in its own gardens ("To Own") compared with how much was received from other households ("From Others"); row marginals percentages summarize how much a household invested in its own gardens ("Own") compared to how much it invested in other gardens ("Other"). When all garden tasks are combined (Table 3F) we surprisingly find that only three of eight households allocated proportionally more labor to their own gardens compared to the labor they allocated to other household gardens. (It should be noted that lowest allocation to one's own garden was 44% and that three were nearly 50%.) The findings here at the interhousehold

[6] Observation frequencies were converted to hours by the following method. All observations were made between 0700 and 2000 hours, yielding a total of 780 minutes of observation per day. The percentage of gardening observations gardening was then multiplied by 780 minutes to gain average minutes per day spent gardening. This product was multiplied by 365 days to arrive at the total number of hours per year spent gardening.

Table 3. Frequency of Exchange for Individual Garden Tasks and All Tasks Combined

A. Clearing

	Other										
Own	1	2	3	4	5	6	7	8	Total	Gave to Own (%)	Gave to Other (%)
1	0	0	0	1	7	1	1	8	10	0.0	100.0
2	0	0	0	0	3	1	3	0	7	0.0	100.0
3	0	0	0	1	4	0	0	0	5	0.0	100.0
4	0	0	1	8	12	4	3	5	34	23.5	76.5
5	0	0	0	5	17	4	5	3	34	50.0	50.0
6	0	0	0	0	3	5	2	3	13	38.5	61.5
7	0	0	0	9	11	9	12	11	52	23.1	76.9
8	0	0	0	1	1	4	1	4	11	46.5	64.6
Total	0	0	1	25	59	28	27	26	166		
Gave to own (%)	0	0	0	32	29	18	44	15			
Received from other	0	0	100	68	71	82	55	85			

B. Burn/Weed

	Other										
Own	1	2	3	4	5	6	7	8	Total	Gave to Own (%)	Gave to Other (%)
1	0	0	0	0	0	0	0	0	0	0.0	0.0
2	0	0	0	0	0	0	0	0	0	0.0	0.0
3	0	0	0	1	0	0	0	0	1	100.0	0.0
4	0	0	0	9	0	0	0	0	9	100.0	0.0
5	0	0	0	0	0	0	0	0	0	0.0	0.0
6	0	0	0	0	0	34	0	0	34	100.0	0.0
7	0	0	0	0	0	3	100	0	103	97.9	2.9
8	0	0	0	0	0	0	0	0	0	0.0	0.0
Total	0	0	0	10	0	37	100	0	147		
Gave to own (%)	0	0	0	90	0	92	100	0			
Received from other (%)	0	0	0	10	0	8	0	0			

C. Planting

	Other										
Own	1	2	3	4	5	6	7	8	Row Total	Gave to Own (%)	Gave to Other (%)
1	2	0	0	0	2	0	0	0	4	50.0	50.0
2	0	22	0	0	7	7	0	0	36	61.1	38.9
3	0	0	0	9	3	3	0	0	15	0.0	100.0
4	0	1	0	75	3	7	0	0	86	87.2	12.8
5	0	0	0	2	25	4	2	0	33	75.8	24.2
6	0	0	0	0	16	8	0	0	24	33.3	66.7
7	0	0	0	2	19	0	17	0	38	44.7	55.3
8	0	0	0	4	45	2	0	7	58	12.1	87.9
Total	2	23	0	92	120	31	19	7	294		
Gave to own (%)	100	96	0	82	21	26	89	100			
Received from other (%)	0	4	0	18	79	47	11	0			

Table 3. *(Continued)*

D. Weeding

Own	Other 1	2	3	4	5	6	7	8	Row Total	Gave to Own (%)	Gave to Other (%)
1	64	2	0	5	0	0	0	0	71	90.0	9.9
2	15	88	0	6	0	0	0	0	109	80.7	19.3
3	0	1	28	5	0	1	0	1	36	77.8	22.2
4	1	5	21	91	2	0	0	0	120	75.8	24.2
5	1	1	1	8	28	0	1	2	42	66.7	33.3
6	3	1	0	2	2	14	0	7	29	48.3	51.7
7	0	0	0	6	5	1	19	6	37	51.4	48.6
8	0	0	0	0	10	1	0	22	33	66.7	33.3
Total	84	98	50	123	47	17	20	38	477		
Gave to own (%)	76	90	56	74	60	82	95	58			
Received from other (%)	24	10	44	26	40	18	5	42			

E. Harvesting

Own	Other 1	2	3	4	5	6	7	8	Row Total	Gave to Own (%)	Gave to Other (%)
1	22	5	2	0	0	0	0	0	29	75.9	24.1
2	2	67	3	0	0	0	0	3	75	89.3	10.7
3	0	7	10	8	0	0	0	0	25	40.0	60.0
4	0	17	18	101	0	0	0	4	140	72.1	27.9
5	0	13	2	5	7	0	0	39	66	10.7	89.4
6	3	2	3	0	4	17	0	32	61	27.9	72.0
7	0	6	2	8	14	0	11	54	95	11.6	88.4
8	3	2	1	0	17	1	5	64	93	68.8	31.2
Total	30	119	41	122	42	18	16	196	584		
Gave to own (%)	73	44	76	17	84	6	31	77			

F. All Gardening

Own	Other 1	2	3	4	5	6	7	8	Row Total	Gave to Own (%)	Gave to Other (%)
1	88	7	2	6	9	1	1	0	114	77.2	22.8
2	17	177	8	6	10	8	3	3	227	78.0	22.0
3	0	8	38	24	7	4	0	1	82	46.3	53.7
4	2	23	40	284	17	11	3	9	389	73.0	27.0
5	1	14	3	20	77	8	8	44	175	44.0	56.0
6	6	3	3	2	25	78	2	42	161	48.4	51.6
7	0	6	2	25	49	13	159	71	325	48.9	51.1
8	3	2	1	5	73	8	6	97	195	49.7	50.3
Total	117	240	92	372	267	131	182	267	1668		
Gave to own (%)	75	74	41	76	28	60	87	36			
Received from other (%)	25	26	59	24	72	40	13	64			

Table 4. Summary of Garden Labor Exchanges Between All Households

Activity	Own		Other		Total	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Clearing	46	28	120	72	166	100
Burn/Weed	143	97	4	8	147	100
Planting	156	53	138	47	294	100
Weeding	354	74	123	26	477	100
Harvesting	299	51	285	49	584	100
Total	998	60	670	40	1668	100

level essentially bear out the findings expressed in Table 2 on age–sex variation in working in "Own" versus "Others" gardens.

The degree to which labor is invested in gardens other than one's own seems to be determined by garden task. Clearing labor (Table 4) is the most cooperative (72% of it was exchange labor) since all men are required to help each other in turn to clear gardens but not all men made gardens. The extreme imbalances between households in this kind of exchange will probably be balanced in the following year when those who made large gardens make no gardens and those who made small or no gardens make gardens. The burn/weed labor category is the least cooperative of all activities; only 3% of the labor is exchange labor. Because it is necessary to plant crops very soon after gardens are burned most individuals who had made successful burns (six of eight) allocated their labor to planting and may not have had the time to aid those who had to weed immediately after poor burns. It is infrequent that one must weed intensively after a burn, but when this does occur a household must literally live in its garden (in a garden house) and devote nearly all of its labor to weeding to get crops planted on time. But household #7, which accounted for 70% of the village's burn/weed labor, had relatives from another village, who happened to be visiting at the time, aid them in this task (the visitor's figures are not included in the table).

Balance in Garden Labor Exchange

The concept of balance has figured importantly in the study of patterns of exchange or reciprocity in egalitarian society (Mauss 1925; Malinowski 1922; Herskovits 1940; Sahlins 1965). Balance in exchange may be defined as the difference between what is given and what is received. This definition of balance is extremely useful and the data in Table 3F can be employed to measure the degree of balance in garden labor exchange between Ye'kwana households in two different ways: *general* and *specific* balance.

General balance may be defined as the degree from which the absolute difference (positive or negative) between what one gives and what one receives diverges from zero. The resulting value indicates the degree of balance, beginning with zero, or perfect balance, to higher values, which indicate progressive degrees of imbalance. Although this measure is more or

Table 5. General Balance in Gardening Between Households

Own \ Other	1	2	3	4	5	6	7	8
1	0	10	2	4	8	5	1	3
2		0	5	17	4	5	3	1
3			0	16	4	1	2	0
4				0	3	9	22	4
5					0	17	41	29
6						0	11	36
7							0	65
8								0

less an operationalization of Sahlins's concept of balance it says nothing about the direction of the balance. Specific balance may be defined as the amount given minus the amount received, and this difference may take on a positive or negative value. A positive value indicates that a household is giving more than it is receiving, a negative value indicates that it is receiving more than it is giving, and a value of zero indicates perfect balance. Thus, the direction of imbalance between exchanging household dyads is indicated.

Table 5 indicates that of the 28 unique household dyads in Toki only one (8 × 3) is in perfect exchange balance (cell value of zero), and 13 other dyads come very close to balance, with cell values ranging from 1 to 5. All other dyads have values ranging from 8 to a high of 65, with 9 of those dyads being extremely imbalanced, with values of more than 15.

Table 6, by showing specific balance in exchange, allows one to determine the direction of balance between households. In addition, the row and column totals show this relation from the perspective of each household to the village as a whole. A positive value in a household's row cells indicates that that household has given, to the value indicated, more than it has received from another household whereas a negative value shows that it has received more than it has given. The column cells for each household have the same value as the row cells except that the positive or negative sign is reversed, that is, the columns chart specific balance from the perspective of what was contributed to its gardens from members of other households.

Table 6. Specific Balance in Gardening Between Households

Own \ Other	1	2	3	4	5	6	7	8	Row Total
1	0	−10	+2	+4	+8	+5	+1	−3	+ 7
2	+10	0	−5	−17	−4	+5	−3	−1	− 15
3	−2	+5	0	−16	+4	+1	−2	0	0 10
4	−4	+17	+16	0	−3	+9	−22	+4	+ 17
5	−8	+4	−4	+3	0	−17	−41	−29	− 92
6	−5	−5	−1	−9	+17	0	−11	+36	+ 22
7	−1	+3	+2	+22	−41	+11	0	+65	+143
8	+3	+1	0	−4	+29	−36	−65	0	− 72
Column Total	−7	+15	+10	−17	+92	−22	−143	+72	

Table 7. Intensity of Garden Labor Exchange Between Households

Own \ Other	1	2	3	4	5	6	7	8
1	0	24	2	8	10	7	1	3
2		0	11	29	24	11	9	5
3			0	64	10	7	2	2
4				0	37	13	28	14
5					0	33	57	117
6						0	13	50
7							0	77
8								

The row totals, as well as the column totals, allow one to determine the total balance of an individual household in relation to the entire village. Households 5, 7, and 8 are rather striking in their degree of exchange imbalance: household 7 gave a whopping 143 more units of labor than it received while households 5 and 8, respectively, received 92 and 72 more units of labor than they gave.

By folding the matrix in Table 3F along the diagonal and pooling the corresponding cells for each household dyad one can obtain a measure of the intensity of exchange between households. This is a measure of the total amount of labor exchanged between households. As is indicated by the exchange intensities given in Table 7, the range is relatively large—from 1 to 117, with a mean of 24.

The Adaptiveness of Exchange and the Problem of Targeting

As mentioned previously, any evolutionary model of the distribution of altruistic acts must first attempt to clarify the nature of the selective forces that make altruism an adaptive response to a particular environmental problem. In regards to the Ye'kwana I must account for why garden labor exchange occurs. Then I must determine whether an individual can directly target his assistance to another individual.

In developing a model of the appearance and disappearance of cooperative agricultural labor in peasant societies, Erasmus (1957) suggested that cooperation occurs only when it is in the net advantage of individuals to participate in such arrangements. Erasmus identifies two conditions that make cooperation individually advantageous: (1) the operation of an economy of scale whereby individual efficiency of work is greater in a group than if done outside a group; and (2) the occurrence of peak labor loads that seasonally outstrip the labor capacity of individuals or households. [Additionally, Smith (1981) gives many examples of economies of scale in hunting and gathering societies.] Unfortunately, while in the field I did not pay enough attention to the factors that could account for cooperative labor among the Ye'kwana; my main concern was to document its intensity and patterning. Nevertheless, I think it important to attempt to provisionally

identify and/or reject the possible environmental forces that lead to cooperation.

The tasks of burn/weed, planting, weeding, and harvesting are highly individualized, lacking any close interaction among individuals working the same garden. It is probable that the rate of individual work accomplished is independent of the number of people working in a garden. The task of clearing consists of two phases. The first is commonly called slashing and consists of cutting undergrowth with a machete. During this phase men work separately with no close coordination. The second phase, felling, requires the hewing of massive forest hardwoods with axes, a complex and difficult task. Whenever possible, driving tree falls are used to open huge gaps in the forest. Setting up a tree fall requires considerable coordination among workers. A giant key tree is carefully selected to begin the fall and felling it frequently requires the construction of a scaffold to lift axmen above its spreading basal butress. The lesser trees in the key tree's path must be partially chopped to ensure a domino-like fall. These felling activities involve a great deal of coordination, with men deployed in teams. For these reasons I feel that an economy of scale is at work in felling but not in slashing, burn/weed, planting, weeding, or harvesting.

The tasks of planting, weeding, and harvesting do not seem to be associated with peak labor loads that could outstrip labor resources of families. These tasks are distributed relatively evenly throughout the year and do not correspond to seasonal climatic change. Crops are harvested when the household runs low on food and weeding occurs as needed. There is a peak of planting soon after gardens are burned, but most planting is distributed evenly throughout the year annd frequently occurs in conjunction with harvesting. Weeding immediately after a burn (Table 3B) is an activity that may easily outstrip the labor resources of a family. As mentioned previously, this activity is uncommon but forces a family to allocate a tremendous amount of labor over a short period time to ensure that crops are planted at an optimal time and to prevent the garden from being permanently choked with weeds. Ironically, this is the least cooperative of all garden tasks, comprising only 4% of all exchange labor. Lack of cooperation in this activity is perhaps explicable by the fact that the family that had the greatest burden in this task (70% of the village's total) happened to have kin from another village visiting them at the time and these kin were enlisted to help weed. In summary, it appears that an economy of scale can account for cooperation in the felling stage of clearing and that peak labor loads can account for cooperation in burn/weed (although assistance came from outside the settlement) but neither can count for cooperation in weeding, harvesting, and planting, which make up the bulk of cooperative activities.

All economic activities are subject to some degree of risk of failure and garden labor exchange may be an adaptation to this problem. Lizot (1974) describes garden failures among recently contacted Yanomamö located about 120 kilometers southwest of the Ye'kwana of Toki on the Upper Siapa

River. There, gardens were planted immediately after burning, but the dry season over extended itself, leaving newly planted plantain ratoons stunted and dying. These Yanomamö were forced to rely heavily on hunting and gathering, while replanting with a quickly maturing alternative cultigens (e.g., maize), and suffered heavy privation as a result. Settlement pattern history collected on the Ye'kwana also attests to the problem of garden failure (Hames 1978, 1983). In about 1955 the people of Toki were forced to abandon the village site of Wadi'ña on the Cunucunuma River several months after their arrival because the village's communal garden failed completely because of "poisoned soil." All were forced to move to the village of Kwashihii'ña (where they had many relatives) and live off their hosts's gardens. In 1969 they were forced out of the village of Shanama'ña (about 5 kilometers upstream from their present village) because of chronic flooding of gardens [see Hames (1978, pp. 21–22) for a fuller account]. Other accounts of Ye'kwana garden failure are found in Gheerbrandt (1954, pp. 222–224), Arvelo-Jimenez (1971), and, especially, Frechione (1982). In part, the Ye'kwana protect against garden failure by overplanting by about 55% beyond household subsistence needs (Hames 1983). In addition, they maintain a large inventory of alternative staple crops and many varieties of these staples (Hames 1983). In a sense, the Ye'kwana appear to be following Sheldon's law of tolerance by adapting to environmental extremes (e.g., flooding, delay of rain, and variable soil characteristics). However, overplanting requires an increased labor expenditure, a point to which I return later.

Ye'kwana women are very cognizant of the amount of labor they contribute to gardens other than their own. In fact, they are able to point out clearly defined areas in a neighbor's garden where they did the planting, and sometimes refer to the crops as their crops. In daily conversation they sometimes remark about the kinds of weeds found in neighbor's gardens and how thick or thin they were and how difficult or easy the soil was to work. These facts—environmental problems, overplanting, maintenance of a diverse crop inventory, remembrance of crops planted in other's gardens, and cognizance of work done and received—lead me to suspect that garden labor exchange is a mechanism to reduce the riskness of gardening by establishing prior claims to the harvest of other's gardens should one's own fail. It should be obvious that the above facts do not provide much in the way of empirical evidence for a strategy of risk reduction. What would be needed is evidence on the frequency of individual garden failure and how this failure was compensated for by gaining permission to harvest from gardens belonging to other households.

If the extension of assistance to other households in the tasks of planting, weeding, and harvesting is a way to provide subsistence insurance in the face of an unpredictable environment then assistance should be extended to no more households than necessary to reduce risk to a tolerable level. The frequency and intensity of failure in gardening should be correlated positively with the number and intensity of cooperative relationships between house-

holds. If one's gardens do fail it is more likely than not that a single neighbor's garden would not provide enough to get by a period of deficit. This would lead to the development of fairly widespread exchange relationships and a tendency to bias this relationship towards kin. Kin would be chosen for the most intense relationships because they have the most to gain (in terms of inclusive fitness) by giving assistance to a failed household and the most to lose by not assisting. The model I am developing here predicts that close kin should receive fairly heavy assistance but that assistance should also be extended to distant kin and even unrelated individuals in villages such as Toki where there are only eight households.

Cooperation in clearing appears to be based on the advantages of an economy of scale. In this situation individuals should be ready to assist anyone who would return the favor. Obviously, kin would have the least motivation to cheat and the most to gain by returning assistance. But given the large labor requirements for coordinating driving tree falls, all able-bodied men in the village may have to participate. The practice of making this activity very public and formal (the rituals and meetings associated with it, described previously) seems to be a cultural mechanism to ensure that reciprocation to those who helped clear (but did not make new gardens of their own) occurs when they make gardens in the following year. Cooperation in clearing should be largely independent of relatedness and can be characterized as reciprocal altruism.

Finally, gaining assistance from individuals who live in other villages should be mentioned. Previously, I described how one household was able to gain assistance in burn/weed from kin who happened to be visiting at the time. This phenomenon was also observed when the men of Toki were engaged in communal clearing of gardens. About 15 people from the neighboring village of Kwashihii'ña (the same village that had given the people of Toki refuge when their gardens failed completely at Wai'ña) passed by Toki as they were returning home from a trading trip. For about a week the men of Kwashihii'ña helped the Tokians clear (Hames 1978, pp. 280–281). This practice may be a way to ensure that assistance would be offered should one village's gardens entirely fail. It is akin to paying a premium on an insurance policy.

A simplifying assumption in kin selection theory is that individuals can directly target or partition their benefits to specific others (see especially Kurland, 1979 for a discussion of this problem). That is, an individual is able to behave in ways to affect only the fitness of a specific individual or a subset of individuals in a group. In the case of garden labor exchange and most other forms of exchange, such as meat exchange, meal sharing, and cooperative house construction, this assumption does not hold. In gardening, *all* individuals in a receiving household benefit from productive improvements made on their gardens (since they all gain food from it). Furthermore, all individuals in the aid-giver's household incur a cost when an aid-giver allocates time to a garden belonging to another household. This cost may

be either an increased labor cost to them or a deterioration of the condition of their garden. This picture is made more complex due to power differentials within households (based on age and sex differences and kinship ties). For example, mothers induce their daughters to labor in the gardens of other households by either requesting that they accompany another woman to her garden or accompany themselves when they labor in another woman's garden [see Alexander (1974) and his discussion of parental manipulation].

Therefore, when a Ye'kwana makes a decision to assist he cannot simply evaluate the relatedness between himself and another individual. Instead, he must choose among a series of households and consider how entire households are related to him. Just as he cannot target his assistance to a specific individual he cannot correspondingly evaluate his relatedness to a particular individual.

There are two possible ways in which an individual could evaluate his relatedness to other households. First, an individual could rank each household, including his own, according to the average degree of relatedness each shares with him. This method is most appropriate when a nepotist is free to distribute his assistance to any household he desires. However, as I noted, not all individuals are unconstrained in the distribution of their assistance. Second, an individual could measure the average degree of relatedness between households. This measure is appropriate when individuals are strongly constrained in their decisions to allocate assistance by members of their own household. Due to the control older household members have over younger members, and mother and father-in-laws have over son and daughter-in-laws (especially those who were born in different villages and have no or few kin in Toki) this second solution best mirrors the compromises and constraints on nepotism.

There are three things that should be noted about these constraints as they are determined by power differentials. First, if a mother induces her daughter to work in gardens of the mother's choosing, some of the time the household garden chosen would be the one chosen by the daughter if she were free to choose. This is because a daughter will always be related to a household that her mother is related to, although the degree of relatedness will differ. A conflict of interest can develop when certain households are differentially valuable to high degrees for mother and daughter. Second, it might be in a mother's interest to value a daughter's relatedness to another household over her own because she will increase the fitness of individuals in that household who are close kin to her daughter and therefore are actual or potential altruists for her daughter. In other words, a mother can ensure that in the future her offspring are surrounded by a large circle of kin. Finally, and most importantly, an individual who is deciding how to allocate his assistance must consider how others in his household are related to households he assists. If his household's garden were to fail, then a household to which he is closely related would only give aid if it were in their net benefit to do so. Since an aid-giving household cannot target its altruism to specific

Table 8. Mean Relatedness Between Toki Households

	Household							
	1	2	3	4	5	6	7	8
1	—	0.0156	0	0	0	0	0	0
2		—	0.0963	0.0927	0	0	0	0
3			—	0.1796	0.0468	0.0468	0.0950	0.0234
4				—	0.0468	0.0468	0.0959	0.0546
5					—	0.1250	0.1150	0.1875
6						—	0.1250	0.1875
7							—	0.1875
8								—

individuals in a needy household it must consider how it is related to the total household. And, of course, there may be strong differences of opinion in the aid-giving household based on individual differences in relatedness to the needy household. Of the two ways of measuring relatedness I feel that the second, "household-to-household," is a better mirror of ethnographic reality than the first, "individual-to-household."

Relatedness and Exchange

If genealogical kinship is a significant determinant of garden labor exchange then there should be a positive correlation between household-to-household relatedness and the intensity of exchange and exchange balance. That is, closely related households should more frequently exchange labor and allow their exchange balances to be more imbalanced than households that are more distantly related.

Household-to-household relatedness was measured by determining the proportion of genes shared (by immediate descent) between each pair of individuals in paired households, summing the relatedness of all pairs, and dividing by number of pairs compared.[7] There were a total of 28 unique household dyads and their relatedness is displayed in Table 8. Table 9, the proportional intensity of exchange, is derived directly from Table 7 and represents the percentage of labor (outside its own household) each household allocated to all other households (but not including labor allocated to itself). Percentages are used instead of the raw figures in Table 7 because households range in size from 5 to 13 people. Thus, percentages more accurately reflect the degree to which households are committing their labor resources to other households. When all households are correlated together (a total of 56 paired data points) the correlation coefficient (Pearson's) is $r = 0.56$ and it is highly significant at $p = 0.001$. If one examines households in isolation to see how each distributes its labor to the seven other households in the village, the correlations are highly variable, ranging from $r = -0.24$ to 0.81, with five of eight achieving statistical significance (Table 10). Al-

[7] Relatedness is calculated for adults only.

Table 9. Proportional Intensity of Exchange

	Household								
	1	2	3	4	5	6	7	8	Total (%)
1	—	27	7	23	35	4	4	0	100
2	34	—	6	12	20	16	6	6	100
3	0	8	—	55	16	9	0	2	100
4	2	22	38	—	16	10	3	9	100
5	1	14	3	20	—	8	8	45	100
6	7	4	4	2	30	—	2	51	100
7	0	4	1	15	30	8	—	43	100
8	3	2	1	5	74	8	6	—	100

though the overall results are good, it is troubling that for three households kinship is not a significant determinant of exchange intensity: this problem is dealt with shortly.

The correlation between relatedness and balance in exchange is a more rigorous test of an inclusive fitness hypothesis because it measures the degree to which nonreciprocation occurs. In Table 5, balance has been defined as the difference between what one household gave to another compared to what it received from the other. A value of zero indicates perfect balance (each household gave as much as it received from the other) and anything other than zero (ignoring the sign, or direction of imbalance) indicates varying degrees of imbalance. The correlation coefficient for all household for this relationship is $r = 0.76$ ($p < 0.001$). If one looks at households in isolation to see how they distributed their labor balances to the other seven households in the village, the correlations range from $r = 0.62$ to 0.88, with all of them significant at $p < 0.05$ or better (Table 11).

It should be noted that kin selection theory would predict that individual households would give more to themselves because they are more related to themselves than other households. Nevertheless, they have been ignored to make a more rigorous test of the hypothesis.

The correlations in Tables 10 show that for some households relatedness is a significant predictor of the intensity of garden labor exchange whereas in others it is not. Given that it is necessary to have fairly extensive exchange

Table 10. Relatedness and Proportional Intensity of Exchange

Household	Correlation[a]	Significance[b]
1	0.50	NS
2	−0.25	NS
3	0.80	<0.01
4	0.81	<0.01
5	0.62	<0.05
6	0.69	<0.025
7	0.79	<0.01
8	0.53	NS

[a] Pearson's product–moment correlation coefficient (r).
[b] One tailed.

Table 11. Relatedness and Balance in Exchange

Household	Correlation[a]	Significance[b]
1	0.72	<0.02
2	0.62	<0.05
3	0.86	<0.01
4	0.70	<0.02
5	0.79	<0.01
6	0.86	<0.01
7	0.79	<0.01
8	0.88	<0.001

[a] Pearson's product–moment correlation coefficient (r).
[b] One tailed.

relationships in order to hedge against garden failure those households who are unrelated to many households in the village, or whose relatedness to all other households is lower than the mean, may not be able to allocate their altruism in a way fully consistent with relatedness. Instead they may have to make significant investments in nonrelatives by engaging in reciprocal altruism. For example, Table 8 shows that households #1 and #2 are related to but one of seven and three of seven other village households, respectively. All other households are related to at least five other households. In addition, Table 10 shows that these two households were two of the three households that show no significant correlation between relatedness and the intensity of exchange. These observations lead to two predictions: there should be a positive correlation between mean relatedness of a household to the village and the correlation coefficient of that household gained in the analysis of relatedness and exchange intensity and exchange balance. That is, the more kin a household has in a village the better relatedness predicts exchange. The data needed to test the first prediction are found in Tables 10 and 11 (correlation coefficients) and Table 8 (relatedness matrix). Mean relatedness to the village correlates with the correlation coefficient gained between relatedness and intensity of exchange ($r = 0.62$, $p < 0.05$, one tailed) and the correlation coefficient gained between relatedness and balance in exchange ($r = 0.66$, $p < 0.05$, one tailed).

Since households with low levels of relatedness to other households in the village have lower intensities of exchange, they may instead attempt to make larger than average gardens to hedge against failure. The data to test this proposition are found in Hames (1978, p. 265, Table V-12; 1983), which measure percentage of surplus garden production (production beyond household consumption requirements) by household and in Table 8. The correlation between mean relatedness of a household to all other households and surplus production is, as hypothesized, significantly negative ($r = -0.64$, $p < 0.05$, one tailed).

DISCUSSION AND CONCLUSION

The analysis of garden labor exchange among the Ye'kwana has a number of implications for inclusive fitness theory and economic anthropology. Most

prominently, it deals with the biasing of assistance towards kin, the role and intensity of cooperative behavior in egalitarian society, and a way to bridge the formalist/substantivist debate in economic anthropology.

It is quite striking that a full 40% of all garden labor an individual performs is devoted to gardens other than his own. But Ye'kwana altruism is not restricted to gardening. It extends to cooperative house and canoe construction, sharing of meals, babysitting, and the exchange of fish, game, and wild vegetables. One could argue that the Ye'kwana are atypical and their example is of little value in understanding economic integration in tribal societies. But I think not. A study of five different Yanomamo villages in Brazil (Saffirio and Hames 1983) reveals that 40%–70% of all fish, game, and wild plants collected by adults was consumed by others outside their nuclear family. Aché hunter-gatherers of the Paraguayan tropical forest show even more intense patterns of sharing (Kaplan et al. 1984; Kaplan and Hill 1985): more than 80% of all food produced by individuals was consumed by others outside the producer's nuclear family. Whether such levels of exchange are characteristic of egalitarian societies is, of course, a matter of empirical investigation, but Kaplan et al.'s (1984) review of the literature on sharing in hunting and gathering societies leads me to suspect that it is (see also Sahlins 1965).

If the extent and intensity of altruism found among the Ye'kwana and other egalitarian societies mentioned above is commonplace, then one must call into question Sahlins's "domestic mode of production." This descriptive concept implies that households are independent economic entities, unconstrained in the utilization of their own labor or material resources by the demands and needs of other households in a settlement, and, similarly, make no similar demands on other households. What Sahlins appears to ignore is that group living is an adaptation to particular environmental problems (Alexander 1974). It is not governed by some blind social impulse. Although the benefits of group living outweigh its costs, these costs manifest themselves in conflicts of interest brought about by reproductive competition among members of a group. The autonomy of a household is necessarily compromised when it must allocate 40% of its most important labor to other households. Although I would agree with Sahlins that households attempt to vigorously maintain their independence (since it would be in their reproductive self-interests to do so), entering into reciprocal relations always leaves the door open to cheating and exploitation (Trivers 1971).

No attempt was made to answer a, perhaps, obvious question: Why are some Ye'kwana households imbalanced in their exchange relationships? In a recent article (Hames, in press) I showed that women who are actively caring for highly dependent infants work significantly less than women who are not caring for infants. Since it was also shown that husbands who had wives with infants did not increase their gardening labor to compensate, I hypothesized that these women must be getting assistance from other women in garden labor. This leads me to hypothesize that those households that

receive significantly more labor than they give (i.e., negatively imbalanced) contain women who are heavily engaged with infant care. This also suggests an alternate or complementary explanation of the adaptiveness of garden labor exchange: garden labor exchange among women is an adaptation to the constraints posed by childcare. I will deal with these issues in a future publication.

The major constraint an individual faces in the allocation of his altruism is his inability to target or selectively benefit particular individuals. This problem led directly to another problem: how to measure relatedness between entities that exchange labor. In resolving this problem I argued that the household-to-household method most accurately mirrors the constraints under which an individual allocates his extrahousehold labor. Statistical analyses not presented here of individual-to-household and individual-to-individual methods of calculating relatedness proved to be statistically significant but poorer predictors (lower correlation coefficients) of garden labor exchange. This provides indirect evidence that household-to-household relatedness is what individuals key on.

In the 1960s a debate raged in economic anthropology between the formalists and the substantivists (Cook 1966; Dalton 1961). The formalists argued that anthropologists could use microeconomic optimization models to explain patterns of exchange in tribal society. Substantivists countered that exchange was "embedded" (Polyanyi 1957) in social institutions (particularly kinship, see Sahlins 1965) and thus could not be considered apart from social constraints on individuals. I feel that kin selection theory effectively settles this dispute because it incorporates the strengths of both models in a single theory. In kin selection theory we find the formalists' emphasis on optimization and individual selfishness and the substantivists' emphasis on the power of kinship and nepotism. Kin selection theory strongly differs from both by denying the relevance of both group selection thinking found in substantivists' models and the assumption that resources or other forms of materialistic profits are the ultimate utility to be maximized in formalists' models. Instead, inclusive fitness theory assumes that prestige, social status, wealth, values, and the like are proximate currencies and that they are sought by individuals only insofar as they correlate with reproductive success.

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