BARGAINING THEORY AND COOPERATIVE FISHING PARTICIPATION ON IFALUK ATOLL

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In this paper we examine the merit of bargaining theory, in its economic and ecological forms, as a model for understanding variation in the frequency of participation in cooperative fishing among men of Ifaluk atoll in Micronesia. Two determinants of bargaining power are considered: resource control and a bargainer's utility gain for his expected share of the negotiated resource. Several hypotheses which relate cultural and life-course parameters to bargaining power are tested against data on the frequency of cooperative sail-fishing participation. Consistent with predictions generated from bargaining theory, we show that (1) age is negatively correlated with cooperative fishing participation, (2) men of high-ranking clans and men with high levels of education fish less than men of low-ranking clans and less-educated men, (3) men with high expected utility gains from fishing returns fish more than men with low expected utility gains, (4) number of dependents is positively correlated with cooperative fishing participation, and (5) the number of young genetic offspring residing with a man is positively correlated with cooperative fishing participation, whereas the number of genetic offspring more than 13 years old who are residing with a man is negatively correlated with cooperative fishing participation.

KEY WORDS: **Bargaining theory; Collective action; Cooperative fishing; Micronesia.**

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Males on Ifaluk atoll regularly cooperate to fish, where cooperation refers to the coordinated efforts of individuals that are directed towards a common goal. The distribution of fish following these cooperative acquisition events is generally biased towards canoe owners or large landholders. As a result of these biases, some males who do not fish often receive a portion of the catch. Since males do not receive returns directly proportional to their participation or effort, it is unclear how males determine how often they will cooperatively fish. How can we explain the variation in frequency of cooperative fishing among males?

Despite the frequent application of optimization models from foraging theory to predict foraging patterns of modern hunter-gatherers (e.g., Bailey 1990; Beckerman 1983; Smith 1991; see Kaplan and Hill 1992, Kelly 1995, and references therein), little progress has been made in determining the optimal foraging strategies of individuals who collaborate in acquisition and subsequently share returns. Prey and patch models, the tools of foraging theory most regularly employed by anthropologists, require that the value of a forager's decision is independent of its frequency in the population (Stephens and Krebs 1986). However, the payoffs to decisions confronting a cooperative forager are often dependent upon the decisions of other individuals in the population; in other words, the payoffs are frequency dependent. This paper will address one such frequency-dependent decision variable; how much effort should a forager invest in a cooperative acquisition event?

Although several evolutionary ecologists have investigated the inherent collective action problem posed by the production of nonexcludable goods in modern hunter-gatherer societies (Hawkes 1993; Hawkes et al. 1991; see Smith 1991:288 for review), issues concerning how the costs in either labor (e.g., time, energy) or capital (e.g., nets, spears, canoes) are partitioned have not been explored. A utility-maximizing individual is expected to contribute to a collective activity as long as her expected benefits are greater than her alternative uses of labor. However, the decision concerning the amount of effort to contribute to a cooperative acquisition event is complicated since she can often improve her net returns by decreasing her labor effort. In contrast to solitary foragers who do not share food, cooperative foragers will generally not receive the exact returns produced from their acquisition efforts. This may be due to two factors. First, when foragers cooperate in pursuit, resource acquisition often has the characteristic that the fraction of returns attributable to any particular individual is undefined because returns are the joint product of the efforts of more than one individual. For example, cooperative sailfishing on Ifaluk atoll requires the simultaneous efforts of multiple individuals and a differentiation of tasks. Although only one individual may actually pull in a fish, an individual holding the sail and another steering the canoe are equally responsible for the success of the catch. Second, returns from cooperative foraging are often redistributed following the foraging event (see Kelly 1995 for review). If foragers do not receive a share of the returns that are proportional to their effort, there is a possibility for some individuals to free-ride on the foraging efforts of others (i.e., some individuals may be able to increase their net returns by decreasing their labor effort). Thus, if a food-sharing ethic or specific food distribution rules constrain the returns that foragers can acquire, there is an inherent problem concerning who will pay the costs of acquisition and how much they will pay.

Explanatory models of cooperation such as tit-for-tat reciprocity (Axelrod and Hamilton 1981) and reciprocal altruism (Trivers 1971) cannot explain how the costs of a cooperative pursuit will be partitioned among cooperative foragers. The iterated prisoner's dilemma (IPD), which is widely thought to characterize the conditions of these models (e.g., Axelrod 1984; Lombardo 1985; Packer 1986; Milinski 1987; Nowak and Sigmund 1990, 1992), has several limitations as a paradigm to explore how the costs of cooperation are partitioned.[1] First, the costs individuals will incur to acquire a resource are likely to be proportional to their expected gain from it. However, the IPD is unable to distinguish between individual differences in utility for a resource and thus assumes that all foragers will pay equal costs for an equal quantity of an acquired resource. Second, the IPD cannot model conditions where foragers are able to cooperate at various levels of effort. The IPD only models a choice between cooperation (contribute a specified level of effort) and defection (contribute less or no effort). The IPD cannot model choices between more than two levels of contribution to a cooperative acquisition event. Third, the IPD cannot address multi-individual associations and collaborations prior to the decision variable of whether to cooperate or defect. For example, in a group of cooperative fishermen some individuals may form smaller coalitions and agree to alternate in their participation of cooperative fishing—in other words, "You fish today, and I'll fish tomorrow." The multi-person IPD assumes that the members of a pool of potential cooperators have an equal opportunity to interact with each other (see Taylor 1987). Among cooperative foragers, however, kin and co-residents may be more likely to form sub-coalitions than others, thus violating this assumption.

In order to understand how the costs of cooperative acquisition are partitioned among foragers, it will be necessary to formulate a model that does not suffer from the same limitations as the IPD. Bargaining theory offers such a set of models and specifically addresses conditions where the payoff for the decision variable is frequency dependent.

BARGAINING THEORY

A forager's decision concerning the amount of effort to invest in a cooperative acquisition event is part of a larger set of economic problems referred to as the "bargaining problem." A bargain is an interaction between two or more individuals which settles what each individual shall give, take, produce, or receive. Bargaining underlies a wide range of economic activity, including most forms of trade or exchange. The central "problem" of a bargaining situation is that the utility gained by pursuing a strategy is dependent upon the decisions of others in the population. The bargaining problem is characterized by conditions in which (1) resources are obtained through the strategic interaction of individuals in the population, (2) individuals have the opportunity to cooperate for mutual benefit in multiple ways, (3) individuals have the choice of whether or not to participate in the negotiation, and (4) mutual defection results in no gains for any interactants (Luce and Raffia 1957; Stahl 1972).

Although economists have formulated a variety of solutions to the bargaining problem (see Shubik 1982), most would agree that the foundations of bargaining theory were developed in a series of papers by John Nash (1950, 1951, 1953). Nash was able to progress beyond the indeterminacy of solutions that had characterized economic thought on strategic interaction for the first part of this century. This was accomplished by utilizing the concept of expected utility functions, which is the foundation of game theory (von Nuemann and Morgenstern 1944). Nash recognized that knowledge of the expected utility functions of bargainers for the resource would provide the means to calculate a specific solution to a bargaining problem. His insight was that how a bargain is struck is determined by the differences in utility gains of bargainers for the resource under negotiation. A bargainer's utility gain for an outcome is the difference in the utility of his expected payoff and the utility of his payoff if the bargain breaks down. The utility of the payoffs if a bargain is not reached is referred to as the disagreement or threat point. Offers below the threat point will never be accepted.

Bargaining power is a measure of an individual's ability relative to other bargainers to secure a portion of the resource in a bargaining situation. Following Nash, economists have focused their attention on how an individual's utility for an expected outcome (i.e., a specific distribution of resources) affects bargaining power. A fundamental principle of bargaining theory to arise out of Nash's use of expected utility functions is that *an individual's bargaining power will decrease as his or her utility gain for the expected resources produced increase*. Individuals who have (1) a low valuation of the anticipated resource gain from an expected outcome, and/or (2) a high threat strategy, have a relative bargaining advantage. Those who have little to lose if a bargain breaks down are in a better bargaining position. Economists have theoretically (e.g., Roth and Rothblum 1982) and empirically (e.g., Murnighan et al. 1988; Roth et al. 1988) shown that impatience and high risk aversion characterize a poor bargaining position.

Bargaining theory in economics has seen a parallel development in behavioral ecology. Theoretical advances in the study of asymmetrical contests have revealed two additional determinants of bargaining power. Noë and colleagues (1991:98) define "power" as analogous to dominance where "the power of an individual A relative to an individual B gives a measure of A's ability to uphold his demands in disputes with B." They recognize two sources of variability in power: fighting ability or resource holding potential (Maynard Smith and Parker 1976; Parker 1974) and possession of an inalienable resource (Hand 1986; Vehrencamp 1983). Noë and colleagues acknowledge that these sources of power are interdependent. Many researchers have noted a relationship between fighting ability and power (e.g., Borgia 1980; Brook 1981; Vollrath 1980) among organisms that can form coalitions, such as many primate species (chimpanzees—de Waal 1982, 1984; gorillas—Harcourt and Stewart 1987; baboons—Smuts and Watanabe 1990), including humans. Power is also likely to be related to an individual's ability to form coalitions. For example, an elderly chief is unlikely to fare well in any physical bout with his subordinates; however, his male kin may be able to protect and defend his position. In addition to the ability to form coalitions, the development of weaponry in the human lineage has probably resulted in a shift further away than any other species from the direct relationship between size or fighting ability and power.

Among humans, control of resources is likely to be a more important determinant of bargaining power than fighting ability. If an individual can offer resources or threaten to withhold resources under his control, he may be able to bias a bargaining outcome so that he pays less per unit of negotiated resource. In other words, bargaining power can be determined by an individual's ability to trade for the resource in question with other goods or services. Under conditions where certain individuals may control vital resources, simply the threat that these resources will be withheld can increase an individual's bargaining power. Noë and colleagues (1991; see also Noë and Hammerstein 1995) argue that bargaining power determined through the control of resources will be influenced by market competition. As the supply of the controlled resources increases among members of the population, the value of the resources will diminish, and hence their effect on the relative bargaining powers of individuals will decrease.

In summary, economists and behavioral ecologists have posited three factors which determine the relative bargaining power of interactants: (1) utility gains of the expected outcome, (2) resource holding potential

(RHP) or fighting ability, and (3) control of resources. Disagreement and outcome utilities are likely to be strongly affected by one's wealth and control of resources, and thus determinants 1 and 3 appear to be highly related. These determinants are distinguished by how economists and ecologists have interpreted their effect on bargaining power. Economists have argued that resource control is likely to influence the value of a bargaining solution and the value of alternative options available to an individual. Ecologists have argued that resource control is also likely to influence an individual's ability to trade or threaten to withhold these resources for a bargaining advantage. Economic and ecological understandings of the influence of resource control on bargaining power are complementary, and we can use both insights to predict the outcome of bargaining situations.

Here we use bargaining theory as developed by economists and behavioral ecologists to model the decision variable of whether or not to participate in a cooperative fishing event. Males on Ifaluk are bargaining over the frequency with which they will participate in a cooperative fishing event. In other words, males are bargaining over the costs that they will pay to acquire fish cooperatively. The bargaining situation arises from the distribution patterns of fish which determine the proportion of the catch that fishermen acquire.[2] On Ifaluk, bargaining power is thus a measure of an individual's ability to *not* participate in cooperative fishing, yet receive returns from the acquisition event. An individual's threat strategy is the utility of the fish he can acquire alone. Individuals with low utility gain for their expected allotment of cooperatively caught fish and individuals who control large quantities of valuable resources are assumed to have high bargaining power. On Ifaluk, individuals with high bargaining power are expected to pay lower costs to acquire a resource in a bargaining interaction; in other words, they should cooperatively fish relatively infrequently. Individuals with high utility gain for their expected allotment of fish and individuals who control few resources are assumed to have low bargaining power and are therefore expected to fish relatively frequently.[3] Bargaining may determine the resource distribution patterns following cooperative acquisition events in many societies; however, the nature of the resource distribution patterns on Ifaluk suggests that bargaining has little if any influence over the distribution patterns, which are thus taken as a given in this paper.

We need to address several concerns that may be raised about the use of bargaining theory to analyze the problem of participation among cooperative foragers. First, bargaining theory is not limited to two-player interactions. Many multi-player bargaining games as well as games modeling coalition formation have been developed (e.g., Binmore 1985; see Noë 1990 for an application of coalition games among baboons). Second, bargaining games are capable of modeling a range of conditions concerning information that is shared between bargainers; interactants may have little accurate knowledge of each other's utility curves, or they may have perfect knowledge of each other's preferences (see Rasmusen 1989 and Friedman 1990 for discussion on information and bargaining games). Third, bargaining theory generally treats the bargaining process as exogenous. The conditions of the bargaining process are typically assumed to be a constraint in the model. The actual bargaining process does not necessarily entail fist-banging around a conference table. Indeed, bargaining has been used to describe the exchange of shells between hermit crabs and coalition formation in chimpanzees (Noë et al. 1991). Some bargaining games allow contractual negotiation (cooperative games; Nash 1953), and in others communication is considered inconsequential (noncooperative games; Nash 1951). It is likely that in most cooperative foraging situations, foragers do not verbally negotiate the amount of effort that they will contribute to a cooperative acquisition event. Negotiation will take the form of continuous reaction to the cooperative effort decisions of other foragers.

The key to understanding how bargaining theory differs from predictions of a general market forces model of resource acquisition (where supply and demand determine the cost of a resource) is recognizing how bargaining theory addresses conditions where decision variables within a population are interdependent. Under both models, if an individual has a high utility for a resource he or she is expected to pay high costs to acquire that resource. However, bargaining theory predicts that an individual will pay a high price for a good because others *know* that he or she desires the good. In other words, bargaining theory only makes the prediction that an individual will pay a high cost for a highly desired good if the interactant(s) know(s) that this individual has a high utility for the good. The vital component of a bargaining interaction is the knowledge that each interactant has about everyone else's utility for the resource, fighting ability, and control of other resources. Bargainers can attain the highest net gains through displays or communication that convinces others of their high bargaining power (Elster 1989:82–83). In the following analysis of cooperative fishing participation on Ifaluk we will assume that bargainers have perfect or near-perfect knowledge of the factors affecting each other's bargaining power. Given that the variables we will be investigating are all public knowledge, since Ifaluk is a small community where everyone knows everyone else throughout their entire lives, this assumption seems reasonable.

The challenge in applying the predictions of bargaining theory to anthropological data is operationalizing bargaining power.[4] What traits affect an individual's bargaining power? How does an individual's bargaining power vary throughout the life course? What are the critical environmental determinants of bargaining power? This paper attempts to relate several cultural and life-course variables to bargaining power. Hypotheses relating these parameters to bargaining power will be tested using data measuring the frequency of participation in cooperative sail-fishing on Ifaluk atoll. The long-term research goal is to generate models from bargaining theory that explain the variation in male cooperative fishing effort on Ifaluk.

ETHNOGRAPHIC BACKGROUND

Ifaluk is a coral atoll located in Yap State in the Caroline Islands of the Federated States of Micronesia (FSM) at 7° 15′ north latitude and 147° east longitude. The nearest inhabited atoll is Woleai, 53 km to the west, and Yap, the largest island in Yap State, is located about 560 km northwest of Ifaluk. Ifaluk consists of four atolls, two of which are inhabited (Figure 1). The total land mass of the four atolls is 1.48 km^2, and the nearly circular lagoon is 2.43 km^2 (Freeman 1951:237–238, 273–274). The two inhabited atolls, Falalop and Falachig, are separated by a 35 m wide channel that is less than a meter deep during high tide and completely dry during low tide. The channel can easily be crossed on foot even during high tide. Ifaluk receives between 254 and 305 cm of rain per year (Tracey et al. 1961). Daily temperatures range from slightly above 21°C to 35°C and remain nearly constant throughout the year. The two seasons on Ifaluk are differentiated by the presence of northeast trade winds from October through May.

From December 1994 to April 1995 the average number of residents on Ifaluk was slightly more than 600.[5] There are four villages on Ifaluk, two on each inhabited atoll. Villages consist of 5–13 matrilocal compounds (*bugot*). The 36 compounds on Ifaluk range in size from 1 to 4 houses and 3 to 35 residents. Households are composed of either nuclear or extended families, and often include several adopted children (see Betzig 1988a for discussion of adoption on Ifaluk). During the 1994–1995 field session R.S. and S.F. collected observational data on the fishing activities of Falalop atoll's residents. Table 1 presents the residential composition of all the compounds on Falalop atoll. Of the 189 individuals who lived on Falalop during the field session, 99 resided in Iyeur village and 90 resided in Iyefang village.

There are seven ranked matriclans on Ifaluk; the five highest are chiefly clans (see Table 1). Clans are not localized, and members of each clan can be found in all four villages. Matriclan chiefs and elders maintain control over a wide range of community activities, such as the type of fishing

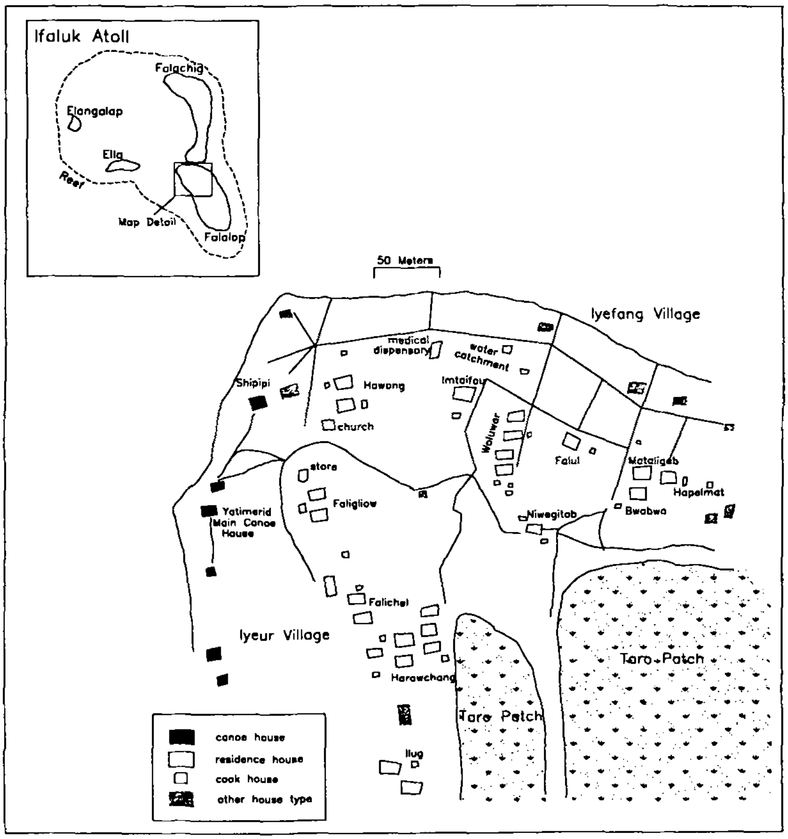

Figure 1. Map of Ifaluk atoll showing Iyeur and Iyefang villages.

allowed, where a house may be built, and whether alcohol is permitted on the atoll. Each village has a chief who controls intra-village decisions, such as the timing of villagewide palm sap sharing, or when gifts from the village residents should be given to the family of a sick person. Each compound also has a chief who controls compound-level decisions, such as where fish from the compound should be redistributed. Cross-cutting the clan and chief hierarchy is an age-graded hierarchy (see below).

Employment on Ifaluk is limited to ten elementary schoolteachers, four Head Start teachers, two Head Start cooks, two medical dispensators, one dentist, and one agriculturist. Salaries are paid by the FSM government and range between $2,000 and $6,000 per year. All but one of the jobs (one of the Head Start cooking positions) are held by men. A store on each of the inhabited atolls offers cigarettes, flour, rice, cloth, thread, and other

Table 1. Residential Composition, Clan Affiliation, and Canoe Ownership of Falalop Compounds

Village/ Compound	*Number of males (≥14 yr.)*	*Number of females (≥14 yr.)*	*Number of children (<14 yr.)*	*Own canoe*	*Clan affiliation of compound matriline (clan rank)*
IYEUR					
Ilug	5	3	8	Y	Beweol (6)
Harowchang	10	15	12	N	Mauruvach (3)
Falichel	3	8	9	N	Sauvalachig (2)
Faligliow	1	7	3	Y	Mauruvach (3)
Hawong	4	6	5	N	Chapavelu (4)
Subtotal	23	39	37		
IYEFANG					
Imtaifou	3	4	2	N	Mauruvach (3)
Woluwar	10	12	15	Y	Mauruvach (3)
Falul	4	3	3	N	Hovalu (1)
Mataligob	2	5	6	Y	Rag (7)
Hapelmat	3	2	4	N	Mauruvach (3)
Bwabwa	2	3	0	N	Sauvalachig (2)
Niwegitob	2	2	3	N	Hovalu (1)
Subtotal	26	31	33		
TOTAL	49	70	70		

assorted goods. The only additional source of income on the atoll is the sale of copra, which occurs approximately three times a year. At these times 100 lb bags of copra can be sold to a Yap State official for approximately $10 a bag.

Subsistence

The people of Ifaluk maintain a subsistence economy. The diet largely consists of pelagic and reef fish, taro, breadfruit, and coconut. Banana and papaya are consumed seasonally, almost exclusively by children. Pigs, chickens, and dogs are also raised for consumption but are usually only prepared for bimonthly feasts. White rice is the most frequently purchased food product, although not all residents can afford it. There is no refrigeration on Ifaluk. Fish are occasionally smoked, but competition with the dogs, cats, and rats makes long-term storage difficult. For a more detailed description of subsistence on Ifaluk see Sosis 1997.

Fish is the primary source of protein and fats for the people of Ifaluk. Only males participate in fishing activities. Fishing on Ifaluk can be considered in two categories: solitary fishing and cooperative fishing. The main type of solitary fishing during the trade wind season is line-fishing with bait.[6] Octopus and land crabs are used as bait. Men line-fish in the lagoon for more than a hundred species of reef fish. Almost all males over 15 years of age own one of the solitary outrigger canoes used for line fishing. Spear and trap fishing were also observed during the trade wind season (see Burrows and Spiro 1957 for description). Over the 98-day observation period from December to April, only 15 males on Falalop atoll engaged in any form of solitary fishing.[7]

Cooperative sail-fishing accounts for 87.7% of all fish caught in the observation period (Sosis 1997). Most mornings during the trade wind season from October through May, males congregate at the central canoe hut on Falalop in preparation for the daily cooperative sail-fishing. After the canoes are prepared, all the males who are present help to push each canoe that will be sailing that morning into the lagoon. The canoes are then sailed outside the reef, where the men fish for large pelagic fish such as yellow fin tuna, mahi mahi, and barracuda. Upon their return, the men throw their catch into a pile which is distributed by a divider after all the canoes have returned (see below).

There are four large sailing canoes on Falalop and eleven on Falachig. Each canoe is owned and maintained by a specific matriline and, hence, compound. Each compound is historically associated with a particular canoe, and males are expected to fish on the canoe that is associated with the compound in which they were raised, their *natal compound*. Indeed, 86.4% of the observed times that males whose natal compounds are located on Falalop fished (n = 815) they sailed on the canoe associated with their natal compound. Although residence patterns are matrilocal, married men in this sample (n = 177) fished on the canoe associated with their wife's compound only 5.6% of the times they fished. Despite the consistency with which males adhere to cultural expectations, these rules appear flexible, especially when there are not enough males to man a particular canoe.

Distribution of Cooperatively Acquired Fish

In order to understand production decisions on Ifaluk it is necessary to explain how resources are distributed following production events. Distribution of fish follows a variety of patterns. Betzig (1988b) has previously described the fish distribution patterns on Ifaluk following cooperative net-fishing, which occurs approximately once every two weeks during the summer. Here we will describe the fish distribution patterns following cooperative sail-fishing, which occurs exclusively in the trade wind season. On Falalop atoll, two men have the inherited responsibility of dividing the fish from the communal pile. The dividers determine the type of distribution and the amount of fish that is allocated to each recipient. During the 1994–1995 field session, five distribution patterns were observed on Falalop atoll. Multiple distribution types often occurred at the same distribution event. The five types are:

1. Canoe owner distribution *(shuliwa).* During this type of distribution, compounds that own canoes receive the catch of their canoe. Table 1 shows which compounds on Falalop atoll own a canoe. A canoe-owning compound that receives fish subsequently redistributes the fish to other compounds, unless the catch is particularly small. Canoe-owning compounds retained an average of 59.7% (SD = 25.0%; n = 24) of the fish they produced. Sosis (1998) has shown that redistributed fish are generally directed towards compounds where kin, and men who fished on the canoe, reside.

2. Village-level *ilet* distribution *(felang).* Villages on Ifaluk are composed of plots of land owned by the matriline of particular compounds. Plots of land each have an *ilet* value, which affects the flow of food resources contributed and received by the owners of the land. Most plots are valued at 1 *ilet,* with the exception of two plots valued at 2 *ilet.* Ownership of land within a village is not restricted to compounds located in the village. Indeed, several compounds on Falachig atoll own land (and hence maintain *ilet*) within villages on Falalop atoll. On Falalop, compounds possess between one and three plots of land and the total *ilet* maintained by compounds is also between one and three. Table 2 presents the number of

Table 2. Number of *Ilet* and Location of Compounds That Possess *Ilet* on Falalop Atoll

Compound		*Number of Ilet in*		
No.	*Name*	*Iyeur*	*Iyefang*	*Village*
1	Imtaifou	1	1	Iyefang
2	Ilug	2	0	Iyeur
3	Harowchang	3	0	Iyeur
4	Falichel	2	0	Iyeur
5	Faligliow	2	0	Iyeur
6	Hawong	3	0	Iyeur
7	Woluwar	0	3	Iyefang
8	Falul	0	1	Iyefang
9	Mataligob	0	1	Iyefang
10	Hapelmat	0	1	Iyefang
11	Bwabwa	0	1	Iyefang
12	Niwegitob	2	0	Iyefang
13	Falfeliuw	1	0	Rawaii
14	Welipiye	1	0	Rawaii
15	Halingelou	1	0	Rawaii
16	Maiyefang	1	0	Mukulong
17	Hagotag	0	1	Rawaii
18	Hatibugot	0	1	Rawaii
19	Somat	0	1	Rawaii
	Total	19	11	

ilet within Iyeur and Iyefang villages by compound and location of compound. There are 19 *ilet* in Iyeur village (representing 184 residents) and 11 *ilet* in Iyefang village (representing 135 residents). On Falalop, the number of *ilet* owned by a compound is positively correlated with the number of residents in the compound ($r = .72$, $p = .008$).

During a village-level *ilet* distribution (on Falatop atoll) fish are divided into two piles, one for Iyeur village and one for Iyefang village. From these piles each compound receives an amount of fish proportional to the number of *ilet* it possesses. The pile of fish for Iyeur village was typically slightly larger, but not proportional to the greater number of *ilet* or the greater number of residents represented by the *ilet* of Iyeur ($n = 17$ events, Iyeur mean = 69 kg, Iyefang mean = 63 kg).[8] One or two women from each compound that owns *ilet* within the village convene at their respective piles to cook and redistribute the fish. The eldest women present are in charge of the redistribution. The amount of fish that each compound receives is ideally determined by the number of *ilet* that a compound possesses. Compounds that have 1 *ilet* expect to receive half as much fish from a redistribution as compounds that have 2 *ilet*, and one third as much fish as compounds that have 3 *ilet*. For example, if a compound owns 2 *ilet* in Iyeur village, the compound expects to receive 2/19 of the total amount of fish received by Iyeur village. Sosis (1998) has shown that the amount of fish compounds received from observed village-level *ilet* distributions closely matches the amount of fish compounds are predicted to receive from village-level *ilet* distributions.

3. Atoll-level *ilet* distribution *(metalilet)*. Similar to a village-level *ilet* distribution, in this distribution pattern fish are distributed according to *ilet*. However, during an atoll-level *ilet* distribution fish are distributed by the dividers directly from the canoe house to the compounds. Therefore, if as above a compound owns 2 *ilet* in Iyeur, the compound will receive 2 / (19 + 11) or 1/15 of the total catch distributed via an atoll-level *ilet* distribution. Since Iyeur does not receive fish during a village-level *ilet* distribution proportional to the number of *ilet* in Iyeur (Iyeur on average receives 52.3% of the fish [as measured at 17 village-level distribution events] but maintains 63.3% of the *ilet*), compounds that have *ilet* located in Iyeur receive a greater proportion of the total catch during an atoll-level *ilet* distribution than during a village-level *ilet* distribution, whereas the converse is true of compounds that possess *ilet* in Iyefang village.

4. Fishermen distribution (*gagolagol*): Fish are distributed directly to males who fished on the canoe that caught the fish. Fish are subsequently cooked and consumed by the residential compound of the fisherman. These distributions take two forms. In the first type fish are divided equally amongst all of the crew members (egalitarian distribution). In the second type fish are distributed separately to any residents of Falachig who participated in the fishing event (Falachig resident distribution).

5. Men's feast (*yafiileo/giubul*): Fish are cooked at the men's house and eaten by any male over 14 years old who desires to eat.

Table 3 presents the observed frequency of each distribution type. Canoe owner, village-level *ilet*, and atoll-level *ilet* distributions never occur together, and nearly all distributions include one of these distribution types. Men's feast, egalitarian, and Falachig resident distributions generally occur in conjunction with another distribution type. The most frequent was the canoe owner distribution, which occurred during 63.1% of all distributions. Canoe owner and village-level *ilet* distributions were clearly the most important distribution types observed. Together these distributions account for 80.9% of the total fish distributed and occur during 89.2% of all fish distributions. Sosis (1998) has shown that the primary determinant of the distribution type used to disburse a catch is the total weight of fish caught. If few fish are caught, fish are distributed via a canoe owner distribution, whereas if the total catch is large, fish are distributed via an *ilet* distribution.

HYPOTHESES

The primary goal of this paper is to explain the variation in frequency of cooperative sail-fishing among males on Falalop atoll. The study popula-

Table 3. Frequency of Fish Distribution Types Observed on Falalop Atoll Following Cooperative Sail-Fishing Events (98 observation days)

	Observed frequency	*% of total distribution events*
EVENTS		
cooperative sail-fishing events	79	
cooperative sail-fishing events with no catch	14	
fish distribution events following cooperative sail-fishing	65	
DISTRIBUTION TYPES		
canoe owner	23	35.4
canoe owner, men's feast	16	24.6
canoe owner, men's feast, Falachig resident	1	1.5
canoe owner, men's feast, egalitarian	1	1.5
village-level *ilet*	6	9.2
village-level *ilet*, men's feast	6	9.2
village-level *ilet*, men's feast, Falachig resident	4	6.2
village-level *ilet*, Falachig resident	1	1.5
men's feast	3	4.6
men's feast, egalitarian	1	1.5
atoll-level *ilet*, men's feast, Falachig resident	3	4.6

tion or risk set (i.e., those individuals who are at risk of participating in a cooperative sail-fishing event on a given observation day) consists of 60 males age 14 and older who either resided on Falalop atoll during the 1994–1995 field session or were raised on Falalop atoll but during the field session resided on Falachig atoll, typically as a result of marriage. The choice of excluding males younger than 14 from the risk set was not arbitrary. Although males younger than 14 often participate and contribute to cooperative fishing events, they are considered to be learning and not fully adult. Males under 14 are never given any portion of the catch regardless of the distribution and they are excluded from any men's feast. As described above, there is a cultural precept that males are expected to fish on the canoe associated with the compound in which they were raised. Therefore, men who were raised in compounds on Falalop were included in the risk set since they are expected to fish on Falalop canoes, even if they currently reside on Falachig. Males who reside on Falalop but were raised on Falachig were also included in the risk set since they often fished on canoes from Falalop.

The variation in frequency of cooperative sail-fishing that we are trying to explain is presented graphically in Figure 2. Twenty-four of the 60 men in the risk set were never observed participating in a cooperative sail-fishing event over 98 observation days. No individual fished more than 75% of the total days for which they were at risk of cooperative sail-fishing. The man who cooperatively sail-fished most frequently participated

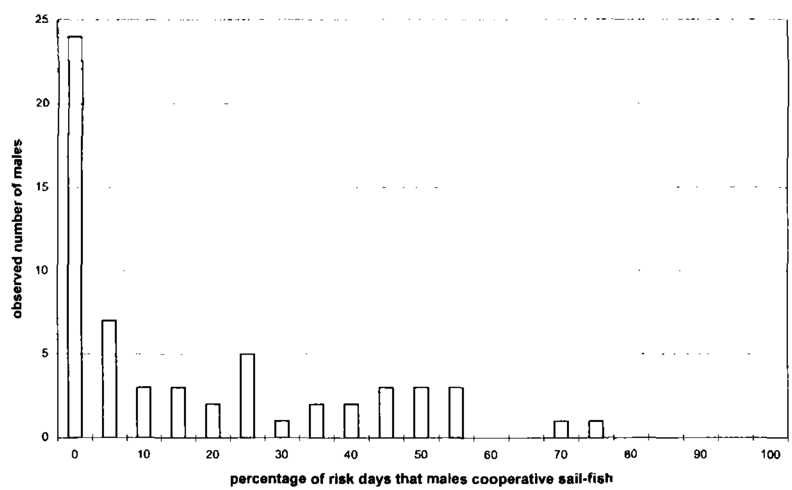

Figure 2. Variation in cooperative sail-fishing on Falalop atoll among 60 males during 98 observation days.

in 66 of the 76 events (86.8%) that took place on Falalop while he was there.

The current literature on bargaining theory does not offer empirical data or theoretical predictions about the impact of basic life history parameters on cooperative investment decisions, despite the likelihood that these variables influence laborers' utility functions, opportunity costs, and ability to control resources. Recognizing that an individual's bargaining power will decrease as his utility gain for the expected resource increases, or as his control of other resources decreases, we can make predictions about individual cooperative fishing effort across various cultural and life-course parameters. Men with a greater utility gain for their expected allotment of fish or less access to other valuable resources (low relative bargaining power) are expected to participate more frequently in cooperative sail-fishing than men with a lower utility gain for their expected allotment of fish or high access to other valuable resources (high relative bargaining power). Men should be willing to pay higher costs for goods that they desire more, and pay lower costs for production if they can coerce others into paying higher costs owing to their control of other resources. Men may additionally pay for the costs of production through trade of other valuable resources. These notions are the underlying assumptions behind all of the following hypotheses.

Variables That Affect Resource Control

Age. Throughout Micronesia (e.g., Alkire 1965; Lessa 1966; Nason 1981), and on Ifaluk especially (Bates and Abbott 1958; Burrows and Spiro 1957), there is an age-graded hierarchy which is most evidently manifest in political power. Male "elders" make up the chief's council regardless of clan rank and typically are the ones to announce as well as monitor chiefly decisions. Inheritance of land and positions of authority on Ifaluk are also age dependent; older siblings receive preference (see Alkire 1974). The age-graded hierarchy is also manifest in seemingly trivial behaviors such as telling one's subordinate to fetch a cigarette from across the atoll. The age-graded hierarchy can also influence more important behaviors such as foraging decisions, as the following example illustrates. One day a schoolteacher went cooperative fishing before school. The canoe he was on returned earlier than usual so he could arrive at school on time. When asked if the other fishermen were upset that they returned early, he responded that it did not matter; they had to listen to him since he was the oldest on the canoe, even though he was only a few years older than some of the other men.

The development and maintenance of this age-graded hierarchy is puzzling, but an in-depth analysis of the system is beyond the scope of this paper. However, if we recognize the hierarchy as a socioecological constraint we can predict how cooperative fishing effort will vary with age. We expect cooperative fishing effort to be negatively correlated with age, since as men age on Ifaluk their bargaining power increases through gains in political and social influence.

Clan affiliation. Clan-based hierarchies permeate the social fabric of all Micronesian societies (Alkire 1974; Lessa 1950; Mason 1968). As described above, there are seven ranked clans on Ifaluk. If clan rank is an important indicator of status and power on Ifaluk (and hence bargaining power), we expect that as clan rank increases, frequency of cooperative sail-fishing will decrease.

Educational status. Data were collected on five levels of education on Ifaluk ranging from no high school degree to attendance at a college in the United States. Educational status can be considered a measure of employment potential on or off the atoll. Financial benefits of current employment on Ifaluk or previous off-island employment, either working on Yap (which generally requires knowledge of English since few outer islanders speak Yapese) or on a fishing boat, leads to prestige among islanders. Higher educational status should therefore be related to higher bargaining power, and thus lower cooperative fishing effort.

Variables That Affect the Utility Gain

Utility gain is affected by how much an individual values a resource as well as his alternative options for acquiring the resource. On Ifaluk, the alternative to acquiring fish cooperatively is fishing alone. However, the weather conditions necessary for the success of cooperative and solitary fishing are mutually exclusive on Ifaluk; cooperative sail-fishing requires strong winds and tide, whereas solitary fishing requires calm winds and tide. During the winter months (trade wind season) solitary fishing is rare on Ifaluk; only 15 men solitary fished over 98 observation days, and only five of these men fished three or more times (see Sosis 1998). Solitary fishing accounts for only 2.2% of all fish caught during the observation period. Thus, most men on Ifaluk apparently have a low threat strategy, in other words, they cannot credibly threaten that they can pursue alternative acquisition possibilities. If the bargain breaks down on a windy day (i.e., nobody cooperatively fishes), men are not likely to receive any fish since solitary fishing would probably result in no catch.

Threat strategies must also encompass the economic status of the bargainers if no bargaining solution is reached. For example, if a rich man and a poor man are asked to divide $100 (and if they cannot agree they each receive nothing), the generalized Nash solution predicts that the rich man will receive a larger share. Since the rich man needs the money less he can always bias the offer in his favor and credibly threaten, "Take it or leave it."[10] Threat strategies are determined by not only the alternative options available to a bargainer, but also the economic situation of a bargainer if a bargain breaks down (see Elster 1989:76–78). These determinants are often not independent.

The following predictions will consider how we might expect the utility gain of fish to vary between Ifaluk men.

Association with a canoe-owning compound. As described above, fish are not distributed equitably following cooperative sail-fishing events. Through an understanding of the bias in the distribution patterns, we can make qualitative predictions concerning cooperative fishing effort.[11] Canoe owner distributions occurred during 63.1% of the distributions and accounted for 27.9% of the total amount of fish distributed. On Falalop atoll, where fish distribution data were collected, there are four sailing canoes and twelve compounds; thus eight compounds do not own a canoe (see Table 1). During a canoe owner distribution, the catch is given to the compound that owns the canoe on which the fish were caught. This compound then redistributes the fish to other compounds; however, redistributing compounds on average retained 59.7% (SD = 25.0%; n = 24) of the fish they received.

The Nash bargaining solution predicts that utility gain will be positively correlated with cooperative fishing participation. Men who regularly receive a larger share of the catch should have lower utility gains for their expected returns than men who regularly receive a smaller share of the catch. Hence, we may predict that men who regularly receive a larger share of the catch will fish less. This, however, would be an unlikely bargaining outcome on Ifaluk. Canoe-owning men only expect to receive a larger share of the catch if they fish—in other words, if they take out their canoe and fish are distributed via a canoe owner distribution. The distribution patterns, although biased towards canoe owners, result in a high threat strategy for men not associated with a canoe-owning compound. If non–canoe owners threaten to stay on shore, canoe owners are left with a choice of letting their canoe sit idle or using it to fish. The latter generally results in positive net gains for canoe owners. Although nobody will gain any fish if the bargain breaks down (see above), canoe owners will be left with an idle canoe for which they have expended considerable labor and money to build.[12] If the investment in a canoe is not returned through caloric gains from fishing (i.e., the canoe is not used), we assume that canoe owners would be in a state of depleted resources relative to non–canoe owners. Given differences in their threat strategies, it is likely that the utility gains of canoe owners are greater than the utility gains of non–canoe owners. Increased utility for returns results in a decrease in bargaining power. We therefore expect males who currently reside or were raised in canoe-owning compounds to cooperatively sail-fish more frequently than other males.

Number of dependents. Anthropologists have often argued that the number of dependents or dependency ratio (number of consumers to producers) should be positively correlated with production effort (Sahlins 1971, 1972; Evans 1974; Smith 1979; Durrenberger 1979, 1984; Barlett 1980; Tannenbaum 1984; Hurtado et al. 1985; Hurtado and Hill 1989; Fratkin 1989; Hames 1988, 1992). Anthropological interest in the number of dependents has often been concerned with testing "Chayanov's rule" (Sahlins 1971, 1972);[13] the greater the number of consumers a producer has to support, the greater his or her work effort will be. The Ifaluk economy violates one of the assumptions of "Chayanov's rule," that households are independent economic units (see Hames 1987). However, Chayanovian analysis is consistent with what we might derive from bargaining theory, which can specifically address conditions where production decisions are interdependent. It could be argued that individuals with a greater number of dependents have greater utility for the output of their production. In other words, individuals with more dependents can translate a unit of food into higher fitness gains. Fitness gains should be even higher if dependents are genetic offspring. We assume here that the fitness gains of a unit of food will reach diminishing returns more quickly if it is divided among fewer dependents. Under the conditions of cooperative foraging, higher utility gain for returns is expected to result in lower bargaining power, and hence higher participation in cooperative foraging. Therefore we anticipate that the number of dependents will be positively correlated with cooperative sail-fishing participation.

This prediction assumes that time spent cooperative fishing has a higher fitness value than direct paternal care. The fitness value of direct paternal care is likely to be a function of the health hazards of the environment, the opportunity costs of child care on female labor, and the availability of alloparental care (Hurtado and Hill 1992; Hurtado et al. 1992). The few health hazards of an atoll environment as well as the availability of elderly and adolescent female caretakers suggest that time spent in cooperative fishing has a higher fitness value than direct paternal care.

The above hypotheses are not tests of bargaining theory. For each hypothesis we have made assumptions about the independent variable as a measure of bargaining power. Age, clan affiliation, and educational status are assumed to measure a male's access to and control of resources, which is expected to affect bargaining power. Expectations about the quantity of fish received from distributions and the number of dependents are assumed to measure a male's utility for the expected outcome, which is also expected to affect bargaining power. The accuracy of these assumptions will determine the success of the predictions.

METHODS

Observational data on cooperative sail-fishing activities were collected daily on Falalop atoll from December 19, 1994, to April 5, 1995, with the exception of nine days in March (March 4–12; n = 98 observation days). R.S. participated in 17 cooperative sail-fishing events, during which no quantitative data were collected. Every morning at 4:00 A.M. during the observation period R.S. walked to Yatimerid, the main canoe house on Falalop, and waited for the men to commence fishing. He recorded which of the four canoes set sail, the names of the fishermen on each canoe, and the time of departure for each canoe. R.S. was also at the canoe house when each canoe returned. He recorded the time of return for each canoe and the weight and species of each fish caught by canoe. Following the distribution of fish from the canoe house R.S. reweighed all the fish and recorded where each fish was distributed. If inconsistencies were found between the first and second weighing, the fish were weighed a third time and the data were corrected accordingly. S.F. monitored eight village-level (*felang*) and 24 compound-level (*shuliwa*) women's redistribution events. During her observations she recorded the names of the distributors, the weight and species of each share redistributed, and the name of the compound that received the share.

Event History Analysis

Event history analysis is used to model the hazard of an event occurring (for detailed descriptions of event history analysis see Allison 1984; Yamaguchi 1991). An event consists of a qualitative change which occurs at a specific point in time (Allison 1984). The hazard is simply the probability of an event occurring to an individual at a defined point in time, given that the individual is at risk of the event occurring at the defined point in time. Event history analysis is prominent in demographic and sociological studies because of its ability to analyze time-varying covariates and censored data, which other statistical models generally cannot handle. In order to determine the effect of a set of variables on the hazard it is useful to employ logistic regression analysis. A logit transformation is necessary to convert a hazard, which is by definition constrained between 0 and 1, to a measure that varies between $-\infty$ and $+\infty$. A regression model of the logit transformation will calculate an estimate of the effect of a set of variables on the probability of an event occurring to an individual at risk over time.

The event that we are interested in modeling is whether or not an individual participates in a cooperative sail-fishing event during the 98 observation days. To determine the hazard of an event for a population it is necessary to define a risk set. Our risk set consists of the number of males at risk of participating in a cooperative sail-fishing event multiplied by the number of observation days. Over the 98 observation days, the number of males at risk of participating in a cooperative sail-fishing event (see Hypotheses) changed 11 times and ranged between 50 and 60 men as a result of individuals arriving at and departing from Ifaluk. Thus, our total risk set consists of 5,212 person days.

In order to determine the effect of age, clan affiliation, educational status, relation to a canoe-owning compound, and number of dependents on cooperative investment decisions, we employed logistic regression. The parameter estimate of a logistic regression model measures the effect of the independent variable on the log odds of the dependent variable. This can easily be converted into a measure of the effect on the probability of an event taking place. All analyses were conducted using SAS. Table 4 lists the independent variables that were used in the analyses. The mean, standard deviation, range, sample size, and how the variables were coded for input into the logistic model are presented.

Results of the logistic regression analyses are presented in Tables 5 and 6. All results of the primary independent variables of interest are presented first in a univariate model. Covariates are then added to the model to evaluate the significance of the primary independent variable with other effects controlled. Each model includes an intercept term, which is not shown in the results. Partial p values calculated from the Wald chi-square statistic are presented for each covariate. Chi-square and p values of the -2 log likelihood for model covariates are also shown for each model presented.

RESULTS

Age

Consistent with our prediction, the results in Table 5 indicate that age is negatively correlated with cooperative sail-fishing participation on Ifaluk. Marital status was used as a control since age may simply be measuring whether or not an individual is married. Marital status is negatively correlated with cooperative sail-fishing effort; in other words, married males fish less than unmarried males. Age remains a significant negative

Table 4. Independent Variables in Logistic Regression Analyses (variables without explicit coding schemes were coded directly as the value of the variable)

Independent variable/ Coding scheme	*Mean*	*Standard deviation*	*Minimum*	*Maximum*	*Sample size*
1 age	40.07	15.68	14	75	60
2 marital status 0 = not currently married 1 = currently married	0.58	0.49	0	1	60
3 clan affiliation 1 = highest ranking clan ⋮ 7 = lowest ranking clan	3.17	1.77	1	7	44*
4 educational status 1 = highest ⋮ 5 = lowest	2.33	1.29	1	5	46**
5 canoe-owning status of ego's residential compound 0 = does not own a canoe 1 = owns a canoe	0.28	0.45	0	1	60
6 canoe-owning status of ego's natal compound (where ego was raised) 0 = does not own a canoe 1 = owns a canoe	0.33	0.47	0	1	60
7 number of genetic offspring, maternal and paternal siblings, and parents who reside in a canoe-owning compound	2.30	3.35	0	12	60
8 number of dependents†	1.58	1.62	0	6	60
9 number of ego's genetic offspring (<14 yr.) who reside in ego's residential compound	0.98	1.52	0	6	60
10 number of ego's male genetic offspring (≥14 yr.) who reside in ego's residential compound	0.21	0.58	0	3	60
11 number of ego's male adopted offspring (≥14 yr.) who reside in ego's residential compound	0.13	0.39	0	2	60
12 number of males residing in ego's residential compound at risk of cooperative sail-fishing	5.35	2.96	1	9	43‡

†number of dependents is the sum of the number of ego's genetic offspring (<14 yr.), adopted offspring (<14 yr.), and maternal siblings (<14 yr.) who reside in ego's residential compound

*Data for some adopted males were coded as missing (n = 11) because it was unclear whether they were affiliated with their genetic mother's clan or their adopted mother's clan. Data from males suspected of endogamous marriage (n = 5) were also coded as missing. Because of a taboo against such marriages, responses by these males were considered unreliable (nobody ever claimed to be of the same clan as their spouse).

**Data on educational status are missing for 14 males.

‡Only males whose residential compound was located on Falalop atoll were included in the analyses.

Table 5. Logistic Regression Analyses of the Probability of Cooperative Sail-Fishing

Independent variable	*Parameter estimate*	*s.e.*	*Partial p*
−2 log likelihood for model covariates = 523.21, $p < .0001$			
df = 1			
n = 5212			
age	−0.0651	0.0033	<.0001
−2 log likelihood for model covariates = 536.55, $p < .0001$			
df = 2			
n = 5212			
age	−0.0607	0.0039	**<.0001**
marital status	−0.3885	0.1203	0.0012
−2 log likelihood for model covariates = 121.98, $p < .0001$			
df = 1			
n = 3946			
clan affiliation	0.242	0.0218	<.0001
−2 log likelihood for model covariates = 114.56, $p < .0001$			
df = 2			
n = 3219			
clan affiliation	0.2065	0.0222	**<.0001**
educational status	0.1255	0.039	0.0013
−2 log likelihood for model covariates = 32.95, $p < .0001$			
df = 1			
n = 4045			
educational status	0.1848	0.0332	<.0001
−2 log likelihood for model covariates = 380.34, $p < .0001$			
df = 2			
n = 4045			
educational status	0.1635	0.0358	**<.0001**
age	−0.051	0.0032	<.0001

predictor of cooperative sail-fishing effort when marital status is added to the model. The results of the univariate model are presented graphically in Figure 3. Although there is considerable variation, the data show that contributions to cooperative fishing peak in the late teenage years.

Clan Affiliation

In addition to age, clan affiliation is also a significant predictor of cooperative sail-fishing participation on Ifaluk. The parameter estimate in Table

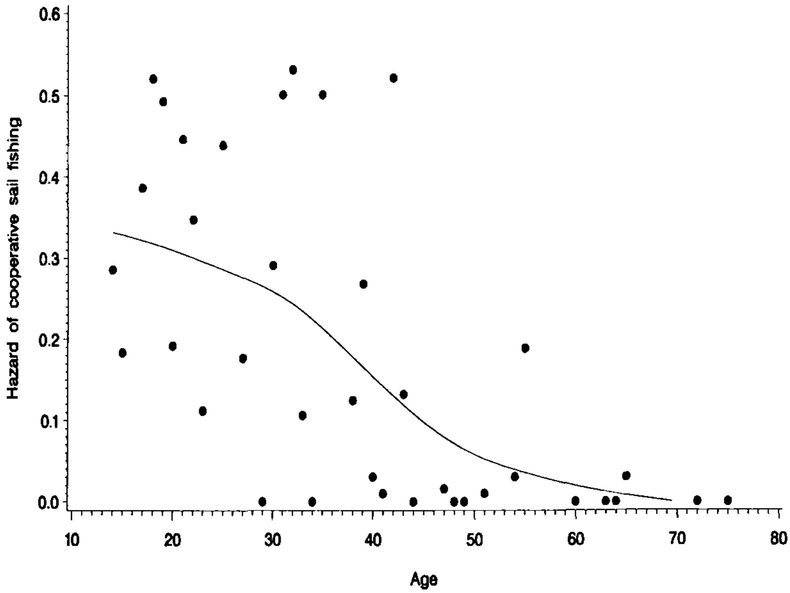

Figure 3. Hazards and composite smooth of cooperative sail-fishing by age. Hazards were calculated at each age as the number of times individuals cooperatively sail-fished, divided by the number of times individuals were at risk of cooperative sail-fishing. The smooth is fit to the binary data (0 = did not, 1 = did cooperatively fish) rather than the calculated hazards since males in the risk set are not evenly distributed across age.

5 is positive, which indicates that as clan rank decreases, participation in cooperative sail-fishing increases (recall that the highest-ranked clan was coded as 1). Educational status was added to the model since clan rank may be measuring the effect of educational status on cooperative fishing decisions. Education on Ifaluk is related to employment, and employment provides a direct opportunity cost to cooperative fishing. Clan rank is positively correlated with educational status (Pearson's $r = .25, p < .0001$). As shown in Table 5 however, educational status does not fully account for the effect of clan rank on cooperative fishing effort.

Educational Status

Table 5 presents the univariate model which indicates that educational status is a significant predictor of cooperative fishing participation; higher educational status is related to lower participation in cooperative fishing. Educational status may be measuring the effects of age on cooperative fishing participation since educational opportunities have increased with modernization. Nevertheless, educational status remains a significant predictor of cooperative fishing effort when age is added to the model.

Association with a Canoe-Owning Compound

The results shown in Table 6 indicate that currently residing or being raised in a canoe-owning compound is positively correlated with cooperative sail-fishing participation. Controlling for the number of kin who reside in a canoe-owning compound, which is positively correlated with cooperative sail-fishing participation, currently residing or being raised in a canoe-owning compound remain significant predictors of cooperative sail-fishing participation.

Number of Dependents

Table 6 shows that when analysis controls for the effect of marital status on cooperative fishing participation, the number of dependents defined as the sum of the number of ego's genetic offspring, adopted offspring, and maternal siblings (all under 14 years of age) who reside in ego's current residential compound is a significant positive predictor of cooperative fishing effort. Considered by itself, number of genetic offspring (<14 years old) living in the same residential compound as the father is a significant negative predictor of his participation in cooperative fishing. This relationship, though, is likely to be confounded by the strong age effect (older men have more children) on cooperative sail-fishing participation. Consistent with our prediction, when age is added to the model the number of co-residential genetic offspring (<14 years old) becomes a borderline significant positive predictor of cooperative sail-fishing participation.

DISCUSSION

Age

It could be argued that participation in cooperative sail-fishing decreases with age owing to the increasing costs with age of an activity that is physically challenging. Although in some production situations this may be true, cooperative sail-fishing is an interesting case since older men can and do provide a useful service simply by holding a line while others direct and maintain the canoe. Additionally, the physical costs of cooperative fishing cannot explain why teenagers fish more than the more muscular cohort of men in their twenties. Therefore, we need to consider alternative explanations.

Table 6. Logistic Regression Analyses of the Probability of Cooperative Sail-Fishing

Independent variable	*Parameter estimate*	*s.e.*	*Partial p*
−2 log likelihood for model covariates = 177.49, $p < .0001$			
df = 1			
n = 5212			
canoe-owning status of ego's residential compound	1.0336	0.0765	<.0001
−2 log likelihood for model covariates = 201.79, $p < .0001$			
df = 1			
n = 5212			
canoe-owning status of ego's natal compound	1.0767	0.0758	<.0001
−2 log likelihood for model covariates = 415.7, $p < .0001$			
df = 3			
n = 5212			
canoe-owning status of ego's residential compound	0.3277	0.0921	**0.0004**
canoe-owning status of ego's natal compound	0.3697	0.0954	**<.0001**
number of genetic offspring, maternal and paternal siblings, and parents who reside in a canoe-owning compound	0.1465	0.0134	<.0001
−2 log likelihood for model covariates = 7.73, $p = .0054$			
df = 1			
n = 5212			
***number of dependents**	0.0624	0.0223	0.0051
−2 log likelihood for model covariates = 163.5, $p < .0001$			
df = 2			
n = 5212			
number of dependents	0.1431	0.0236	**<.0001**
marital status	−0.9765	0.0796	**<.0001**
-2 log likelihood for model covariates = 12.56, $p = .0004$			
df = 1			
n = 5212			
number of ego's genetic offspring (<14 yr.) who reside in ego's residential compound	−0.0926	0.0269	0.0006
−2 log likelihood for model covariates = 526.18, $p < .0001$			
df = 2			
n = 5212			
number of ego's genetic offspring (<14 yr.)	0.0504	0.0289	**0.0817**
age	−0.0674	0.0036	<.0001

*sum of the number of ego's genetic offspring (<14 yr.), adopted offspring (<14 yr.), and maternal siblings (<14 yr.) who reside in ego's residential compound.

The apparent asymmetry in bargaining power between young and old males is conceivably a result of the valuable resources that older males control on Ifaluk, particularly land. Land provides subsistence as well as the materials for building and repairing canoes and houses on Ifaluk. The control of land may enable older males to coerce younger males to participate in cooperative sail-fishing against their own interest, or it may enable the same older males to trade land or land-based resources (e.g., a tree to build a canoe) for the cooperative fishing effort of younger males. Young males who do not cooperatively fish (i.e., do not adhere to the bargain) may lose access to these resources. If land is a source of power for elderly males, it is still unclear how they maintain their land possessions. What is preventing younger males from usurping this land? The ultimate power of older males may lie in their ability to influence the chiefs in punishing others. We suggest that chiefs only maintain their ability to punish transgressors when punishment is perceived by the community as a communal benefit. The most common punishment on Ifaluk was the chopping down of an individual's trees, although imprisonment occurs as well (one man was imprisoned for the duration of the field session, and had been so for years; see Sosis 1997).

An alternative to these hypotheses is the "show-off" hypothesis (Hawkes 1991); younger males may be contributing more to cooperative fishing as a form of mating effort, rather than somatic or parental investment. Younger males may have higher utility than older males for fishing returns because of their ability to establish long-term reputations for diligence or physical prowess. Males and females on Ifaluk distinguish between and continuously comment on slackers and hard workers. When questioned, females unequivocally claim that they want to marry a hardworking fisherman. Young males may be investing in a long-term reputation that will benefit them in mating opportunities and male alliances. The available data are unable to distinguish between these hypotheses.

Clan Affiliation

In addition to age, clan affiliation is also a significant predictor of cooperative fishing effort on Ifaluk. Betzig (1988b) showed that two chiefs on Falalop spend less time in productive activities than other males of the same cohort. During the 1994–1995 field session the only clan chief residing on Falalop never cooperatively sail-fished.

As with the age-graded hierarchy, understanding how the clan hierarchy is maintained is enigmatic. The native explanation of clan rank is priority of settlement. Clan rank is likely to be associated with other parameters that may directly affect participation in cooperative sail-fishing. Clan rank may simply measure an individual's relation to canoe-owning compounds (association with a canoe-owning compound implies a greater share of the cooperative sail-fishing returns). Indeed, clan rank is negatively correlated with canoe ownership ($r = .65, p = .022$); in other words, lower-ranking matrilines are more likely than higher-ranking matrilines to own a canoe. However, results indicate that even when the analysis controls for whether or not a man's natal or residential compound owns a canoe, clan affiliation remains a significant predictor of cooperative fishing participation (see Table 7). Therefore, canoe ownership cannot explain the effect of clan rank on cooperative fishing effort. The number of *ilet* owned by a compound also cannot explain the effect; clan rank is not correlated with number of *ilet* owned by a compound ($r = .14, p = .96$). Current clan size cannot explain the asymmetry in power between clans; the third-ranked clan is the largest clan, and the second-ranked clan is one of the smallest. It is unlikely that clan rank is influencing the utility function of fish for a clan member, but that clan rank is influencing the bargaining outcome through the ability of individuals with high clan rank to bestow favors on others or make credible threats to coerce low-ranking males into cooperative fishing. It is unclear, however, what favors or threats individuals of high rank on Ifaluk possess. Once again, it is possible that high-ranking clan members have greater influence with the clan chiefs, although if true, it still does not explain how high-ranking clan members maintain their influence.

Educational Status

Educational status is thought to be an important component of bargaining power because of the financial, status, and political advantages of education on Ifaluk. For example, the high chief of the second-ranking clan is de facto the high chief of the island because of his ability to speak four languages (Woleaian, Yapese, Japanese, and English). The political

Table 7. Logistic Regression Analyses of the Probability of Cooperative Sail-Fishing

Independent variable	*Parameter estimate*	*s.e.*	*Partial p*
−2 log likelihood for model covariates = 429.53, $p < .0001$			
df = 3			
$n = 3975$			
clan affiliation	0.2334	0.0233	**<.0001**
canoe-owning status of ego's natal compound	1.0931	0.0872	<.0001
canoe-owning status of ego's residential compound	0.7895	0.0880	<.0001

gains of this clan chief are exemplified by his attendance at the biannual meeting of all the high chiefs of the outer atolls of Yap State. In addition, education is related to employment. All employees of the atoll have studied beyond high school. Employment on Ifaluk provides a direct opportunity cost to cooperative fishing. Unfortunately, only three men in the risk set were employed, so direct tests of the effect of employment on cooperative fishing effort could not be conducted. Unemployed males with high educational status may exhibit high bargaining power owing to past or future employment opportunities, which may indicate access to financial resources.[14] However, the causal direction of the educational parameter is unclear. The current data set is unable to determine whether high educational status is a result of high bargaining power (possibly attained through clan rank), or high bargaining power is a result of attaining high educational status.

Association with a Canoe-Owning Compound

Canoe-owning compounds receive significantly more fish per day than non-canoe-owning compounds. Over 98 observation days, canoe-owning compounds received on average 3.99 kg (SD = 6.83, n = 392) of fish per day, and non-canoe-owning compounds received 2.38 kg (SD = 4.58, n = 784) of fish per day. The results presented in Table 6 indicate that residents of canoe-owning compounds are paying higher costs for the benefits of a greater proportion of the returns for themselves or their kin. Despite higher costs, canoe-owning compounds have higher mean daily net caloric gains than non-canoe-owning compounds ($t = -3.74$, $p < .001$; Sosis 1997). On average, canoe-owning compounds gain 3624.8 net kcal per day (SD = 6840.1, n = 392) and non-canoe-owning compounds gain 2246.8 net kcal per day (SD = 4724.4, n = 784).

Individuals who were raised in a canoe-owning compound are expected to fish on the canoe of that compound. Although they may not reside in the compound where they were raised because of the matrilocal residence pattern, they are more likely than others to visit the compound and partake in a meal there (personal observations). In addition, they are likely to be closely related to individuals who reside in the compound (see Sosis 1997).

Although the results support our hypotheses, our predictions were based on assumptions about the utility of fish and about threat strategies. We have assumed that canoe owners are in a state of depleted resources owing to their considerable investment in building a canoe. It may be the case that canoe owners were able to build a canoe because they had abundant resources. Indeed, Sosis (1997) has shown that canoe owners have greater access to financial resources. However, it was also shown that canoe-owning compounds do not have greater labor resources (measured as the number of available workers) than non-canoe-owning compounds, suggesting that canoe-owning compounds had greater caloric expenses while building their canoe. This expense is not limited to the male laborers of the compound; women must also increase their production activities since extra taro and breadfruit are generally provided for men of other compounds who assist in the building process. Without precise measures of resource status, however, it is difficult to assess the validity of our assumption that canoe owners are in a state of depleted resources owing to their considerable investment in building a canoe. Also, in order to evaluate our assumption we need to improve our understanding of the relationship between fish consumption and fitness gains on Ifaluk and how one's nutritional status affects this relationship.

Number of Dependents

Consistent with our predictions, when analysis controls for the effect of marital status on cooperative fishing participation, the number of dependents is shown to be a significant positive predictor of cooperative sail-fishing participation. Also, when the analysis controls for the strong age effects on cooperative sail-fishing participation, the number of ego's co-residential genetic offspring (<14 years old) is a borderline positive predictor of cooperative sail-fishing participation. As discussed earlier, the effect of the number of dependents on cooperative fishing participation will be dependent upon the ecological factors influencing the tradeoff between cooperative fishing participation and direct paternal care. Unfortunately we do not have data that can assess the importance of male time investment on co-residential offspring and young maternal siblings. Betzig et al. (1989) showed from focal scans of seven married couples that men and women spent 13% and 48% of their time, respectively, within 5 m of their genetic offspring. Additional time allocation data on child care activities will be necessary to determine the variation in investment between different types of dependents, and the value of that investment in terms of increased fitness benefits.

Intra-compound Bargaining

The above predictions and interpretation of results assume that males are determining the effort that they will contribute to cooperative sail-fishing relative to all other males at risk of cooperative sail-fishing. However, given the observed fish distribution patterns on Ifaluk, we may expect that males will interact differently with co-resident males than they will with males who reside in different compounds. The bargaining process should be more acute between co-residents since they will be sharing any returns received by the compound directly. How does the number of co-residents at risk of cooperative sail-fishing affect cooperative fishing effort? We may expect that as the number of males within a compound at risk of cooperative fishing increases, the frequency with which individual males will participate in cooperative fishing will decrease owing to increasing potential for free-riding. However, Table 8 reveals that number of males at risk of cooperative sail-fishing residing within a compound is a significant positive predictor of cooperative fishing effort. Table 8 also shows that the number of males at risk of cooperative sail-fishing residing within a compound remains a significant predictor of cooperative fishing effort if we control for canoe ownership. This result may simply be due to the fact that, with more males at risk of cooperative fishing in a compound, an individual is more likely to be woken by one of these men in order to go fishing. Men never went to another compound to awaken someone to go fishing, although co-residential males undoubtedly wake each other in the morning to fish. When men were asked why they did not go to each other's compounds to wake each other for fishing, men always responded that such behavior would be very inappropriate but did not provide further explanation.

We expect that the bargaining dynamics within a compound will be shaped by the nature of the relationship between the bargainers. Within-compound adult male interactions can be characterized by the following dyads: father–genetic son, father–son-in-law, father–adopted son, genetic son–genetic son, son-in-law–son-in-law, adopted son–adopted son, genetic son–adopted son, genetic son–son-in-law, and adopted son–son-in-law. Unfortunately sample sizes in the current data set are too small to test any hypotheses concerning these relationships. Data from two sets of relationships are interesting and suggestive, however. Consistent with the negative relationship between age and cooperative sail-fishing participation, in all six cases in which fathers and adult genetic sons reside in the same compound, sons have a higher cooperative fishing hazard rate than their fathers. Fathers only fished 4 of 529 times they were at risk of cooperative sail-fishing, whereas sons fished 371 of 902 times they were at risk. In addition, a male's cooperative fishing effort decreases with increasing number of co-resident genetic sons older than 13 years, even controlling for age (see Table 8). In other words, not only do fathers cooperatively sail-fish less than their residential sons, they also cooperatively sail-fish less than those males without co-residential adult genetic sons. The bargaining dynamic between fathers and genetic sons is complicated owing to their high relatedness. Our results suggest that fathers have greater relative bargaining power than their sons. This may be due to the father's land and tree holdings, which may ultimately be passed on to his son(s) (see Alkire 1974 for discussion of land and tree transfer in the

Table 8. Logistic Regression Analyses of the Probability of Cooperative Sail-Fishing

Independent variable	*Parameter estimate*	*s.e.*	*Partial p*
−2 log likelihood for model covariates = 110.08, $p < .0001$			
df = 1			
n = 3975			
number of males residing in ego's residential compound at risk of cooperative sail-fishing	0.1437	0.0139	<.0001
−2 log likelihood for model covariates = 178.93, $p < .0001$			
df = 2			
n = 3975			
number of males residing in ego's residential compound at risk of cooperative sail-fishing	0.1168	0.0144	**<.0001**
ego's residential compound owns canoe	0.6991	0.0841	<.0001
−2 log likelihood for model covariates = 201.6, $p < .0001$			
df = 1			
n = 5212			
number of ego's male genetic offspring (≥14 yr.) who reside in ego's residential compound	−2.1791	0.271	<.0001
−2 log likelihood for model covariates = 574.17, $p < .0001$			
df = 2			
n = 5212			
number of ego's male genetic offspring (≥14 yr.) who reside in ego's residential compound	−1.3843	0.2679	**<.0001**
age	−0.0569	0.0034	<.0001
−2 log likelihood for model covariates = 39.55, $p < .0001$			
df = 1			
n = 5212			
number of ego's male adopted offspring (≥14 yr.) who reside in ego's residential compound	−0.7483	0.1354	<.0001
−2 log likelihood for model covariates = 544.67, $p < .0001$			
df = 2			
n = 5212			
number of ego's male adopted offspring (≥14 yr.) who reside in ego's residential compound	0.776	0.1558	**<.0001**
age	−0.072	0.0036	<.0001
−2 log likelihood for model covariates = 491.33, $p < .0001$			
df = 3			
n = 3946			
number of ego's male adopted offspring (≥14 yr.) who reside in ego's residential compound	0.2728	0.1602	**0.0886**
age	−0.0594	0.0038	<.0001
clan affiliation	0.1912	0.0233	<.0001

Woleai region where Ifaluk is located), or a son's greater utility for fishing returns owing to the effect of participation on long-term reputation.

A comparison of the bargaining dynamics of the father–genetic son and father–adopted son dyads provides further insight. Similar to the father–genetic son dyad, and consistent with the negative relationship between age and cooperative sail-fishing participation, adoptive fathers fish considerably less than their co-residential adopted sons older than 13 years. Adoptive fathers fished 54 of 568 times they were at risk of cooperative sail-fishing, whereas adopted sons fished 119 of 682 times they were at risk, and in only one of six dyads did an adoptive father fish more than his adopted son. In contrast to the effect of co-residential adult genetic sons on cooperative sail-fishing participation, controlling for age, a male's cooperative fishing effort significantly increases with increasing number of co-residential adult adopted sons (see Table 8). In other words, although adoptive fathers fish less than their adopted sons, they fish more than other males of their same age cohort. Fathers may have lower relative bargaining power over their adopted sons than fathers have over their genetic sons because of the lower status of adoptive fathers. Betzig (1988a) found that lower-status males are more likely to adopt children than higher-status males. However, status does not fully explain the difference between genetic and adopted dyads since, when clan affiliation is added to the model, the number of male adopted offspring remains a borderline significant variable. The difference in the two dyads may be due to our earlier suggestion; that is, a father holds access to valuable land which may be passed on to his son. Adopted sons may be less likely to inherit these resources. To test this idea it will be necessary to collect data on the inheritance patterns of land and trees on Ifaluk.

CONCLUSION

Bargaining theory is instructive in a wide array of human behaviors of interest to anthropologists, including coalition formation (Noë 1990; Noë et al. 1991), food sharing (Hill and Kaplan 1993), marital decisions (Manser and Brown 1980), and parental care (Anderson et al. n.d.; Chase 1980; Houston and Davies 1985). In this paper, bargaining theory in its economic and ecological form has proven to be useful in generating predictions and interpreting the effect of a wide array of cultural and life-course variables on participation in a cooperative foraging activity. It was shown that age, clan rank, educational status, expected quantity of returns, and number of dependents are significant predictors of the frequency of participation in cooperative sail-fishing on Ifaluk. Additionally, the number of genetic offspring is a borderline significant predictor of cooperative sail-fishing participation.

Despite the value of these preliminary results, our investigation of cooperative foraging effort will ultimately have to progress beyond qualitative predictions. A number of bargaining solutions offer quantitative predictions about the outcome of bargaining problems [e.g., Nash product (1953); Kalai and Smorodinsky solution (1975)]. To proceed beyond qualitative generalizations, it will be necessary to determine the utility functions of foragers for their foraging returns. If foragers are gaining more than caloric benefits for their foraging effort as several researchers have suggested (Kaplan and Hill 1985; Hill and Kaplan 1988; Hawkes 1990, 1991, 1992, 1993), this will be especially challenging. Our discussion of bargaining theory reveals that further research will be necessary to evaluate the effect of threat strategies on the bargaining power of cooperative foragers. The most promising area of study is the bargaining process itself. Cross-cultural differences in how bargainers are able to resolve their bargaining problem are likely to be important in explaining the variation of cooperative pursuits across societies. Throughout this paper we have assumed that interactants have perfect or near-perfect knowledge about each other's control of resources or respective utilities for the fish they expect to receive. The validity of this assumption here and elsewhere is dependent on the context of the bargaining interaction. Determining what individuals know about each other's utility for or control of resources, and how individuals are displaying or communicating what they want others to believe, will provide us with invaluable data that should generate more precise predictions concerning bargaining outcomes. Bargaining theory holds a promising key to explaining the maintenance and possibly the emergence of cooperative behavior.

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NOTES

1. For a more detailed discussion of the limitations of the IPD see Noë (1990), Dugatkin et al. (1992), Mesterton-Gibbons and Dugatkin (1992), and Boyd (1992).

2. If fishermen were paid an hourly wage or simply received all the fish they personally caught, there would be no bargaining problem over labor input among fishermen. If, however, men expect to receive some percentage of the catch, a situation results that characterizes all bargaining situations: individual interests are "neither completely opposed nor completely coincident" (Nash 1953:128). Men can increase their returns through increases in their labor input, but they can also increase their returns if others increase their labor input.

3. The Nash solution is based on the maximization of the product of utility gains. The solution is characterized by a "determination of the amount of satisfaction each individual should expect to get from the situation" (Nash 1950:155), which can be translated into a physical division of the resource under negotiation. Therefore, in order to predict that bargaining power will be negatively correlated with cooperative fishing frequency, we must assume that individuals value the costs of labor similarly (i.e., the disutilities of labor are assumed to be equal).

4. Since Nash's seminal works, most empirical studies have been pursued by experimental economists interested in determining the utility functions of subjects placed in controlled bargaining situations in order to define the characteristics of bargainers that can be used to predict an outcome (e.g., Roth 1987; Roth and Malouf 1979; Roth and Shoumaker 1983).

5. The movement of residents on and off the atoll were monitored from December 1994 to April 1995 for Falalop atoll but not for Falachig atoll. Census data on Falachig atoll were collected over a two-month period in which there were several opportunities for residents to return to and leave the atoll. No data were collected on the number of residents for all of Ifaluk at any specific point in time. Therefore we have given an estimate of slightly more than 600 residents, rather than an exact figure.

6. Informants claimed that solitary line fishing with bait was the main type of fishing (solitary or cooperative) during the season of calm winds (*lecheg*) from May to October.

7. These data refer to daytime solitary fishing. We did not collect systematic data on nighttime solitary fishing activities. However, casual discussions about solitary fishing indicate that nighttime solitary fishing occurred less frequently than daytime solitary fishing, and that no individual exclusively fished at night.

8. On average Iyeur received 9.5% more fish than Iyefang during village-level *ilet* distributions, but it maintains 72.7% more *ilet* than Iyefang and those *ilet* represent 36.3% more residents.

9. Males under 14 years old may of course receive fish within their own compound.

10. The disadvantage of the poor man is that his marginal utility for money decreases more rapidly than the rich man's marginal utility for money (Luce and Raffia 1957:129–130).

11. We concentrate here on the bias in the canoe owner distribution. The affect of the bias in *ilet*-based distributions on cooperative sail-fishing effort will be presented elsewhere in a more detailed investigation of the sharing patterns.

12. Sailing canoes take approximately one year and $1,200 to build (see Sosis 1997 for details on Ifaluk canoe building).

13. The Russian economist Chayanov (1966) argued that since peasant household economies do not use wages, they are not subject to the categories of standard

economic analysis. He claimed that the amount of time worked by a peasant was determined by the intersection of his marginal utility of production and marginal disutility of labor curves. Although Chayanov recognized that a variety of variables influenced these curves (rent, costs of machinery, soil fertility, etc.), anthropologists have been particularly interested in how a household's ratio of consumers to producers affects the marginal utility and disutility curves.

14. Many males on Ifaluk work on Japanese or Chinese fishing boats for several years after school and subsequently return to Ifaluk. Males with higher education are sometimes able to secure work in the state or federal government on Yap.

REFERENCES

Alkire, W.

1965 *Lamotrek Atoll and Inter-Island Socioeconomic Ties.* Urbana: University of Illinois Press.

1974 Land Tenure in the Woleai. In *Land Tenure in Oceania,* H. Lundsgaarde, ed. Pp. 39–69. Honolulu: University of Hawaii Press.

Allison, P.

1984 *Event History Analysis: Regression for Longitudinal Event Data.* Newbury Park: Sage Publications.

Anderson, K., H. Kaplan, and J. Lancaster

n.d. Paying for Children's College Costs: Parental and Mating Tradeoffs among Albuquerque Men. Ms. in authors' possession, Department of Anthropology, University of New Mexico, Albuquerque.

Axelrod, R.

1984 *The Evolution of Cooperation.* New York: Basic Books.

Axelrod, R., and W. Hamilton

1981 The Evolution of Cooperation. *Science* 211:1390–1396.

Bailey, R.

1990 *The Behavioral Ecology of Efe Pygmy Men in the Ituri Forest.* Ann Arbor: University of Michigan Press.

Barlett, P.

1980 Cost-Benefit Analysis: A Test of Methodologies. In *Agricultural Decision Making,* P. Barlett, ed. Pp. 137–160. New York: Academic Press.

Bates, M., and D. Abbott

1958 *Coral Island: Portrait of an Atoll.* New York: Charles Scribner's Sons.

Beckerman, S.

1983 Carpe Diem: An Optimal Foraging Approach to Bari Fishing and Hunting. In *Adaptive Responses of Native Amazonians,* R. Hames and W. Vickers, eds. Pp. 269–299. New York: Academic Press.

Betzig, L.

1988a Adoption by Rank on Ifaluk. *American Anthropologist* 90:121–129.

1988b Redistribution: Equity or Exploitation? In *Human Reproductive Behavior: A Darwinian Perspective,* L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds. Pp. 49–63. Cambridge: Cambridge University Press.

Betzig, L., A. Harrigan, and P. Turke

1989 Childcare on Ifaluk. *Zeitschrift für Ethnologie* 114:161–177.

Binmore, K.
1985 Bargaining and Coalitions. In *Game-Theoretic Models of Bargaining*, A. Roth, ed. Pp. 269–304. Cambridge: Cambridge University Press.
Borgia, G.
1980 Sexual Competition in *Scatophaga stercoraria*: Size and Density Related Changes in Male Ability to Capture Females. *Behaviour* 75:185-206.
Boyd, R.
1992 The Evolution of Reciprocity When Conditions Vary. In *Coalitions and Alliances in Humans and Other Animals*, A. Harcourt and F. de Waal, eds. Pp. 473–489. New York: Oxford University Press.
Brook, M. d. L.
1981 Size as a Factor Influencing Ownership of Copulation Burrows by the Ghost Crab *(Ocypode ceratophthalmus). Zeitschrift für Tierpsychologie* 55:63–78.
Burrows, E., and M. Spiro
1957 *An Atoll Culture: Ethnography of Ifaluk in the Central Carolines*. Westport, Connecticut: Greenwood Press.
Chase, I.
1980 Cooperative and Non-cooperative Behavior in Animals. *American Naturalist* 115:827–857.
Chayanov, A., ed.
1966 *The Theory of Peasant Economy*. Homewood, Illinois: American Economic Association.
de Waal, F.
1982 *Chimpanzee Politics*. New York: Harper and Row.
1984 Sex Differences in the Formation of Coalitions among Chimpanzees. *Ethology and Sociobiology* 5:239–255.
Dugatkin, L., M. Mesterton-Gibbons, and A. Houston
1992 Beyond the Prisoner's Dilemma: Toward Models to Discriminate among Mechanisms of Cooperation in Nature. *Trends in Ecology and Evolution* 7:202–205.
Durrenberger, E.
1979 An Analysis of Shan Household Production Decisions. *Journal of Anthropological Research* 35:447–458.
1984 *Chayanov, Peasants, and Economic Anthropology*. London: Academic Press.
Elster, J.
1989 *The Cement of Society*. Cambridge: Cambridge University Press.
Evans, M.
1974 A Note on the Measurement of Sahlins's Social Profile of Domestic Production. *American Ethnologist* 1:269–279.
Fratkin, E.
1989 Household Variation and Gender Inequality in Ariaal Pastoral Production: Results of a Stratified Time-Allocation Survey. *American Anthropologist* 91:430–440.
Freeman, O., ed.
1951 *Geography of the Pacific*. New York: John Wiley and Sons.
Friedman, J.
1990 *Game Theory with Application to Economics*. Oxford: Oxford University Press.

Hames, R.
1987 Garden Labor Exchange among the Ye'kwana. *Ethology and Sociobiology* 8:259–284.
1988 The Allocation of Parental Care among the Ye'kwana. In *Human Reproductive Behaviour,* L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds. Pp. 237–254. Cambridge: Cambridge University Press.
1992 Variation in Paternal Investment among the Yanomamo. In *Father-Child Relations: Cultural and Biosocial Contexts,* B. Hewlett, ed. Pp. 85–110. Chicago: Aldine de Gruyter.
Hand, J.
1986 Resolution of Social Conflicts: Dominance, Egalitarianism, Spheres of Dominance and Game Theory. *Quarterly Review of Biology* 61:201–220.
Harcourt, A., and K. Stewart
1987 The Influence of Help in Contests on Dominance Rank in Primates: Hints from Gorillas. *Animal Behaviour* 35:182–190.
Hawkes, K.
1990 Why Do Men Hunt? Some Benefits for Risky Choices. In *Risk and Uncertainty in Tribal and Peasant Economies,* E. Cashdan, ed. Pp. 145–166. Boulder, Colorado: Westview Press.
1991 Showing Off: Tests of Another Hypothesis about Men's Foraging Goals. *Ethology and Sociobiology* 11:29–54.
1992 On Sharing and Work. *Current Anthropology* 33:404–407.
1993 Why Hunter-Gatherers Work: An Ancient Version of the Problem of Public Goods. *Current Anthropology* 34:341–361.
Hawkes, K., J. O'Connell, and N. B. Jones
1991 Hunting Income Patterns among the Hadza: Big Game, Common Goods, Foraging Goals, and the Evolution of the Human Diet. *Philosophical Transactions of the Royal Society of London* B 334:243–251.
Hill, K., and H. Kaplan
1988 Tradeoffs in Male and Female Reproductive Strategies among Ache Foragers. In *Human Reproductive Behaviour,* L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds. Pp. 277–305. Cambridge: Cambridge University Press.
1993 On Why Male Foragers Hunt and Share Food. *Current Anthropology* 34:701–706.
Hill, K., H. Kaplan, and A. Hurtado
1987 Foraging Decisions among Ache Hunter-Gatherers: New Data and Implications for Optimal Foraging Models. *Ethology and Sociobiology* 8:1–36.
Houston, A., and N. Davies
1985 The Evolution of Cooperation and Life History in the Dunnock *Prunella modularis.* In *Behavioural Ecology,* R. Sibley and R. Smith, eds. Pp. 471–487. Oxford: Blackwell Scientific.
Hurtado, A., and K. Hill
1989 Seasonality in a Foraging Society: Variation in Diet, Work Effort, Fertility, and the Sexual Division of Labor among the Hiwi of Venezuela. *Journal of Anthropological Research* 34:293–246.
1992 Paternal Effect on Offspring Survivorship among Ache and Hiwi Hunter-Gatherers: Implications for Modeling Pair-Bond Stability. In *Father-*

Child Relations: Cultural and Biosocial Contents, B. Hewlett, ed. Pp. 31–55. Hawthorne, New York: Aldine de Gruyter.
Hurtado, A., K. Hawkes, K. Hill, and H. Kaplan
1985 Female Subsistence Strategies among Ache Hunter-Gatherers of Eastern Paraguay. *Human Ecology* 13:1–28.
Hurtado, A., K. Hill, H. Kaplan, and I. Hurtado
1992 Tradeoffs between Female Food Acquisition and Childcare among Hiwi and Ache Foragers. *Human Nature* 3:185–216.
Kalai, E., and M. Smorodinsky
1975 Other Solutions to the Nash Bargaining Problem. *Econometrica* 43:513–518.
Kaplan, H., and K. Hill
1985 Food Sharing among Ache Foragers: Tests of Explanatory Hypotheses. *Current Anthropology* 26:223–246.
Kelly, R.
1995 *The Foraging Spectrum*. Washington D.C.: Smithsonian Institution Press.
Lessa, W.
1950 Ulithi and the Outer Native World. *American Anthropologist* 52:27–52.
1966 *Ulithi: A Micronesian Design for Living*. New York: Holt.
Lombardo, M.
1985 Mutual Restraint in Tree Swallows: A Test for the Tit-for-Tat Model of Reciprocity. *Science* 227:1363–1365.
Luce, R., and H. Raffia
1957 *Games and Decisions*. New York: Wiley.
Manser, M., and M. Brown
1980 Marriage and Household Decision-making: A Bargaining Analysis. *International Economic Review* 21:31–44.
Mason, L.
1968 Suprafamily Authority and Economic Process in Micronesian Atolls. In *Peoples and Cultures of the Pacific*, A. Vayda, ed. Pp. 299–329. Garden City, New York: Natural History Press.
Maynard Smith, J., and G. Parker
1976 The Logic of Asymmetric Contests. *Animal Behaviour* 24:159–175.
Mesterton-Gibbons, M., and L. Dugatkin
1992 Cooperation among Unrelated Individuals: Evolutionary Factors. *Quarterly Review of Biology* 1992:267–281.
Milinski, M.
1987 Tit for Tat in Sticklebacks and the Evolution of Cooperation. *Nature* 325:433–435.
Murnighan, J., A. Roth, and F. Shoumaker
1988 Risk Aversion in Bargaining: An Experimental Study. *Journal of Risk and Uncertainty* 1:85–101.
Nash, J.
1950 The Bargaining Problem. *Econometrica* 18:155–162.
1951 Non-cooperative Games. *Annals of Mathematics* 54:286–295.
1953 Two-Person Cooperative Games. *Econometrica* 21:128–140.
Nason, J.
1981 Respected Elder or Old Person: Aging in a Micronesian Community. In

Other Ways of Growing Old, P. Amoss and S. Harrell, eds. Pp. 155–173. Stanford: Stanford University Press.

Noë, R.
1990 A Veto Game Played by Baboons: A Challenge to the Use of the Prisoner's Dilemma as a Paradigm for Reciprocity and Cooperation. *Animal Behavior* 39:78–90.

Noë, R., and P. Hammerstein
1995 Biological Markets. *Trends in Ecology and Evolution* 10:336–339.

Noë, R., C. van Schaik, and J. van Hooff
1991 The Market Effect: An Explanation for Payoff-Asymmetries among Collaborating Animals. *Ethology* 87:97–118.

Nowak, M., and K. Sigmund
1990 The Evolution of Stochastic Strategies in the Prisoner's Dilemma. *Acta Applied Mathematics* 20:247–265.
1992 Tit for Tat in Heterogeneous Populations. *Nature* 355:250–253.

Packer, C.
1986 Whatever Happened to Reciprocal Altruism? *Trends in Ecology and Evolution* 1:142–143.

Parker, G.
1974 Assessment Strategy and the Evolution of Fighting Behaviour. *Journal of Theoretical Biology* 47:223–243.

Rasmusen, E.
1989 *Games and Information*. Cambridge: Blackwell.

Roth, A.
1987 Bargaining Phenomena and Bargaining Theory. In *Laboratory Experimentation in Economics: Six Points of View*, A. Roth, ed. Pp. 14–41. Cambridge: Cambridge University Press.

Roth, A., and M. Malouf
1979 Game-Theoretic Models and the Role of Information in Bargaining. *Psychological Review* 86:574–594.

Roth, A., and U. Rothblum
1982 Risk Aversion and Nash's Solution for Bargaining Games with Risky Outcomes. *Econometrica* 50:639–647.

Roth, A., and F. Shoumaker
1983 Expectations and Reputations in Bargaining: An Experimental Study. *American Economic Review* 73:362–372.

Roth, A., J. Murnighan, and F. Shoumaker
1988 The "Deadline Effect" in Bargaining: Some Experimental Evidence. *American Economic Review* 78:101–124.

Sahlins, M.
1971 The Intensity of Domestic Production in Primitive Societies. In *Studies in Economic Anthropology*, G. Dalton, ed. Pp. 30–51. Washington D.C.: American Anthropological Association.
1972 *Stone Age Economics*. Chicago: Aldine.

Shubik, M.
1982 *Game Theory in the Social Sciences*. Cambridge, Massachusetts: MIT Press.

Smith, A.
1979 Chayanov, Sahlins, and the Labor-Consumer Balance. *Journal of Anthropological Research* 35:477–480.
Smith, E.
1991 *Inujjuamiut Foraging Strategies*. New York: Aldine.
Smuts, B., and J. Watanabe
1990 Social Relationships and Ritualized Greetings in Adult Male Baboons *(Papio cynocephalus anubis). International Journal of Primatology* 11:147–172.
Sosis, R.
1997 *The Collective Action Problem of Male Cooperative Labor on Ifaluk Atoll*. Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.
1998 The Emergence and Stability of Cooperative Fishing on Ifaluk Atoll. In *Human Behavior and Adaptation: An Anthropological Perspective*, L. Cronk, N. Chagnon, and B. Irons, eds. New York: Aldine de Gruyter, in press.
Stahl, I.
1972 *Bargaining Theory*. Stockholm: Economics Research Institute, Stockholm School of Economics.
Stephens, D., and J. Krebs
1986 *Foraging Theory*. Princeton: Princeton University Press.
Tannenbaum, N.
1984 The Misuse of Chayanov: "Chayanov's Rule" and Empiricist Bias in Anthropology. *American Anthropologist* 86:927–942.
Taylor, M.
1987 *The Possibility of Cooperation*. Cambridge: Cambridge University Press.
Tracey, J., D. Abbott, and T. Arnow
1961 *Natural History of Ifaluk Atoll*. Honolulu: University of Hawaii Press.
Trivers, R.
1971 The Evolution of Reciprocal Altruism. *Quarterly Review of Biology* 46:35–57.
Vehrencamp, S.
1983 A Model for the Evolution of Despotic versus Egalitarian Societies. *Animal Behaviour* 31:667–682.
Vollrath, F.
1980 Male Body Size and Fitness in the Web-Building Spider, *Nephila clavipes. Zeitschrift für Tierpsychologie* 53:61–78.
von Nuemann, J., and O. Morgenstern
1944 *The Theory of Games and Economic Behavior*. Princeton: Princeton University Press.
Yamaguchi, K.
1991 *Event History Analysis*. Newbury Park: Sage Publications.