



Fishing and the Sexual Division of Labor among the Meriam

ABSTRACT Do men and women forage differently because they are cooperatively responding to children's requirements for care or because they are differentially sensitive to variance? In this article, I examine how care trade-offs and variance contribute to gender differences in fishing strategies among Torres Strait Islanders (Meriam). Women's fishing had lower failure rates, coefficients of variation, and frequencies of sharing than men's fishing. Men and women responded to trade-offs between mean and variance differently: Women spent less time on high mean–high variance activities, men less time on high mean–low variance activities. Although child-care trade-offs affected time allocation to different fishing activities among women, they did not affect differences in time allocation between the sexes. These results support previous work implicating variance and sharing frequency as important resource currencies shaping gender differences in subsistence decisions, and they offer challenges to a general model of the division of labor predicated on economic notions of specialization as increasing production efficiency. [Keywords: Torres Strait, behavioral ecology, division of labor, fishing, food sharing]

GENDER DIFFERENCES IN PRODUCTION are a ubiquitous feature of modern human subsistence strategies. Early attempts at explaining why men and women produce differently emphasized women's physiological constraints (Durkheim 1933; Murdock 1949), but more recent approaches recognize the important role of more proximate social, ecological, and economic variables such as gender role socialization (Broude 1990; Draper 1975); agricultural intensification (Burton and White 1984; Ember 1983); taboo and gender politics (Brightman 1996); seasonal changes in foraging productivity (Hurtado and Hill 1990); child-care trade-offs (Brown 1970; Hurtado with Hill, Kaplan, and Hurtado 1992); the maintenance of cooperative labor partnerships (Hewlett 1992); the relative importance of male-to-male competition and hunting prestigious game (Bliege Bird with Smith and Bird 2001; Sanday 1981); and the unpredictability of certain foraging activities (Hawkes 1991; Peacock 1991).

Of these, two models have shown particular empirical promise as predictors of the sexual division of subsistence labor (hereafter, DOL). One sees women's subsistence choices as shaped by context-specific economic trade-offs between production and reproduction. In this model, child-care constraints are incorporated into a more general model of household production in which the basic function of a di-

vision of household labor is to enhance the efficiency of cooperative production through complementary work effort by married partners (Durkheim 1933; Halperin 1980; Hurtado with Hill, Kaplan, and Hurtado 1992; Kaplan with Hill, Lancaster, and Hurtado 2000; Lévi-Strauss 1956; Murdock 1949; Sahlins 1972). This "economy of scale" model masculinizes or feminizes subsistence roles to tap the relative skills and abilities (comparative advantages) of men and women as they attempt to maximize household production (Becker 1985). The model proposes that households are like larger labor markets in that there are considerable common gains from specialization and trade. If each member of a household specializes in certain productive tasks, and subsequently trades or pools the results with other household members, household production as a whole is greater. To explain how to divide labor, the model incorporates ideas about "comparative advantage" in which tasks are assigned according to ability. Women, faced with the constraints of pregnancy, lactation, and child minding, specialize on gathering plant foods and food preparation and processing, while men, free from such constraints, are most efficient at hunting and fishing (Brown 1970; Burton et al. 1977; Murdock and Provost 1973). This model predicts that the DOL is shaped by women's preferences for subsistence activities that are more productive for child foragers, less

dangerous to small children, or those in which productivity does not decline significantly when children are present (Brown 1970; Hurtado with Hill, Kaplan, and Hurtado 1992).

The second model focuses on the intersection between social interactions and local ecology, proposing that differential sensitivity to variance in resource acquisition shapes foraging preferences (Bird 1999; Hawkes 1990; Jochim 1988; Peacock 1991). Social and ecological contexts create benefits and opportunities for acquiring resources with different probabilities of success. Competitive regimes and opportunities for gaining social status through resource sharing bias some foragers (more often men) toward more variable resources, whereas those who gain greater benefits for actually consuming the resource or feeding dependent household members (more often women) do better with a strategy that minimizes variance in acquisition.

Both the variance model and the child-care constraints model have been proposed to explain the DOL among Ache hunter-gatherers. Kristen Hawkes (1990, 1991) demonstrated that the relative foraging effort of each sex could be predicted by the variance in harvest efficiency. Men's preference for variance, she argued, was the outcome of preferences for unpredictably acquired resources that were subject to widespread sharing; likewise, Hawkes proposed that women's aversion to variation was the outcome of preferences for resources that predictably met a nutritional threshold. Ana Magdalena Hurtado with colleagues (1992) examined the Ache DOL from a time allocation perspective. Their results suggested that the DOL was maintained by the trade-offs women faced between caring for children and feeding them, producing a cooperative "economy of scale" wherein males and females specialized in different resource types to optimize household production. Men preferred high variance resources because they offered (a) high child-care trade-offs to women and (b) larger harvests, which could be directed both to households and to the wider public arena.

These models identify three possible sources for gendered biases in foraging choices: variance, sharing, and child-care constraints. The models also make different predictions concerning the relationship between men's and women's foraging effort and child-care trade-offs. In this article, I draw on these models to propose some testable hypotheses to explain gender biases in Meriam men's and women's fishing decisions. Do women who must care for children prefer resources associated with low child-care trade-offs? Are the differences in fishing preferences between the sexes predicted by resource variance or child-care trade-offs? Do preferences for sharing affect gender-biased fishing decisions? Is sharing a function of harvest size or variance?

ETHNOGRAPHIC BACKGROUND AND METHODS

The Meriam Islands (Mer, Dauar, and Waier) are located on the northern Great Barrier Reef, 140 kilometers from New

Guinea in Australia's Torres Strait. Meriam peoples are culturally Melanesian, and historically they occupied a central role in trading networks reaching north to Highlands New Guinea and south to Aboriginal communities on the Cape York Peninsula. In 1998, there were 430 Meriam living in 84 households along the northwest foreshore of the main island, Mer. Until the mid-1970s, most Meriam relied extensively on subsistence gardening. Although horticulture has declined in importance today, marine fishing remains a vital component of Meriam social and economic life, particularly in the incorporation of fish, shellfish, and turtle into the public feasting cycle, which features elaborate funeral feasts and involves dancing, distribution, and display (Bliege Bird and Smith 2005; Smith with Bliege Bird 2000).¹

Observations of Meriam marine fishing and food-sharing strategies were conducted over a period of 27 months between January 1993 and July 1999 specifically to examine the costs and benefits of the DOL and to determine the nature of the trade-offs affecting men's and women's fishing decisions. The data collected included: (1) time allocation to various fishing activities in three different marine habitats; (2) fishing efficiency and the frequency of sharing to another household; and (3) the effect of the presence of dependent children on women's fishing efficiency and time allocation.

The marine environment contains three distinct fishing macropatches that usually define the boundaries of any fishing trip (foragers tend not to switch between patches during a single fishing trip). *Macropatches* are large-scale habitats within which there are several types of distinct prey patches and fishing activities characterized by mutually exclusive search (which I refer to as "fishing activities"). The fishing activities in each macropatch are associated with different levels of variance, different expected returns (sometimes), and different child-care compatibility. The patches are as follows: (1) *intertidal*, the exposed reef at low tide on the southwest end of the island; (2) *beach*, the sandy nearshore on the northeast end of the island, near the village; and (3) *offshore*, reefs and open water, accessed with open boats equipped with outboard motors. The analysis below considers the decisions men and women made about how to allocate their time to various subsistence fishing activities within each of the three fishing macropatches. Details on turtle hunting and sharing and demographics are presented elsewhere (Bird and Bliege Bird 1997; Bliege Bird and Bird 1997; Bliege Bird with Smith and Bird 2001; Bliege Bird with Kushnick, Bird, and Smith 2002).

Because Meriam clan- and patrilineage-based ownership of residential, gardening, and fishing territories is still intact and actively defended, and the beach and reef macropatches are small and highly visible from the shoreline, I employed a patch sampling scheme to collect data on time allocation and fishing efficiency. I randomly selected a two-hour observation period between 6:00 a.m. and 6:00 p.m. (very little fishing occurs at night) from March 1994 to March 1995 and monitored the time all individuals allocated to different fishing activities. I was able to observe

the entire length of the foreshore, including all patrilineal fishing territories by alternating my position during the sample period. This record resulted in 1,300 person-hours of observation on 96 women and 60 men over the age of 15. I use the record to calculate the proportion of time devoted to each fishing activity within the beach and intertidal macropatch, and to evaluate differences in time allocation to different fishing activities according to one's overall constraints and trade-offs (such as having more dependent children to feed). During this observation period, I also used focal individual follows (Altmann 1974) to record the activities of the first individual to arrive after the sample block had started, including time spent in travel to the patch, time spent in each fishing activity, and counts and weights of the individual's harvest at the end of the episode. The total focal follow sample used here includes 384 bouts, and it is used to calculate return rates, success rates, harvest sizes, sharing frequencies, the effect of children's presence, and the percentage of calories acquired by men and women.

To sample decisions about offshore fishing, I also incorporated the use of focal follows and direct observational techniques, but I was not able to select individuals randomly. I invited individuals to use my boat or accompanied them in theirs. Measures of return and time allocation to different fishing activities while offshore are derived from these ad lib samples. In addition to making systematic observations, I also interviewed 13 women and 18 men on issues related to the DOL, examined perceptions of men's work and social status of both men and women, and conducted a three-month survey of acquisition and sharing on eight households over 29 sample days.²

Decisions about how much time to spend on different simultaneously available fishing activities within a macropatch are difficult to model because, generally, to predict what types of fishing activities people should choose, we need to know the average energetic return rates from fishing activities they did not choose, as well as other opportunity costs people face in deciding to exploit one patch or fishing activity over another. Because this is empirically difficult, a rough proxy model of patch choice is often used, which combines the standard assumption that foragers seek to maximize overall mean foraging return rates (Kaplan and Hill 1992) with the patch residence time predictions of the marginal value theorem (Charnov 1976) that foragers will switch fishing activities when returns fall below the marginal rate for the entire zone including travel to the next fishing location (Smith 1991). One prediction consistent with this model is that within a set of spatially and temporally congruent resources (foraging patch) all foragers should end up spending more time in the fishing activity with the highest return rate, and less time in other fishing activities, in an attempt to maximize total energetic return rates. Any departures from this pattern should indicate that foragers have other goals in mind (e.g., time minimization or threshold requirements) or are faced with constraints that prevent them from gaining high returns. As Richard Sosis (2002) points out, such a correlation is not a direct

test of any patch choice model, but it offers a useful starting point to evaluate gender differences in time allocation to particular fishing activities.

One way to test for variance sensitivity is to experimentally present foragers with two or three simultaneous options: Usually, a forager chooses between prey types with similar mean returns but different variance. Here, I focus on fishing decisions in three macropatches (the beach, the reef, and offshore waters) and explore how males and females within each macropatch allocate their time among fishing activities. The child-care trade-offs model predicts that (1) men prefer (and women avoid) fishing activities with high child-care trade-offs; (2) foragers accompanied by small children will choose to spend more time in fishing activities associated with low child-care trade-offs; and (3) sharing is a function of harvest size, so that only large harvests have a portion directed to consumers other than one's own household. The variance sensitivity model predicts that (1) given equal rates of return, women will spend less time and men more time in the more variable fishing activities; and (2) men should spend more time, and women less time, on resources that are widely shared. The null hypothesis in this case states that if males and females are not sensitive to variance or to child-care constraints, and if they are attempting to maximize the rate of caloric gain, they should simply allocate their time within each macropatch according to expected rates of return. In the following section, I test these five predictions within each macropatch.

RESULTS

Division of Labor in the Beach Macropatch

The beach macropatch is located along the village foreshore within each patrilineage's residential boundary, where the reef is more deeply submerged and a wider variety of fish are available. In the beach patch, there are three different fishing activities simultaneously available. Sardine netting (NET) involves casting a weighted circular hand net into schools of sardines along the foreshore. Small-hook fishing (SHF) targets small- to medium-sized reef fish using dough, small morsels of fish, or weed baits. Large-hook fishing (LHF) targets semipelagic and reef-dwelling piscivorous fish that forage intermittently along the nearshore. Foragers use a metal hook baited with whole or live sardine attached to a monofilament hand line.

Null Hypothesis: Men and Women Allocate Their Time According to Energetic Rates of Return. According to the null hypothesis, both men's and women's average time allocation to fishing activities within a patch should correspond to the average expected energetic return rate associated with each fishing activity. In the beach patch, the most efficient fishing activity (NET) yields ten times the efficiency of the two alternatives, SHF and LHF fishing (see Table 1). The sexes did not differ in their time allocation to NET, but they did differ significantly on the two lower-efficiency fishing activities. Men preferred to spend 62 percent of their

TABLE 1. Characteristics of fishing activities in three macropatches.

Fishing Activity	% Macropatch Time		Mean Returns Kcal/hr	Coeff of Var (CV)	Success Rate	Mean Harvest Size (kcal)	Harvest Size Range	N	Sharing Freq	% kcal by F
	F	M								
NET	9	9	9810	.667	.94	2547	6602	27	.048	85
SHF	66 ^a	15 ^a	356 ^b	1.300 ^c	.755 ^d	709	5874	101	.300	95
LHF	23 ^a	62 ^a	838 ^b	1.761 ^c	.489 ^d	735	7525	87	.643	10
RFC	76 ^a	31 ^a	1492 ^b	.796 ^c	.001	1962	8268	47	.357	73
RSH	14 ^a	4 ^a	575	.441	.050	520	963	10	.140	80
RFS	9 ^a	63 ^a	328 ^b	2.120 ^c	.500	414	3280	29	.300	1
RTF	40 ^a	8 ^a	677	1.134 ^c	.059	988	5279	20	.201	44
RBD	0	25	1348	.707	.120	3016	10464	17	.652	0
TRM	7 ^a	47 ^a	2312	2.335 ^c	.540	3076	26594	46	.850	2

^a denotes means that are significantly different at $p < .001$ (t-test) between males and females in the same fishing activity.

^b denotes means that are significantly different at $p < .001$ (t-test) between fishing activities in the same macropatch.

^c denotes variances that are significantly different at $p < .001$ (Levene's test) between fishing activities in the same macropatch.

^d The odds of SHF success are increased 1.46 times with every additional 30 minutes spent fishing (logistic regression, odds ratio = 1.46 [per 30 minutes], $p = .0041$). There is no significant effect of time on success rate for LHF (odds ratio = .912, $p = .6898$).

time in LHF and 15 percent in SHF. Women instead preferred SHF (66 percent) to LHF (23 percent). Here, the null hypothesis was violated in two ways: Both men and women allocated most of their fishing time to lower-efficiency fishing activities, and men and women differed in which lower-return activity they preferred.

Why Do Men Prefer Large Hook Fishing and Women Small Hook Fishing?

Prediction 1. Is LHF associated with a bigger loss to efficiency when children are present? I compared women's return rates with and without children (0–5 years) present using an unpaired, small sample *t* test, which showed no significant effect of a child's presence on either SHF or LHF efficiency (see Table 2).

Prediction 2. Do women with strong child-care trade-offs choose to forage more often in SHF than LHF? I approached this question in two ways, one by measuring women's immediate trade-offs (did they have a child aged 0–5 present while fishing?) and their overall trade-offs (the presence of young [aged 0–5] dependent children at home). If child-care tradeoffs affect how differently women forage from men, those women with children present or with many children at home should have higher costs for engaging in typically men's fishing and should spend less time LHF compared to women foraging alone or with no dependent children at home. The results of this test are presented in Table 2. Women did not spend more time SHF when young children were present, and women with more young children at home allocated their time between fishing activities similarly to women with no dependent children.

Prediction 3. Is the likelihood of sharing a function of harvest size? To test this prediction, I incorporated the independent covariates harvest size (continuous) and the sex of the acquirer into a logistic regression model with a dichotomous dependent variable "Sharing Outcome" (1 = some or all of harvest given to another household, 0 = all kept within household of acquirer). Table 3 shows that the effects of harvest size on sharing are significant only for SHF, and not LHF. This suggests that LHF harvests are more likely to be shared regardless of harvest size, and that SHF harvests are shared between households only when harvests are larger.

Prediction 4. Are men's choices biased toward (and women's away from) the higher variance fishing activity? LHF has significantly higher efficiency and higher variance than SHF (see Table 1). LHF is also more variable in another way: Success rates for LHF (49 percent) are much lower than for SHF (75 percent). Success rates for SHF are also more predictable: The odds of success can be increased 1.46 times with every additional 30 minutes spent fishing. There is no significant effect of time on success rate for LHF.

Prediction 5. Are men's choices biased toward (and women's away from) fish that are more likely to be shared? In total, 64 percent of large-hook (18/28) and 30 percent of small-hook harvests (19/64) were shared to at least one other household. Table 4 shows that relative to small-hook fish, the odds of sharing a portion of harvest of large-hook fish are three times higher, controlling for harvest size and sex of the acquirer.

Division of Labor in the Intertidal Macropatch

The reef macropatch is located on the southwest (windward) side of the island, where the reef is shallow and broad, approximately a ten- to 20-minute walk from the village. Most intertidal reef activities take place during the six months of the year when the diurnal tides are lowest. The key fishing activities here are reef-flat collecting (RFC), reef spearfishing (RFS), and rocky-shore harvesting (RSH). RFC targets primarily large tridacnic clams and conch scattered across the reef; RFS targets reef fish in lagoons and at the reef edge; and RSH involves the search for sand bivalves and periwinkles in the upper intertidal. All three fishing activities occur in the same patch during the same conditions, during a two-hour window when the reef is exposed at low tide.

Null Hypothesis: Men and Women Allocate Their Time According to Energetic Rates of Return. The reef offers foragers the choice between taking a set of reliable, high efficiency prey (RFC); reliable, low efficiency prey (RSH); or unreliable, low efficiency prey (RFS). Here, men and women differ significantly in the time they allocate to the most

TABLE 2. Childcare tradeoffs and women's fishing decisions in three macropatches.

Tradeoff	Prediction	Result		T-Test
		Child Present	Child Absent	
Child present (care vs. efficiency)	Presence of child does not affect mean efficiency (kcal/hr) in SHF	SHF: 560 kcal/hr (<i>n</i> = 16 bouts)	SHF: 384 kcal/hr (<i>n</i> = 29 bouts)	<i>p</i> = .3546
		LHF: 272 kcal/hr (<i>n</i> = 14 bouts)	LHF: 876 kcal/hr (<i>n</i> = 20 bouts)	<i>p</i> = .1156
	Presence of child increases time allocation to SHF	SHF: 74% TFT*	SHF: 72% TFT	<i>p</i> = .8745
		LHF: 25% TFT (<i>n</i> = 12 beach trips)	LHF: 11% TFT (<i>n</i> = 18 beach trips)	<i>p</i> = .3342
	Presence of child does not affect mean efficiency (kcal/hr) in RFC	RFC: 549 kcal/hr (<i>n</i> = 4 bouts)	RFC: 1393 kcal/hr (<i>n</i> = 13 bouts)	<i>p</i> = .0300
		RSH: 478 kcal/hr (<i>n</i> = 4 bouts)	RSH: 503 kcal/hr (<i>n</i> = 7 bouts)	<i>p</i> = .8996
	Presence of child does not affect time allocation to RFC	RFC: 48% TFT	RFC: 76%	<i>p</i> = .0445
Presence of child does not affect mean efficiency in RTF	RSH: 47% TFT (<i>n</i> = 4 intertidal trips)	RSH: 14% (<i>n</i> = 13 intertidal trips)	<i>p</i> = .0013	
	RTF: 745 kcal/hr (<i>n</i> = 8 bouts)	RTF: 940 kcal/hr (<i>n</i> = 3 bouts)	<i>p</i> = .6180	
Presence of child increases time allocation to RTF	TRL: 268 kcal/hr (<i>n</i> = 6 bouts)	TRL: 746 kcal/hr (<i>n</i> = 3 bouts)	<i>p</i> = .2690	
	RTF: 51% TFT	RTF: 44%	<i>p</i> = .7883	
	TRL: 11% TFT (<i>n</i> = 11 offshore trips)	TRL: 25% (<i>n</i> = 4 offshore trips)	<i>p</i> = .0745	
Young family (care vs. subsistence)	Having more small children (age 0–5) at home to care for increases time allocation to SHF compared to women with no children.	SHF: 60% TFT	SHF: 64% TFT	<i>p</i> = .8147
		LHF: 28% TFT (<i>n</i> = 17 women)	LHF: 12% TFT (<i>n</i> = 16 women)	<i>p</i> = .1415

Note. *TFT: Total Foraging Time within the macropatch. Percentages that do not add to 100 reflect time allocated to alternative activities within the macropatch.

TABLE 3. Logistic models for the odds of sharing according to harvest size in kilocalories.

Model	Variable	Slope Coefficient(β)	Std. Error	Chi-Square	P-value (Wald test)	Odds ratio (harvest size) ^a
Small hook	Shared: constant	-1.600	.451	12.609	.0004	.202
	Harvest size	.0004	.0001	4.197	.0405	(0) 1.000 (1000) 1.350 (5000) 4.482 (10000) 20.085
Large hook	Shared: constant	-.170	.753	.051	.8210	.843
	Harvest size	.0002	.0002	1.256	.2625	(0) 1.000
Reef top	Shared: constant	-3.101	.887	12.231	.0005	.045
	Harvest size	.001	.0002	7.439	.0064	(0) 1.000 (1000) 2.718 (5000) 148.413 (10000) 22026
Trolling	Shared: constant	1.075	.983	1.197	.2739	2.931
	Harvest size	.00007	.0001	.410	.5219	(0) 1.000
Spearfish	Shared: constant	-4.725	3.507	1.816	.1788	.009
	Harvest size	.002	.002	1.444	.2295	1.002
Reef Flat	Shared: constant	-1.733	.663	6.820	.0090	.177
	Harvest size	.001	.0003	4.987	.0255	1.001 (1000) 2.718 (5000) 148.413

Note. Likelihood ratio tests: **Small hook fishing:** $\chi^2 = 7.095$, $p = .0077$; **large hook fishing:** $\chi^2 = 1.442$, $p = .2297$; **Reef top fishing:** $\chi^2 = 10.454$, $p = .0012$; **Trolling:** $\chi^2 = 1.082$, $p = .2982$; **Spearfish:** $\chi^2 = 5.186$, $p = .0228$; **Reef flat:** $\chi^2 = 7.168$, $p = .0074$.

^a **Odds ratios.** For continuous variables, odds ratios are given as the odds of sharing a one unit increment of the independent variable (here, a single kilocalorie [kcal]). To calculate the odds of sharing a 1,000 kcal harvest compared to the odds of sharing a 10,000 kcal harvest, we use the formula, $e^{x\beta}$, where x = the size of the harvest and β = the slope coefficient. Because these are independent models looking only at the effects of increasing harvest size within a fishing activity, the odds ratios are not comparable between fishing activities. To compare relative odds between fishing activities, the odds ratios in Table 4 must be used.

TABLE 4. Logistic regression model for the relative odds of sharing in each fishing activity.

Model	Variable	Slope Coefficient (β)	Std. Error	Chi-Square	P-value (Wald test)	Odds Ratio
Full	Shared: constant	-3.914	1.071	13.352	.0003	.020
	Harvest size	.0003	.0001	10.455	.0012	(0) 1.000 (1000) 1.350
	Sex: Female	Reference				
	Sex: Male	.128	.418	.094	.7586	1.137
	Sardine	Reference				
	Small hook	2.382	1.081	4.855	.0276	10.831
	Large hook	3.458	1.134	9.302	.0023	31.755
	Reef top	1.646	1.126	2.135	.1440	5.184
	Trolling	3.759	1.268	8.794	.0030	42.915

Note. Likelihood ratio test: $df = 6$, $\chi^2 = 62.299$, $p < .0001$. 79.6 percent of observations correctly classified ($n = 167$). Sex has no effect on sharing outcome in the model ($\chi^2 = .094$, $p = .7591$), while both harvest size ($\chi^2 = 15.257$, $p < .0001$) and fishing activity ($\chi^2 = 21.869$, $p = .0002$) remain highly significant.

efficient fishing activity. As I report in Bliege Bird with colleagues (2001), men spend the majority of their reef time in the least efficient fishing activity (spearing), while women allocate their time according to long-term energetic rates of return, spending more time in RFC, an activity that provides three times higher efficiency than men's spearing (see Table 1).

Why Do Women Prefer Shellfishing and Men Prefer Spearfishing?

Prediction 1. Is RFS associated with a bigger loss to efficiency than RFC when children are present? Unfortunately, women so rarely went spearing that it was not possible to examine the effect of children on return rates. However, it is possible to examine the effects of children on RFC. When RFC foragers were accompanied by children under age five (7/34 bouts), they appeared to face rather strong trade-offs. They had significantly smaller harvests and experienced a 53-percent reduction in their collecting efficiency (see Table 2). Their harvest efficiency with children dropped so far that RSH was only marginally less efficient. RSH did not show any significant decline in efficiency with children's presence.

Prediction 2. Do women with stronger trade-offs spend more time in RFC? Women with stronger child-care trade-offs actually spent less time in RFC and more time RSH during the low tide (see Table 2). When young children were present, women spent half as much time RFC (48 percent) and twice as much time RSH (47 percent) as they did when their children were absent. Even though RFC returns declined by 53 percent with the presence of children, all women in the sample allocated their time among reef-fishing activities in the long term, according to the predictions of the patch choice model. Their decisions departed from the model only when small children were present and thus when their likely returns in both fishing activities were similar.

Prediction 3. Is sharing a function of harvest size? Table 3 shows that RFS is not more likely to be shared with increasing harvest size. RFC harvests are 55 times more likely to be shared at a five-kilogram harvest as compared to a one-kilogram harvest.

Prediction 4. Is RFS more variable than RFC? Table 1 shows that the coefficient of variation in mean returns for RFC is one-third that of spearing (0.796 vs. 2.12). Only 50 percent of RFS bouts are successful, whereas no RFC episode ever failed to acquire any meat.

Prediction 5. Are RFS harvests more likely to be shared? RFS does not produce harvests that are more likely to be shared. RFC produces harvests that are more than five times larger and that are more often shared: 36 percent are distributed to more than one household, compared to 30 percent of spearing harvests. However, given that RFS harvests are on average tiny compared to RFC harvests, they seem to be shared more often than expected.

Division of Labor in the Offshore Macropatch

Offshore trips incorporate three different fishing activities: (1) reef-top fishing (RTF), targeting flooded nearshore reefs and focusing on small carnivorous reef fish like coral cod and sea perch; (2) reef-bottom diving (RBD), occurring at reef slopes and lagoon bottoms and targeting commercial species (spiny lobster, trochus, and coral trout); and (3) trolling at flooded reef margins (TRM), targeting large pelagic fish like Spanish mackerel and tuna. RBD is a commercial fishing activity (85 percent of a harvest is sold on average) in which few women (and only a small proportion of men) were currently participating; it is thus excluded from the analysis.

Null Hypothesis: Men and Women Allocate Their Time According to Energetic Rates of Return. TRM efficiency is three times higher than RTF, but because of the high exogenous variance, the difference is not statistically significant. Even so, there were significant gender differences in time allocation to TRM versus RTF. Women spent the majority of their total offshore time RTF, men in TRM (see Table 1).

Why Do Women Prefer RTF?

Prediction 1. Is TRM associated with a bigger loss to efficiency when children are present? When women did take small children with them offshore fishing, they experienced reduced return rates in TRM, but the sample size was very small: Children were present on eight trips and absent on five (see Table 2). Mean RTF return rates were 26 percent lower and trolling rates 64 percent lower when women fished with children under age five, but the effect was not significant and likely swamped by other exogenous sources of variance.

Prediction 2. Are women less likely to TRM when children are present? The presence of a child changed women's

relative time allocation but not significantly (see Table 2). Women spent twice as much time trolling and slightly more time RTF when children were absent, but the difference was not significant.

Prediction 3. Is sharing a function of harvest size? The offshore model in Table 3 shows that harvest size has a strong effect on the likelihood of sharing for RTF but not TRM. The odds of sharing a 5,000-kilocalorie harvest of RTF fish are 55 times greater than a 1,000-kilocalorie harvest, but TRM fish at small and large harvests have the same odds of sharing.

Prediction 4. Do men prefer the more variable fishing activity? Trolling is associated with 65 times more variance and a success rate half that of RTF. The coefficient of variation in mean trolling returns is twice that of RTF (see Table 1).

Prediction 5. Is women's time allocation biased toward the fishing activity with lower frequencies of sharing? TRM harvests are shared 85 percent of the time, whereas only 20 percent of RTF harvests are distributed beyond the acquirer's household. The logistic regression model in Table 4 shows that after controlling for harvest-size effects, the relative odds of sharing following a trolling harvest (42.9) are still eight times higher than the odds of sharing a reef-top harvest (5.2), relative to the least shared fishing activity (NET).

Summary of Results

The null hypothesis that both men and women would choose sets of fishing activities that maximize their average caloric gain rate was not supported in any of the three macropatches.

On the beach, men spent more time line fishing for pelagic fish with a failure rate that did not diminish with time, while women spent the most time fishing for resident reef fish with a higher chance of success. Here, children were often present and did not cause women's fishing returns to decline. LHF harvests were shared more frequently than SHF harvests, but SHF harvests were more likely to be shared as a function of harvest size. The fact that neither men nor women spent most of their time in sardine netting could indicate that the decision to line fish does not offer any opportunity cost to sardine netting because the sardines are generally always present along the foreshore, or that the marginal benefits from continuing to spend more time at NET may saturate relatively quickly, because the rate of caloric acquisition is so high that one can supply an entire family's meal with ten or 15 minutes of netting.

On the reef, women chose to spend most of their time in the most efficient fishing activity, which was associated with significant declines in efficiency if combined with child care. Women switched to the second-highest efficiency fishing activity, RSH, when young children were present. Men preferred the lower efficiency, higher variance fishing activity (RFS), at a significant cost to their overall returns, but these harvests were not more likely to be shared.

Offshore, men spent more time in high variance trolling, women in low variance RTF. The presence of small children had a negative, but nonsignificant effect on

fishing-return rates and time allocation. Although sharing was more frequent for trolled harvests, harvest size predicted sharing only for RTF. Trade-offs between variance and mean efficiency affected men and women differently: Women maximized energetic efficiency when high efficiency resources were associated with low variance (intertidal), whereas men did so when high efficiency resources were high variance (offshore). Differences between men and women were most strongly predicted by differential variance sensitivity, whereas differences among women were predicted by child-care trade-offs. Child-care trade-offs explained why some women spent less time RFC and more time RSH, but they did not account for why women chose SHF over LHF, collected shellfish, or fished on the reef top in preference to trolling.

DISCUSSION

Ethnographic accounts of hunter-gatherer subsistence often conclude that women prefer to acquire resources associated with lower acquisition variance (Hawkes 1991; Noss and Hewlett 2001; Peacock 1991). This generalization holds across Oceania as well, where fishing strategies follow a very similar pattern to that observed among the Meriam (Chapman 1987). Women's subsistence effort focuses on shellfish collecting and reliable types of fishing, whereas men turn toward pelagic fish and hunting turtles or marine mammals. Women's harvests seem to be relatively consistent on both a daily and seasonal basis, and sometimes they may be more productive than men's (Carrier 1982; Dye 1983; Ryan 1981).

The premise that women's child-care constraints and trade-offs cause these gender differences in labor has a long history in anthropology. Women face trade-offs between foraging and caring for children, especially when children are very young and care contributes more to their survival than does more food (Hurtado with Hill, Kaplan, and Hurtado 1992). Women also face trade-offs between maximizing individual returns and group returns when they forage with their older children, who can be very productive on some resources and less productive on others (Hawkes with O'Connell and Blurton Jones 1995). They also face trade-offs between carrying heavy loads of food and carrying children (Blurton Jones 1987), which can influence birth spacing. Such trade-offs often make some resources more attractive than others: For example, Hadza women devote more time to foraging for tubers when they are postmenopausal, and they devote more time to berries and other "kid-friendly" foods during their reproductive years because children are more productive picking berries than root digging and, thus, can actually enhance team return rates (Hawkes with O'Connell and Blurton Jones 1995). The trade-off I tested here centered on the reduction in fishing efficiency when women must combine foraging with child care. There are many other possible trade-offs related to parental investment that women might face. These results suggest only that considerations of care compatibility

TABLE 5. Subsistence production by Meriam adults, ten-household sample.

HH	CH	#HH	Obf	Obm	ObDays	Facq	Macq	Fkept	Mkept	Totkept	%FHHC
Gig4	0	4	1	10	26	1415	51802	1415	12022	13437	0.105
Seb1	1	5	5	9	12	8964	64041	5352	3589	8941	0.599
Gig6	2	6	13	7	20	16388	22019	16112	1848	17960	0.897
Gig9	3	6	5	2	7	5795	123666	1200	1647	2847	0.421
Zeu2	3	7	9	11	20	9674	251270	9354	14206	23560	0.397
Deo2	3	8	4	5	17	11503	8706	11503	7386	18889	0.609
Gig1	4	8	5	2	25	19260	10027	10036	0	10036	1.000
Zom2	3	13	8	21	28	9321	287980	9321	104292	113613	0.082
Zom3	8	15	12	2	27	18198	5858	16981	5858	22839	0.744
Zom5	6	16	23	27	60	49338	143296	43602	41517	85119	0.512
Total						149856	968665	124876	192365	317241	0.394

are not among the trade-offs shaping the sexual division of labor among the Meriam.

My results would also seem to suggest that not all divisions of labor follow from the law of comparative advantage. All else being equal, household production of food would be greater if men collected shellfish rather than spearing fish, or if men acquired more reef-top and small-hook fish that are less likely to be shared. Meriam men do not specialize in fishing activities that confront women with high child-care trade-offs; they specialize in high variance fishing activities that are routinely shared. This preference for variance often trades off with the ability to maximize energetic efficiency, as it does for men fishing on the reef. Men prefer variance and unpredictability at a cost to their provisioning efficiency, and this choice further handicaps their ability to adjust subsistence effort to household needs. In contrast, women's focus on more predictable resources allows them to tailor their harvest size through adjusting their time allocation. They can choose to stay longer to share surplus with another household, or they can quit early and keep what they acquire. Although women sometimes acquire high risk prey, they seem to find the trade-off between fame and reliability too expensive: According to one source, "Some women like to catch the big fish, but men like it more. Women, mostly they like the reliable fish." When I asked why this was so, the person replied, "If a woman didn't catch a fish for the table, she'd hear about it" (conversation with author, June 30, 1994).

This does not mean that men never provision their households. As Table 5 shows, men contribute 60 percent of the household's total production after sharing. To make up for the loss in production because of their preferences for high variance, widely shared, and (sometimes) low return fishing activities, they collect turtle during the nesting season, an activity in which women and children also participate (Bliege Bird and Bird 1997). I have not explicitly considered turtle hunting and collecting here, because data on these activities were collected using different methodology and are not directly comparable. My colleagues and I have previously shown that turtle collecting satisfies very different subsistence goals than turtle hunting: Collectors net big benefits for their households, whereas hunters gain little in consumption but get big payoffs in social status, marriage, and family size (Bliege Bird and Bird 1997; Bliege

Bird with Smith and Bird 2001; Smith with Bliege Bird and Bird 2003). Turtle hunting has a higher failure rate than turtle collecting. Hunted turtle are shared more widely than collected turtle, and women often collect but never hunt. The sex biases in turtle acquisition are thus consistent with the patterns in fishing described here.

There are two significant questions relative to gender and sharing that arise from these data: Why are trolled, large-hook, and speared fish more likely to be shared than an equal sized harvest of low variance fish, and why are low variance fish shared at all? It is not simply that men share more often than women; the type of fish acquired trumps sex in determining sharing. That is, when women acquire the same fish as men, they are equally likely to share. There are a number of possible explanations: Variance in large-hook fish is higher and thus demand for such fish is likely to be greater; small-hook harvests are shared only after household needs are satisfied; or, perhaps, different fish provide different types of sociopolitical benefits through sharing.

Meriam attach particular cultural significance to that swim quickly, grow large, and are temporally and spatially unpredictable, especially the pelagic fish Spanish mackerel (*dabor*), giant trevally (*geigi*), and northern blue-fin tuna (*malouap*). These can only be captured through the three fishing activities men more often choose: spearfishing, LHF, and trolling. Meriam revere these fish as symbols of their clan and patrilineage, claim their potency through metaphor, and advertise their capture in various subtle and not so subtle ways. Such fish are displayed prominently and are more likely to be shared at feasts. Attractive young men are likened to the *kem guz* of the *dabor*, the richest belly meat. Anyone, male or female, who manages to catch a large *dabor* or *geigi* adds to their reputation as a skilled fisher. When I asked several men why they spent so much time spearfishing or walking up and down the beach with a large hook and line, each told a story about the time that he had speared a 20-kilogram *geigi* on the reef or the time he caught a huge *malouap* from the beach. They always recount the tale with a satisfied grin, "Everyone was talking about it for days after." These big, risky fish may be significant precisely because they honestly advertise the types of skills that advance sociopolitical goals (Bliege Bird with Smith and Bird 2001; Smith with Bliege Bird and Bird 2003). Sociopolitical competition is what makes a Meriam man (Beckett 1988).

Women's gender identities are constructed through "hard work"; such an identity can be claimed through advertising how much time they have spent fishing, among other things. Meriam women thus may prefer low variance resources not only because they best provision households but also because harvest size more accurately reflects the time they spend fishing, and thus can be an honest index of production effort when shared (Bliege Bird and Smith 2005).

CONCLUSION

The data I present here suggest that Meriam gender differences in fishing are maintained by both men's variance-prone and women's variance-averse fishing decisions, and the ability of each type of resource to satisfy different subsistence goals. High variance resources are more frequently shared regardless of harvest size, satisfying sociopolitical goals. Low variance resources are shared less frequently, only when harvests are larger, satisfying a goal of optimizing household provisioning effort. These results support previous work implicating variance and sharing frequency as important resource "currencies" (at least as important as energy content) shaping gender differences in subsistence decisions. But they also refine our understanding of the relationship between variance, gender, and subsistence decisions: Variance sensitivities can prevent both men and women from maximizing energetic efficiency, sharing is a function of harvest size only for low variance resources, and men and women are equally likely to share if they acquire the same resource type. Although variation in women's time allocation decisions is predicted by child-care trade-offs, such trade-offs do not seem to structure fishing differences between men and women. Taken together, these results offer challenges to a general model of the division of labor predicated on the notion that both men and women prefer to acquire resources that optimize household provisioning effort.

REBECCA BLIEGE BIRD Department of Anthropology, Stanford University, 450 Serra Mall, Stanford, CA 94305

NOTES

Acknowledgments. Douglas Bird, Sarah Hrdy, Peter Rodman, Kristen Hawkes, John Beaton, Eric Smith, and Monique Borgerhoff Mulder commented on many early drafts of this article. The writing of this article would not be possible without the friendship, support, and generosity shown us by the Passi family, who, having adopted Alfred C. Haddon in 1898, took Douglas and I in at the centenary of his visit to Mer. I also owe profound debts of gratitude to the Cowley, Mabo, Blanco, Tabo, Ghee, Noah, Salee, Rice, Kaigey, Kabere, Tapau, and Bon families. This research was supported by grants from the Leakey Foundation, the Wenner-Gren Foundation, the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS), and the National Science Foundation.

1. For additional background on Meriam culture and ecology, see Bliege Bird and Bird 1997, 2002; Bliege Bird with Smith and Bird 2001.

2. For additional detail on methods, see Bird and Bliege Bird 2000; Bliege Bird and Bird 1997; Bliege Bird with Kushnick, Bird, and Smith 2002.

REFERENCES CITED

- Altmann, Jeanne
1974 Observational Study of Behavior: Sampling Methods. *Behaviour* 49(3):227–267.
- Becker, Gary
1985 Human Capital, Effort, and the Sexual Division of Labor. *Journal of Labor Economics* 3:33–58.
- Beckett, Jeremy
1988 *The Torres Strait Islanders: Custom and Colonialism*. Cambridge: Cambridge University Press.
- Bird, Douglas W., and Rebecca Bliege Bird
1997 Contemporary Shellfish Gathering Strategies among the Meriam of the Torres Strait Islands, Australia: Testing Predictions of a Central Place Foraging Model. *Journal of Archaeological Science* 24:39–63.
- 2000 The Ethnoarchaeology of Juvenile Foraging: Shellfishing Strategies among the Meriam Children. *Journal of Anthropological Archaeology* 19:461–476.
- Bird, Rebecca (also listed as Bliege Bird)
1997 Cooperation and Conflict: The Behavioral Ecology of the Sexual Division of Labor. *Evolutionary Anthropology* 8:65–75.
- Bliege Bird, Rebecca, and Douglas W. Bird
1997 Delayed Reciprocity and Tolerated Theft: The Behavioral Ecology of Food Sharing Strategies. *Current Anthropology* 38:49–78.
- 2002 Constraints of Knowing or Constraints of Growing? Fishing and Collecting among the Children of Mer. *Human Nature* 13:239–267.
- Bliege Bird, Rebecca, and Eric A. Smith
2005 Signaling Theory, Strategic Interaction, and Symbolic Capital. *Current Anthropology* 46(2):221–248.
- Bliege Bird, Rebecca, with Geoff Kushnick, Douglas W. Bird, and Eric A. Smith
2002 Risk and Reciprocity in Meriam Food Sharing. *Evolution and Human Behavior* 23:297–321.
- Bliege Bird, Rebecca, with Eric A. Smith and Douglas W. Bird
2001 The Hunting Handicap: Costly Signaling in Human Foraging Strategies. *Behavioral Ecology and Sociobiology* 50:9–19.
- Blurton Jones, Nicolas
1987 Bushman Birth Spacing: Direct Tests of Some Simple Predictions. *Ethology and Sociobiology* 8:183–203.
- Brightman, Robert
1996 The Sexual Division of Foraging Labor: Biology, Taboo, and Gender Politics. *Comparative Studies in Society and History* 38:687–729.
- Broude, Gwen
1990 The Division of Labor by Sex and Other Gender-Related Variables: An Exploratory Study. *Behavior Science Research* 24:29–49.
- Brown, Judith
1970 A Note on the Division of Labor by Sex. *American Anthropologist* 72(5):1073–1078.
- Burton, Michael L., Lilyan A. Brudner, and Douglas R. White
1977 A Model of the Sexual Division of Labor. *American Ethnologist* 4(2):227–251.
- Burton, Michael L., and Douglas R. White
1984 Sexual Division of Labor in Agriculture. *American Anthropologist* 86(3):568–583.
- Carrier, James
1982 Fishing Practices on Ponam Island (Manus Province, Papua New Guinea). *Anthropos* 77:904–915.
- Chapman, Margaret
1987 Women's Fishing in Oceania. *Human Ecology* 15:267–288.
- Charnov, Eric
1976 Optimal Foraging: The Marginal Value Theorem. *Theoretical Population Biology* 9:129–136.
- Draper, Patricia
1975 Cultural Pressure on Sex Difference. *American Ethnologist* 2(4):602–616.

- Durkheim, Emile
1933[1893] *De la Division du Travail Social* (The division of labor in society). George Simpson, trans. Glencoe: Free Press.
- Dye, Thomas
1983 Fish and Fishing on Niuatoputapu. *Oceania* 53(3):242–271.
- Ember, Carol R.
1983 The Relative Decline in Women's Contribution to Agriculture with Intensification. *American Anthropologist* 85(2):285–304.
- Halperin, Rhoda
1980 Ecology and Mode of Production: Seasonal Variation in the Division of Labor by Sex among Hunter-Gatherers. *Journal of Anthropological Research* 36:379–399.
- Hawkes, Kristen
1990 Why Do Men Hunt? Benefits for Risky Choices. *In* Risk and Uncertainty in Tribal and Peasant Economies. Elizabeth Cashdan, ed. Pp. 145–166. Boulder, CO: Westview Press.
1991 Showing Off: Tests of an Hypothesis about Men's Foraging Goals. *Ethology and Sociobiology* 12:29–54.
- Hawkes, Kristen, with James F. O'Connell and Nicolas Blurton Jones
1995 Hadza Children's Foraging: Juvenile Dependency, Social Arrangements, and Mobility among Hunter-Gatherers. *Current Anthropology* 36:688–700.
- Hewlett, Barry
1992 Husband-Wife Reciprocity and the Father-Infant Relationship among Aka Pygmies. *In* Father-Child Relations: Cultural and Biosocial Contexts. Barry Hewlett, ed. Pp. 153–177. New York: Aldine.
- Hurtado, Ana Magdalena, and Kim Hill
1990 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* 46:293–346.
- Hurtado, Ana Magdalena, with Kim Hill, Hillard Kaplan, and Ines Hurtado
1992 Tradeoffs between Female Food Acquisition and Child Care among Hiwi and Ache Foragers. *Human Nature* 3:185–216.
- Jochim, Michael A.
1988 Optimal Foraging and the Division of Labor. *American Anthropologist* 90(1):130–136.
- Kaplan, Hillard, with Kim Hill, Jane Lancaster, and Ana M. Hurtado
2000 A Theory of Human Life History Evolution: Diet, Intelligence, and Longevity. *Evolutionary Anthropology* 9:156–185.
- Kaplan, Hillard, and Kim Hill
1992 The Evolutionary Ecology of Food Acquisition. *In* Evolutionary Ecology and Human Behavior. Eric A. Smith and Bruce Winterhalder, eds. Pp. 167–201. New York: Aldine.
- Lévi-Strauss, Claude
1956 The Family. *In* Man, Culture, and Society. H. L. Shapiro, ed. New York: Oxford University Press.
- Murdock, George P.
1949 *Social Structure*. New York: Free Press.
- Murdock, George P., and Caterina Provost
1973 Factors in the Division of Labor by Sex: A Cross-Cultural Analysis. *Ethnology* 12:203–225.
- Noss, Andrew, and Barry Hewlett
2001 The Contexts of Female Hunting in Central Africa. *American Anthropologist* 103(4):1024–1040.
- Peacock, Nadine
1991 Rethinking the Sexual Division of Labor: Reproductive and Women's Work among the Efe. *In* Gender at the Crossroads of Knowledge: Feminist Anthropology in the Postmodern Era. Micaela di Leonardo, ed. Pp. 339–360. Berkeley: University of California Press.
- Ryan, Thomas
1981 Fishing in Transition on Niue. *Journal de la Societe des Oceanistes* 70–71(37):193–203.
- Sahlins, Marshall
1972 *Stone Age Economics*. Chicago: Aldine de Gruyter.
- Sanday, Peggy
1981 *Female Power and Male Dominance: On the Origins of Sexual Inequality*. Cambridge: Cambridge University Press.
- Smith, Eric A.
1991 *Inujjumiut Foraging Strategies: Evolutionary Ecology of an Arctic Hunting Economy*. Aldine: New York.
- Smith, Eric A., with Rebecca Bliege Bird
2000 Turtle Hunting and Tombstone Opening: Public Generosity as Costly Signaling. *Evolution and Human Behavior* 21:245–261.
- Smith, Eric A., with Rebecca Bliege Bird and Douglas W. Bird
2003 The Benefits of Costly Signaling: Meriam Turtle Hunters and Spearfishers. *Behavioral Ecology* 14:116–126.
- Sosis, Richard
2002 Patch Choice Decisions among Ifaluk Fishers. *American Anthropologist* 104(2):583–598.