

Why Women Hunt

Risk and Contemporary Foraging in a Western Desert Aboriginal Community

by **Rebecca Bliege Bird** and **Douglas W. Bird**

An old anthropological theory ascribes gender differences in hunter-gatherer subsistence to an economy of scale in household economic production: women pursue child-care-compatible tasks and men, of necessity, provision wives and offspring with hunted meat. This theory explains little about the division of labor among the Australian Martu, where women hunt extensively and gendered asymmetry in foraging decisions is linked to men's and women's different social strategies. Women hunt primarily small, predictable game (lizards) to provision small kin networks, to feed children, and to maintain their cooperative relationships with other women. They trade off large harvests against greater certainty. Men hunt as a political strategy, using a form of "competitive magnanimity" to rise in the ritual hierarchy and demonstrate their capacity to keep sacred knowledge. Resources that can provision the most people with the most meat best fit this strategy, resulting in an emphasis on kangaroo. Men trade off reliable consumption benefits to the hunter's family for more unpredictable benefits in social standing for the individual hunter. Gender differences in the costs and benefits of engaging in competitive magnanimity structure men's more risk-prone and women's more risk-averse foraging decisions.

They were putting up the boughshed for the mourners in the reburial ceremony that was due to take place in Parnngurr the following day. Martu were coming in for the ceremony from all over the Western Desert and Pilbara—Jigalong, Warburton, Bidyadanga, Wiluna, Yandeyarra, even Kiwirkurra—and there was little to eat in the store. Karimarra was preparing *jurnpa* (ash) behind the house for her husband to mix with his tobacco. A strong, cold wind blew steadily from the southeast. It was a good time to set fire to a tract of spinifex for hunting sand goanna, but no one wanted to go. They all wanted to look for bigger meat. "We should go *kipara-karti* [bustard hunting]," she said, poking at the small fire with a stick. "Look for *kuwiyi* [meat]."

What Karimarra said called to mind something her brother had once said about Martu foraging gender roles: "Women dig goanna," he grinned, knowingly oversimplifying. "Men chase kangaroo." Ethnographers working in the Western Desert have long noted that throughout much of the arid zone the sexual division of labor was flexible, variable, and seasonally overlapping (Gould 1969, 1980; Cane 1987; Berndt

and Berndt 1988; Tonkinson 1991). Women hunted and men gathered, but at times men focused entirely on hunting kangaroo and emu, failing often and acquiring less than 10% of the total calories consumed (Gould 1980). Women occasionally hunted kangaroo but more often smaller animals, and there were periods when their production was almost entirely based on roots, fruits, and seeds (Kaberry 1939; Sackett 1979; Gould 1980). Most scholars have emphasized that gender differences in foraging emerge here through the political and reproductive benefits men gain from provisioning affinal kin and influential people with meat from large animals, particularly kangaroos, bustards, and emus (Sackett 1979; Hiatt 1982; Altman 1987; Tonkinson 1988*b*). Men hunt kangaroo to gain the approbation of in-laws in order to marry younger (or additional) wives (Altman 1984, 1987), to build their reputations as good hunters in order to rise in the ritual hierarchy (Sackett 1979; Tonkinson 1988*b*), and to share generously in order to establish networks of "followers" (Myers 1986). It has been argued that hunting in ways that contribute to the collective good demonstrates a commitment to the Law, which may ultimately allow a man control over more ritual knowledge (Sackett 1979). But what about women? Do they prefer to hunt the smaller goanna lizards, or are they constrained from hunting kangaroo? What social, political, and reproductive benefits do they gain from their foraging choices? Most of the explanatory models of gender difference in for-

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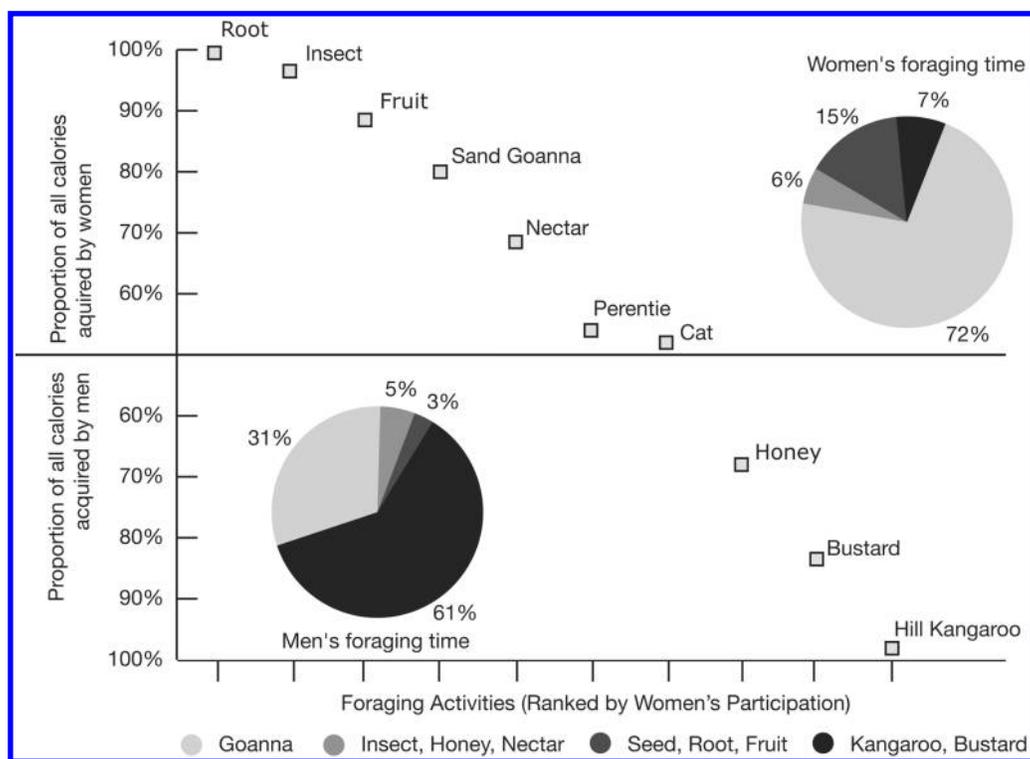


Figure 1. Martu gender division of foraging labor (the proportion of calories acquired by women and men in each foraging activity). Activities toward the center line (0 difference in relative proportional contribution, or 50–50 division of labor) are characterized by equal contributions on the part of each gender; those toward the top end are characterized by high women’s contribution and those toward the bottom end by high men’s contribution. The pie charts show the percentage of all men’s and all women’s foraging time spent on each activity.

aging do not consider such costs and benefits; instead, they draw on notions of the economic benefits of cooperative specialization or the difficulty of hunting while caring for children.

Asked why none of the ladies wanted to go goanna hunting, Karimarra continued to poke the fire for a long time. Finally she said,

They don’t want anyone to call them *malya* [selfish]. It’s selfish to go get goanna when so many people are visiting. When you go hunting goanna, you just sit and eat it. You only get enough for yourself and the people hunting with you. You might be able to save one, if you’re lucky. You come back here and if people see that you went out for goanna, they’ll say, oh that one, she’s selfish, she only thought about herself, she didn’t think about us hungry people left behind.

Was it better to spend the day bouncing along hunting tracks in the Land Cruiser with a .22 poking out the window, looking for a bustard in the bush, and come home with nothing?

“Yes,” she said, “Better to come back just as hungry as everyone else. *We* hunt to share.”¹

Being a hunter is an important part of being a Martu² woman. Unlike most other hunter-gatherers, Martu women spend most of their time hunting³ and provide just as much meat on foraging camps as men do. While sometimes overlapping, men’s and women’s foraging strategies often differ (fig. 1). Women will occasionally hunt bustard and kangaroo

1. Quotations from Martu were recorded in a variety of formats (Martuwanka, pidgin, and English) and were rewritten here in standard English at the request of the speakers.

2. “Martu” is a contemporary self-referential term with a variety of meanings depending on context. Most specifically it is used to refer to “the People” from a number of linguistic groups whose homelands make up about 150,000 km² of the northwestern portion of the Western Desert. When we refer to Martu in this paper, we refer only to those Martu we have lived with in this portion of the desert.

3. Here we define “hunting” as the search for mobile prey, that is, prey with some chance of eluding pursuit once encountered. This is in keeping with Martu classification of *wartilpa* (hunting mobile resources) versus *nganyimpa* (collecting immobile resources).

but prefer to search for smaller prey, particularly cat, goanna, and snake, which are dug from burrows in the winter after burning large areas of overgrown spinifex grass and in the summer are tracked and chased. Men will sometimes hunt goanna but more often pursue larger, more mobile game. Plant or insect-derived resources are a minor component of foraged foods during most times of the year, but there are again important distinctions between men and women in the way they prefer to spend their time: men forage for honey and nectar and women for grubs, fruit, and roots. This pattern contradicts one of the most widespread assumptions about the function of the gender division of foraging labor, that it operates as a form of cooperative specialization in different types of macronutrients (protein, fat, and carbohydrate)—an assumption that no doubt emerged through the seeming ubiquity of foraging divisions of labor predicated on an animal/plant, hunting/collecting dichotomy. Martu gender differences are more subtle than this, but the differences are far from arbitrary. If not for macronutrient specialization, why might Martu men and women make different foraging decisions?

Two explanations are prominent in hunter-gatherer foraging studies. One is a socioeconomic model (the economy-of-scale model) that proposes that women's subsistence choices are shaped by context-specific economic trade-offs between producing food and producing children and that gender differences are the result of a cooperative economy in which husbands and wives specialize in different resource types in order to optimize household production. The trade-offs that women face make investing in the skills required to hunt big prey too costly when they are younger and heavily invested in pregnancy, nursing, and the care of small children; husbands thus take up the slack. When women are older, they still forage according to the ghosts of their past constraints (see Brown 1970; Burton, Brudner, and White 1977; Hurtado and Hill 1990; Hurtado et al. 1992; Kelly 1996; Marlowe 2003, 2007). The other is a socioecological model (the risk model) that focuses a theoretical lens on the costs and benefits of unpredictability in resource acquisition, which tends to affect individuals differently depending on their foraging goals (the economic and social utility of the food they acquire). The model predicts that individuals who value food for the consumption benefits it supplies will find a hunt failure more costly than those who hunt to exchange or display, especially if children go hungry as a result. The risk model argues that the differences we see on average between men and women result from incongruent foraging goals, with women more often foraging to gain the benefits of consumption and men more often foraging for food's social utility (for arguments along similar lines, see Dahlberg 1981; Sanday 1981; Hurtado et al. 1985; Chapman 1987; Jochim 1988; Hawkes 1990, 1991; Hawkes, O'Connell, and Blurton Jones 1991; Peacock 1991; Bird 1999; Bliege Bird 2007).

The Risk Model

From Mer Island, where women's intertidal foraging is over three times more reliable than men's and is usually more productive (Bliege Bird, Smith, and Bird 2001; Bliege Bird 2007), to Botswana, where Ju/'hoansi men's success rates hover around 25% per hunt (Lee 1979), and Tanzania, where an average Hadza man acquires game at a rate of .03 prey per day (Hawkes, O'Connell, and Blurton Jones 1991), and from the boreal forest of the Cree, where hare trapping and fishing (typically women's activities) are both more predictable and more productive than moose hunting (Winterhalder 1981), to the Neotropical forest of Paraguay, where men pass over less variable palm starch to acquire more variable large game (Kaplan, Hill, and Hurtado 1990; Hawkes 1991), men's foraging decisions often substantially increase the variance in their day-to-day food acquisition compared with women's. Variance refers to the unpredictability of an outcome, and in the context of foraging it can be understood as a measure of the dispersion of rewards (harvest size or calories gained per hour foraging) around the mean, or expected, value. Variance in foraging outcomes results from unpredictability both in harvest size and in the chances of failure. An example of a resource type or foraging activity with high variance in mean reward is honey; an average harvest may be 2 kilos of comb, but a forager may have the same chance of getting a huge bonanza (say, 10 kilos) as of coming back empty-handed. An example of a low-variance target is goanna; a forager will usually come back with four or five lizards and will rarely come home with nothing or with a ten-lizard bonanza harvest. Low-variance resources are more likely to provide a forager with the mean value and less likely to provide extremely large or extremely small harvests. High-variance resources are characterized by a wide range of possible harvest sizes and a high percentage of failures to find or capture prey. Low-variance resources possess a smaller range of potential harvest sizes and have much lower failure rates. Whether a resource is high- or low-variance can depend critically on prey behavior and mobility as well as on the technological investments of the forager. For example, sea turtles are a high-variance prey when pursued with motorized dinghies in open water, but they are a low-variance prey when captured while nesting in rookeries (Bliege Bird and Bird 1997).

Depending on their current constraints, opportunities, or condition, foragers, both human and nonhuman, are expected to be more or less sensitive to resource variance (Jochim 1988; Hawkes 1990, 1991; Kaplan, Hill, and Hurtado 1990; Kacelnik and Bateson 1996; Smallwood 1996; Bateson and Kacelnik 1998; Winterhalder, Lu, and Tucker 1999; Bateson 2002). A forager exhibiting variance sensitivity either avoids variable means in favor of less variable ones (is variance averse) or seeks out variable means and prefers them to less variable ones (is variance prone). Sensitivity to variance arises if there is a nonlinear relationship between the amount of a resource and its utility to the forager (Winterhalder, Lu, and Tucker

1999). A variance-prone forager values larger harvests proportionately more than smaller ones and thus prefers a resource with higher variance because it maximizes the chances of getting a bonanza harvest. Such a strategy gambles on the probability of a higher-than-average reward, a decision that pays off when the costs of failure are low relative to the benefits of a bonanza. A variance-averse forager has the opposite problem: as harvest size increases, benefits increase at an increasingly slower rate until a forager gets no additional benefit from any additional harvest. If this happens, the costs of getting too little outweigh the benefits of a bonanza. Variance-averse foragers thus prefer lower variance if it minimizes the risk of an undersized harvest.

The way that value varies with harvest size will depend on a forager's goals. Foraging for consumption results in declining marginal returns; the first portion of food to a hungry consumer provides higher benefits than additional portions as the consumer becomes satiated. Such a goal may best be satisfied with risk-averse foraging decisions. Foraging for social status may result in increasing marginal returns: if one gains more prestige from a harvest larger than anyone else's, foragers will value a bonanza over the costs of failure and should be more risk prone (Hawkes 1990; Smith 1991). Low-variance foraging thus best satisfies goals of optimizing consumptive and nutritive value; high-variance foraging better serves the competitive pursuit of political power, social status, reproductive rewards, and control over crucial resources (Hawkes 1991; Sanday 1981). Where there are few benefits or opportunities for men or women to gain political and reproductive advantages by seeking high variance, we would expect them to hunt in more risk-averse ways. Similarly, where individuals face few costs and can gain big benefits from investing in sociopolitical competition, they may forage in more risk-prone ways. Where gender is correlated with foraging goals, we would expect men and women to have different sensitivities to variance. While this may often take the form of risk-averse women and risk-prone men, we should also expect shifts in goals of one gender or the other that correspond with shifts in the availability of resources associated with different levels of variance.

Implicit in the risk model is the assumption that high-variance resources are intended for a wider public arena than are low-variance resources and are not given contingent on exchange of other resources or as part of a cooperative provisioning agreement (Hawkes 1993). High-variance resources tend to be asynchronously acquired across foragers, creating momentary peaks in production inequalities: few who have, many who have not. Low-variance resources are considered more private goods, consumable by those whom the acquirer determines will receive a share, and are more synchronously acquired, thus sustaining production equality. That high-variance resources are more widely shared follows both from the fact that food tends to flow from those who have to those who do not and from the greater information value inherent in the display of high-variance resources (Bliege Bird, Smith,

and Bird 2001). This does not mean that high-variance resources function only as display or that one's own household does not benefit from consuming the resource. Instead, it suggests that producers of high-variance resources gain from distribution more than they gain from consumption, and if the benefits of distribution are high enough they may keep little, if any, to eat themselves (Hawkes and Bliege Bird 2002). If men specialize in high-variance resources, competition to share more might lead them to be unreliable provisioners, and therefore the risk model emphasizes intrasexual cooperation and divisions of labor, particularly among older and younger women (see Hawkes, O'Connell, and Blurton Jones 1997). Thus, evidence that producers place themselves at a consumption disadvantage through sharing would be consistent with the risk model.

The Economy-of-Scale Model

While it is widely recognized that men and women allocate their time to risky resources differently, it is not clear whether variance preferences are the cause of this pattern or merely the outcome of other correlated factors. Men may accept higher risk not because they prefer rewards with greater risk (Hawkes 1990, 1991) but because they are free from child-care constraints and thus can acquire high-return resources whose greater reward compensates them for the increased risk and for which reciprocal sharing serves to dampen the daily variance across individuals (Kaplan, Hill, and Hurtado 1990). Similarly, it is not clear whether women are discounting high means associated with high risk or whether they are facing some other trade-off correlated with high mean returns. The relationship we see between risk and the sexual division of labor could thus be the result of men's preferences for high-mean-return activities, which tend to be correlated with increased risk, combined with women's constraints on acquiring high-mean-return resources and not risk sensitivity *per se* (Kaplan, Hill, and Hurtado 1990; Hurtado et al. 1992).

Some economic theorists predict that if women face these kinds of trade-offs cooperative specialization between men and women is inevitable (Becker 1991). This prediction emerges from an assumption about the basic function of a division of labor: that it exists to enhance the efficiency of household production through complementary work effort (Durkheim 1933; Murdock 1949; Lévi-Strauss 1956; Sahlins 1972; Halperin 1980; Hurtado et al. 1992; Kaplan et al. 2000; Gurven 2004). This model masculinizes or feminizes subsistence roles in order to tap the relative skills and abilities of men and women as they attempt to maximize household production (Becker 1985). It 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 (an economy of scale). 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 in gathering plant foods and in food preparation and processing while men, free from such constraints, are most efficient at hunting and fishing (Murdock 1949; Brown 1970; Murdock and Provost 1973; Burton, Brudner, and White 1977). Cooperative specialization may involve coordination of foraging time: as women allocate less time to productive foraging, men allocate more. Or it may involve specialization in different types of foraging activities offering greater comparative advantages to each sex: men allocate more time to those activities that women avoid. If men and women respond dynamically to the foraging decisions of the other in ways that increase efficient household production, seasonal changes in child-care constraints or the productivity of resources should evoke negative correlations between men’s and women’s time allocation; that is, as women allocate more time to foraging for a particular resource, men should allocate less.

Consistent with this assumption about household function is the assumption that foraged products should be shared among producers in ways that maximize the benefits of food consumption at the household level. Higher-variance resources should be shared as a form of insurance against the future risk of acquisition failure while lower-variance resources are retained to supply consumption benefits for the household. This produces two complementary pathways of reciprocity: one in which men acquire high-variance prey and share with women, who return low-variance resources, and another in which men share high-risk prey when successful in order to receive portions of high-variance prey from others when unsuccessful. Researchers generally assume that low-variance prey is shared more narrowly than high-variance prey and that low-variance prey goes primarily to a woman’s own children and husband. High-variance prey, if shared reciprocally as a form of failure insurance, should be shared in ways that preserve some immediate advantage for the producer; the producer’s share should be larger than those that nonproducers receive.

Do Martu men and women make different foraging decisions because they are cooperatively specializing in different sets of resources? Or do they differ because their foraging goals are often quite disparate? Our goal here is to situate the sexual division of foraging labor among the Western Desert Martu within the theoretical debates surrounding the causes of variation in men’s and women’s foraging production and to test some predictions drawn from the economy-of-scale and risk models and, in so doing, to draw some tentative conclusions about the relative importance of each to understanding variation in the division of foraging labor.

We first present a qualitative assessment of both historical and contemporary Martu foraging relative to the contexts of each model. The risk model focuses on women forming strong cooperative intergenerational bonds with each other to solve their foraging trade-offs, and the economy-of-scale model

focuses on the primacy of the pair-bond. The risk model predicts that strong social and political benefits accrue to those who provide high-variance resources within a wide social arena and that low-variance resources are shared in ways that provide most benefits to a smaller network of close kin. The economy-of-scale model emphasizes that sharing of both resource types should be directed, contingent, and focused on benefiting the nuclear family. Is there any evidence that those who share high-variance resources gain a different set of social and political benefits from those who share low-variance resources?

We then turn to some quantitative tests of predictions of each model using observations of contemporary foraging. Does foraging risk predict the relative contribution of each sex to harvests in a particular foraging activity—are men more risk prone and women more risk averse? Do Martu women hunt more when risk is lower, as the risk model might predict, or when men hunt less, as the economy-of-scale model predicts? We also evaluate predictions about sharing implicit in each of the models: Do producers of high-variance resources have a disadvantage? Do women cooperate with spouses or with other women? Are women’s foods shared primarily with men and children or with other women and children? To answer these questions, we look both at the long-term average division of foraging labor among the Martu (the structural division of labor, as one might calculate it in order to compare one group with another) as well as more short-term temporal and spatial variability in Martu men’s and women’s time allocation.

Ethnography and Ethnohistory

Martu are the indigenous owners of the estates that surround Lake Disappointment and the Percival Lake in the northwest section of Australia’s Western Desert (fig. 2; see Tonkinson 1974, 1978, 1988*a*, 1988*b*, 1990, 1991, 2007; Walsh 1990). As highly mobile hunter-gatherers in one of the most remote and arid regions of Australia, most Martu managed to maintain their lifeway relatively independent of colonial influence well into the second half of the twentieth century. Limited contact between a few Martu and white explorers and settlers began in the early twentieth century with pastoral efforts on the western and southern fringe of Martu territory. In the 1930s some Martu began a process of migration westward from their desert estates, visiting and eventually settling around Jigalong and surrounding cattle stations (see Tonkinson 1974 for a detailed history). However, many families, especially those from the easternmost part of Martu territory, remained in the heart of the desert until the mid-1960s, when depopulation and the establishment of the Blue Streak nuclear missile testing range pulled them from their homelands into Jigalong and neighboring pastoral stations (Davenport, Johnson, and Yuwali 2005). In the mid-1980s numerous families (mostly those that were the last to leave the desert) returned permanently to their desert estates. By 1986 they had estab-

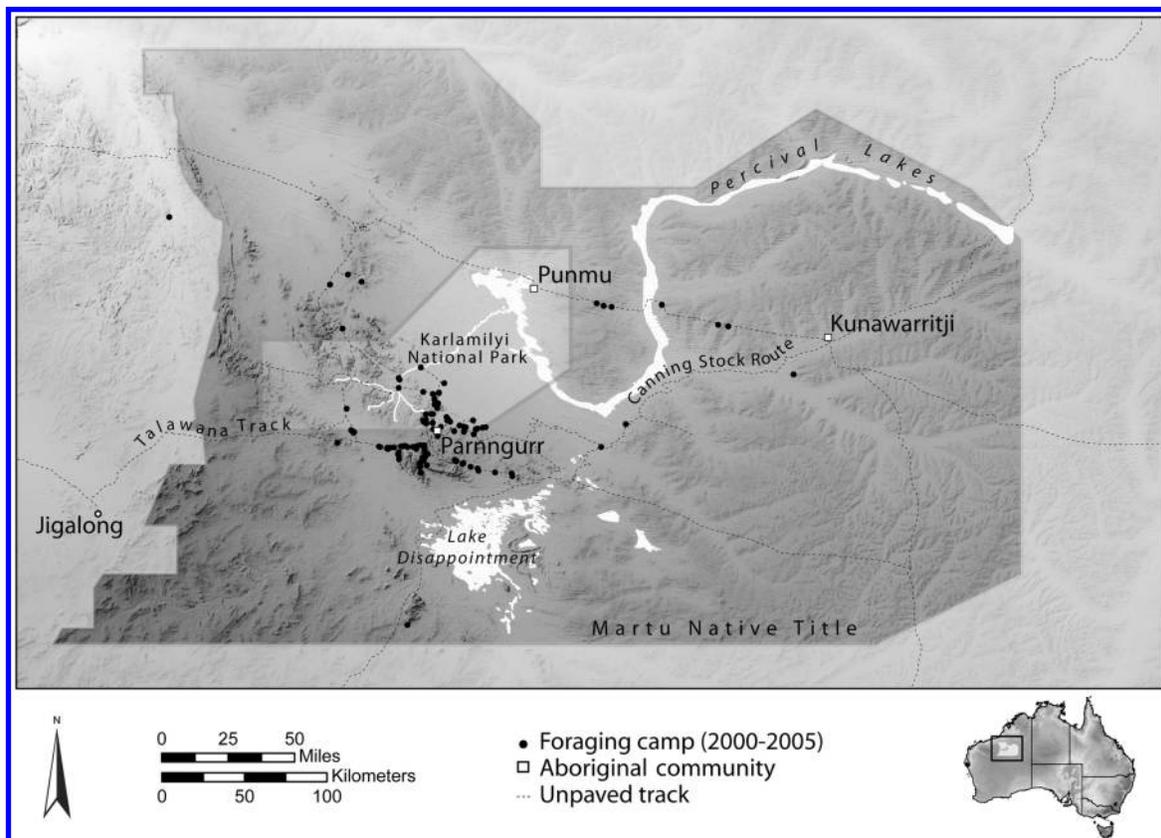


Figure 2. The Martu homelands and study area.

lished two “outstation” communities (Punmu and Parnngurr) in the newly designated Karlamilyi (Rudall River) National Park. Another outstation at Kunawarritji, Well 33 on the Canning Stock Route, soon followed. Martu established the outstations in response to the threat of dispossession and assimilation to assert ownership of their homelands and maintain their ritual and socioeconomic obligations to the desert. Today these obligations are manifest in their defiance of complete reliance on the welfare economy and the regular maintenance of their estates through daily hunting, gathering, and mosaic landscape burning, which ultimately provided a foundation for Martu to gain native title to much of their homeland in 2002.

Martu number about 1,000; at any given time each outstation has a population between 50 and 200, and about 500 Martu live in the nearest towns of Newman, 400 km to the west, and Port Hedland, 800 km toward the northern coast. While most Martu families keep a permanent camp (*ngurra*) in one of the outstations, they maintain high residential mobility between communities and are often away for extended periods of time traveling throughout the Western Desert and Pilbara regions to fulfill traditional religious and social obligations. The outstations are composed mostly of people from the Manyjiljara, Kartujarra, and Warnman linguistic groups,

and most are linked through marriage or kinship with the bands first contacted in this region in the 1960s. Most of the people over age 40 in the outstations were members of those bands.

There are few paid jobs available in the outstations. Most Martu are employed in the Community Development Employment Programme (CDEP), which involves various tasks related to infrastructure maintenance, but these never take precedence over foraging. Children are encouraged by their parents to attend the small primary/secondary school but are often taken out to go hunting or traveling. Contemporary residential organization reflects both continuity with the fluidity of the nomadic past and change to accommodate new circumstances. Camps in the outstations are typically organized around an extended family clustered near a relatively permanent structure. Most are matrifocal with multiple generations, although unmarried young men’s and widows’ camps are also common. Each outstation has a small store, but most Martu prefer not to spend their CDEP, pension, or child payments (roughly A\$200–300/fortnight) on food. Many (especially older people) rank food purchases quite low compared with diesel fuel, vehicle maintenance, gambling, toys and clothes for children, and tobacco. Martu take great pride in being foragers and place a high premium on fresh

bush foods, and many complain that shop costs are prohibitive on such limited incomes. Consequently, the majority of food purchases for Martu center around the production of damper (a simple bread leavened with baking powder). Rather than relying on the store to buffer uncertainty in foraging, Martu rely on foraging to buffer uncertainty and variability in access to store food: "Why should we buy food, when food is free all around us?" The total diet composed of bush foods we estimate as between 20% and 50% depending on the season and whether ritual business is occurring (see table 1). Most camps with access to a vehicle forage daily.

Gender and Social Relationships

To what extent do Martu women form strong cooperative bonds with each other, and how important are these ties relative to the bonds between spouses? In the past, women may have relied more on cooperation and social ties with other female relatives and co-wives than with their spouses, who were frequently much older, were focused on ritual business, and were often absent (for additional details on Martu historical demography, see Scelza and Bliege Bird 2008). At the core of flexible residential bands were clusters of related women—sisters and classificatory sisters, co-wives, and mother-daughter dyads—around which their brothers congregated with their wives and families. These data come from a combination of patrol reports and retrospective interviews covering the period just before the last remaining bands left the desert, between 1955 and 1966. During this period there were at least 164 Martu in nine composite family bands living in the region around Karlamilyi (see fig. 2), including 58 women, 34 men, and 60 children under 14, the age of the youngest married person. Bands ranged in size from 6 to 29 individuals, with a mean group size of 18. Almost half the marriages were polygynous (11 out of 23), with 74% of 49 married women in a polygynous union and 37% in sororal polygyny. Although Aboriginal bands are commonly thought of as being relatively patrilocal and the inheritance of sacred sites patrilineal, these bands were composed of both matrilineal and patrilineal relations. Fifty-seven percent of the married adult women under age 30 had their mothers present, while 76% of all married women had either a mother or an adult sister or cousin-sister present. Of 46 marital pairs, wives had significantly higher average coefficient of relatedness to all other adult group members (.10) than husbands (.06) and more same-sex kin (2.3 compared with their spouses' average of .7). In most of the bands, adult sex ratios were skewed in favor of women: there were 1.59 women for every man. This is a reflection of both increased male mortality and higher male mobility, especially for unmarried men. Men were often away traveling on ritual business or were drawn to settlements to work as cattle drovers and stockmen.

While residential patterns have changed since the nomadic days, there are important continuities. Martu women continue to rely on building strong cooperative relationships with

other women, as is evidenced by the consistent coresidence of mothers and adult daughters and the persistence of polygyny. Fifty-eight percent of postmenopausal women in the 2005 census were living with their daughters' children. Older women (age 35 and older) and children (up to age 15) also tend to be the most active foragers; younger women often remain behind at camp or in the community to care for small children, but they are more likely to accompany a foraging party when foraging for resources that children acquire on their own (ridge-tailed goanna, grubs, fruit, and roots [Bird and Bliege Bird 2005]). This division of labor reflects explicit preferences for cooperative intergenerational exchange: young women address the constraints of family by forging partnerships with older women. Most of these partnerships today are between mother and daughter, but in the past they would also have occurred between older and younger co-wives, especially when co-wives were related (sisters or cousin-sisters).

Women who were married before the desert exodus relied on the cooperation of their sisters and co-wives, often recalling more assistance than jealousy:

My sister was my co-wife. She was like a mother to me. My sister and I would hunt together. One of us would go out with our husband to hunt meat while the other one would stay with the kids in camp and get plant food. We had a loving relationship. Fighting between co-wives happens more when there are five, not two. (J. B. 2006)

In the bush, women would tell their husbands to get another wife, a young wife, if they needed help. They wanted a young wife to stay home, get firewood, and cook the damper. They got the woman, even if he didn't want one. They wanted a young woman so their husbands would leave them alone and they wouldn't have so many babies. You don't need a co-wife anymore—that's why the young women are so jealous. (N. T. 2003)

Women often speak about their continued reliance on each other on contemporary hunting trips, especially in food acquisition and sharing:

Women often work together, sharing things. Men hunt differently from women: they mostly work alone, although they might ask another to help them track a large kangaroo. Women often work together. There are people you like to hunt with, friends, and family. I like to hunt with someone who's going to share meat with me. When I hunt with someone else, if she is older, I might give her my goanna to cook. She will put hers on one side of the fire and mine on the other side. She will give me mine after it is cooked, and then we'll exchange goanna after. And each person who hunted or collected the food will share it with others. Before [i.e., while we were nomadic], if a small group of family, like uncle and his family with four, and mom and our family with six, if she got ten goanna, she would give four to uncle's

Table 1. Martu Foraging Activities and Mean Return Rates, 2000–2005

Foraging Activity	Resource Type(s)		Primary Season	Habitat ^a	n (Bouts)	Foraging Time (min/bout)		kcal/Bout		Return Rate/Bout (kcal/h)	
	Primary	Secondary				Mean	SD	Mean	SD	Mean	SD
Goanna hunting	Sand goanna (<i>Varanus gouldii</i>)	Skink, python, cat, larvae, ridge-tailed goanna	All	S	575	194	76	1,971	1,693	635	513
Bustard hunting	<i>Ardeotis australis</i>	Sand goanna	May–January	M, S	260	139	92	3,413	5,765	1,800	4,767
Kangaroo hunting	Euro <i>Macropus robustus</i>		All	R	76	203	90	3,292	5,023	967	2,763
Perentie hunting	Perentie (<i>V. giganteus</i>), spotted goanna (<i>V. panoptes</i>)	Sand goanna	November–April	W	76	162	81	2,075	2,373	704	941
Fruit collecting	<i>Solanum diversiflorum</i> , <i>S. central</i>		April–May, October–November	S	58	76	38	3,044	2,031	2,757	1,797
Root collecting	Root: <i>Vigna lanceolata</i> ; bulb: <i>Cyperus bulbosus</i>		May–August	W	43	81	54	548	441	416	237
Cat hunting	Feral cat (<i>Felis cattus</i>)	Sand goanna, skink, python, larvae	All	S	25	213	59	3,103	3,617	913	1,185
Grub collecting	Larvae: <i>Endoxyla</i> spp.		Variable	S, M, W	33	74	26	632	379	515	253
Seed collecting	Seeds: <i>Acacia aneura</i> , <i>Eragrostis eriopoda</i>		Tree: October–December; grass: April–June	S, M	10	–	–	2,968	3,608	–	–
Honey collecting	Honeybee (<i>Apis mellifera</i>)		Variable ^b	W	17	65	57	5,461	4,739	5,378	3,081
Nectar collecting	Nectar: <i>Hakea</i> spp.	<i>Grevillea eriostachya</i>	September ^c	S	15	45	25	6,355	4,881	8,482	3,350
Other	Emu, red kangaroo	Feral camel	–	–	8	188	101	–	–	–	–

Note: Availability of many resource types, especially plants, depends on highly variable rains. The Martu calendar is divided into three roughly equal seasons: Yalijarra (hot/wet; January–April); Wantajarra (cool/dry; May–August); Tulparra (hot/dry; September–December).

^aS = spinifex sandplain, M = mulga woodland, R = rocky range, W = watercourse margin.

^bFeral honeybees first established hives in the region in 2003. Since then honey collecting has become a common activity.

^cNectar from *Hakea* flowers is available only during a two-to-four-week period in the spring. In a given patch the flowers will produce nectar for about a week.

family and keep six for her family. If she got more food from her husband, she would give all ten away to the other family. Seed is the same, she could make a damper and give it to them. Nowadays people don't share as much. Everyone was *mirtilya* [a skilled and generous hunter] back then. (N. T. 2003)

The Politics of Hunting and Sharing

Do social and political benefits accrue to those who provide high-variance resources generously within a wide social arena? Among Martu, there are two pathways to political influence.

One is a hierarchical pathway through which one gains the rights to hold the secret knowledge of the Law (Yulipirti) after adherence to years of rigorous ritual training and physical initiation. The Jukurrpa (Dreamtime) rituals and their associated paraphernalia are held by elders with tremendous authority who are obligated to protect and uphold their power (Bird and Bliege Bird n.d.). The administration of the Law is carried out by all initiated men and women, but it is most powerfully held by the *ngurraru*, the caretaker of the Yulipirti and Jukurrpa for a given area or community. The *ngurraru* adjudicates failure to uphold the Law through formal punitive procedures that are arranged and carried out in collaboration

with his allies. The most sacred and powerful knowledge is gender exclusive, and not every individual has access to the secret/sacred knowledge that serves to mark position in the ritual hierarchy; such knowledge is closely guarded, divulged only to those who have paid the price (initiation) to demonstrate their trustworthiness. Those with more knowledge thus have power over those with less. While men's ritual "business" is far more elaborate than women's and often takes precedence (Tonkinson 1991), the long path to ritual power is open to both genders (Hamilton 1980; Dussart 2000).

The second pathway to social distinction is egalitarian, one in which the goal is not to gain and withhold but to give magnanimously, to demonstrate a "disengagement with property" (Tonkinson 1988b, 550). As Myers (1986, 252–55) and Martu describe it, secular authority lies in holding (*kanyanimpa*) or nurturing the autonomy of others. Influence, renown, and power are sustained by generously providing equal access to valued material resources (Myers 1986, 265). There is shame (*kurnta*) in forceful command, the accumulation of wealth, refusal to share, and overt assertiveness. In practical terms this means anticipating asymmetries and giving to each individual on demand rather than withholding resources for the common good or future use (Folds 2001, 48–60). The social distinctions that arise through this pathway are not those of material possession, where individuals are marked by what they own or can claim, but of dispossession. Distinctions are made by the lack of attention to material ownership, the careless treatment of property that is the true sign of an aesthetic of disengagement. Ironically, only by demonstrating disengagement with property can one claim inalienable possession of it (Weiner 1992).

Property disengagement is essential to an understanding of the conversation we recounted at the outset—what it means to be *malya* (selfish), what it means when someone says "We hunt to share." In order to understand *malya*, we must first understand its opposite, *mirtilya*. A productive, skillful hunter is *mirtilya*, and a skillful seed winnower is *mirkaya*. Anyone (man, woman, child, dog) gains the title of *mirtilya* or *mirkaya* by consistently acquiring and sharing production surplus, particularly in the context of providing food for mourners or visitors at public ritual events. A *mirtilya* shares not only with her own family but with those with whom she has little obligation to share. The role of *mirtilya* is not simply one of skill at accumulation but one in which accumulation's only purpose is magnanimity, one that emerges from a sincere and honest disengagement with the "property" one has worked so hard to acquire, an honesty that is insured by the cost of acquisition (Bliege Bird and Smith 2005). But one's reputation as *mirtilya* is not simply maintained by giving: a *mirtilya* is a person who not only frequently gives but frequently has things to give—a person who works harder than others so that surplus production can be distributed to all. The designation therefore depends on sustaining the largest differential between what is acquired and what one actually consumes. A *mirtilya* is thus one who "hunts to share." If one

is satisfied to be *malya*, one can work less and hunt simply to feed oneself and one's children.

Some have argued that the two realms of social influence as described above are linked, especially for men: men produce generously and skillfully because in doing so they demonstrate their commitment to and concern for the Law and are more likely to rise in the ritual hierarchy, pass the final stage of initiation, and marry their promised wives (Sackett 1979; Tonkinson 1988a). In that sense men produce more than others as a way to gain political and reproductive advantages through competition with other men. We suspect that being generous may be less important for women's rise in the ritual hierarchy than for their ability to sustain wide, supportive social networks. Wiessner (2002) has suggested that generous provisioners among the Ju/'hoansi enjoy larger, more cohesive social and residential groups. This allows for two benefits: long-term control and occupation of a *!nore*, the foraging area surrounding a permanent waterhole, which can be passed to one's descendants, and the maintenance of a group structure that facilitates cooperative childrearing. The benefits of being *mirtilya* for Martu women may fall between similar lines. Being generous to others feeds one's cooperation partners, the women who stay behind to care for children, make the fire, or cook a damper, but it also can feed free riders, those who hunt little and do not reciprocate. This may not be as costly to *mirtilya* as one might suppose: while the benefits of maintaining larger and more stable residential groups could be active in that one reciprocally exchanges benefits with other group members, group living also confers important passive benefits, especially for cooperative breeders. Broad comparative data on group living in many social mammals suggests that while it may increase resource competition to some extent, living in a larger social group may deter aggression and provide enhanced offspring survival even if there are many free riders (Jennions and Macdonald 1994; Clutton-Brock et al. 1999; Kokko, Johnstone, and Clutton-Brock 2001). While Martu residential groups may not have collaborated to control access to waterholes and foraging areas, simply being in a larger group in the past may have been critically important for cooperative child care, hunting, and group defense, particularly for the deterrence of raiding and revenge parties (see Tonkinson 1991).

Contemporary Foraging and the Gendered Division of Labor

Research Methods

The contemporary foraging data described here were collected over 24 months between 2000 and 2005, primarily in the region surrounding Parnngurr community, but trips were also made to more remote locations and to locations surrounding the communities of Punmu and Kunawarritji. Given that Martu now operate out of permanent settlements, vehicles are usually used to reach more remote foraging locales. Our

trips usually began with someone requesting that we go hunting and a few circuits through the community to pick up those who wished to go. No one was turned away from joining the foraging party, and although the size of our vehicle (Toyota Landcruiser) did limit the number of bodies that could be transported, this limit was much larger for Martu than for the researchers. A typical foraging party consists of 8 participants (2 men, 4 women, and 2 children), but parties as large as 15–23 were not uncommon.

After a very subtle process of decision making that begins with consensus on which of the four cardinal directions they will take on the hunting roads out of the community, the party typically travels to a foraging location and establishes a short-term (“dinnertime”) foraging camp or a longer-term residential foraging camp (ranging in duration from 1 to 22 days in our data set). Neither the degree of genealogical relatedness nor specific kinship ties determine the composition of foraging parties. While some participants often join foraging parties with others who share close ties of marriage, kinship, or friendship, foraging-party and camp composition from day to day is highly fluid and almost always includes members of different camps in the community.

Foraging is defined as the total time spent searching for, pursuing, capturing, and processing wild food resources. During foraging trips we recorded the identity of each participant in the *foraging party* (the group that leaves together), the time they spent traveling to the foraging locales, the route taken, the foraging location, and the foraging-bout time of all participants. *Foraging bouts* are defined as time away from the bush camp engaged in a single *foraging activity*. Foragers usually engaged in one bout per day, although sometimes they returned to the bush camp and left again or switched foraging activities while out from camp, in both instances initiating a new bout. After each bout we recorded the number and whole weight of each type of resource that each forager in the party acquired and monitored transfers of food from acquirer to first consumer. During each trip, at least one researcher present also asked permission to conduct a focal *foraging follow* for the duration of the bout, during which we recorded time allocation to search, pursuit, capture, field processing, and transport. Throughout our analysis, we use Martu definitions of *foraging activities*; these are mutually exclusive activities associated with acquiring a particular suite of resources. Martu designate a given foraging activity by the term for its primary resource type and a directional suffix (e.g., *parnajalpa* [sand goanna]-*karti* [moving toward]). In turn, Martu group foraging activities into hunting (*wartilpa*, activities whose primary resource type requires active pursuit of mobile prey) and collecting (*nganyimpa*, activities whose primary resources are relatively immobile on encounter), which to some degree can crosscut food types grouped as plant (*mirka*) or animal (*kuwiyi*); for example, while grubs and other insects are considered *kuwiyi*, acquiring them is considered to be *nganyimpa*, not *wartilpa*.

Foraging returns are calculated as the mean gross energetic

gain per individual forager per unit time spent in a foraging bout. We calculated energy gain for game animals by first measuring whole weight relative to edible weight in a sample of 46 lizard, skink, and snake specimens as well as four bustards. Proportional meat and marrow weights for each shared parcel of male or female hill kangaroo were obtained from O’Connell and Marshall (1989, tables 3, 4). For insect and plant foods, only one species (*Solanum diversiflorum*) has any measurable inedible portion; we weighed a kilogram of this species before and after the inedible seeds were removed to determine the percentage of edible weight. Edible weights of all resources were then converted to kilocalories using Brand Miller, James, and Maggiore (1993).

The data set used in this analysis consists of the results of 1,196 adult foraging bouts (750 by women, 446 by men; table 1). We define the sexual division of foraging labor as the proportion of total calories harvested by each sex and the proportion of total time contributed by each sex in each specified foraging activity. In order to analyze the variance associated with men’s and women’s resource acquisition strategies, we average foraging returns and harvest sizes from this main data set in two ways. The first data set is constructed by averaging all returns, time allocation, and measures of variance across all seasons and foraging locations to acquire long-term measures of the sexual division of labor and time allocation. The second set is designed to examine temporal variability in foraging returns and time allocation decisions and is constructed by averaging over a number of foraging camps (a “campset”). A campset corresponds either to a foraging camp of several days’ duration or to a series of dinnertime camps in the same area over a period of time in which people went back to the community to sleep but returned over subsequent days to the same foraging area. On each campset, both men and women were present and actively foraging. There are 24 campsets, each between 7 and 22 sample days in duration (table 2).

Gender Differences in Foraging Production

On foraging camps, per capita production of wild foods by adults and children averages 1,700 kcal/day, with about 300–500 kcal supplied by store foods (mostly commercial flour for damper, tea, sugar, and canned goods). Seventy-three percent of the bush-camp diet comes from a wide array of animal prey, including monitor lizards, goanna (*Varanus gouldii* or sand goanna; *V. giganteus* and *V. panoptes*, perentie goanna; and the smaller *V. acanthurus*, or ridge-tailed goanna), bustards (*Ardeotis australis*), feral cats, skinks (*Tiliqua scincoides*), pythons (*Aspidites ramsayi*), and hill kangaroos (*Macropus robustus*). Collecting insects and their products, especially the large larvae of the cossid moth (*Endoxyla* spp., the “witchetty grub”) and honey, is also important. Vegetable foods make up only 27% of the bush-camp diet and are fairly evenly divided between store food (15%) and collected bush food (12%), although this long-term average ob-

Table 2. Characteristics of the Campset Database

	Men	Women	Men and Women
No. campsets	–	–	24
Average no. foragers/day	–	–	7.95
Average no. sample days/campset	–	–	8.13
Average no. foraging bouts/campset	19	33	–
Total no. foraging bouts	446	750	–
Total foraging production/campset	35,009	24,291	–
Mean harvest size per bout/campset	1,459	1,012	–
Median harvest size/campset	487*	703*	–
Average coefficient of variation in			
harvest size/campset	1.874*	.869*	–
No. cold-season camps	–	–	14
No. hot-season camps	–	–	17

*Difference between men and women significant at $P < .01$.

scures temporal variation in availability. While Walsh (1990) records 106 species of plant food Martu recognize as edible, the majority of the vegetable portion of the bush-camp diet comes from bush tomatoes (*Solanum diversiflorum*) and desert raisins (*S. centrale*), nectar from *Hakea suberea* and *Grevillea eriostachya* flowers, and geophytes (especially *Vigna lanceolata* roots and *Cyperus bulbosus* bulbs; see table 1).

Women are more active foragers in our sample, contributing 63% of all adult foraging hours and 52% of all foraged foods (by kilocalories). Their most important foraging activity, goanna hunting, accounts for 74% of their time and 58% of their total bush-food production (table 3). Goanna hunters track and chase prey on the surface during the summer, and in the winter they use fire to expose burrows and excavate with digging sticks (Bliege Bird and Bird 2005). Hunting goanna in both seasons is very difficult: it requires extensive knowledge of the behavior and ecology of monitor lizards, the skill to track small game over long distances, the capacity to age burrows by the degree of entrance-mound compaction and the date of the most recent rainfall, the ability to detect the terminal den, the courage to risk snakebite (many women have been bitten while goanna hunting), the agility to chase a lizard that escapes through a “pop-hole” (goanna elude pursuit 11% of the time), and the ability to navigate using the sun to inscribe a circular route across endless identical sand dunes back to camp. Women cooperate while goanna hunting, in the winter to coordinate a burn (*nyurnma*) and in the summer to track prey on the surface. While a few married couples form cooperative hunting partnerships, most men hunt alone, their wives cooperating with other women (Bliege Bird and Bird 2005). Twenty percent of women’s foraging production comes from fruits, geophytes, and nectar or honey, and 15% comes from prey of more than 2.5 kg (cat, perentie, bustard, and kangaroo).

Men also hunt goanna, but they spend more time on bustard and kangaroo (table 3). Together these make up over 60% of men’s foraging effort (42% and 19% respectively) and contribute 40% of all calories. Bustard hunters use vehicles

to search large tracts of country, and when prey are sighted the vehicle becomes a mobile blind, allowing the hunter to approach close enough for a shot. Hill kangaroo are hunted on foot in low-lying rocky ranges with long, stealthy pursuits involving extended tracking punctuated by fast chase over rugged country. Men spend only 2% of their foraging time collecting, and that mainly on honey and *Hakea* nectar.

Hypotheses Tested

Do these differences between men and women arise because they have different foraging goals that lead them to place different values on the costs and benefits of resource variance? Or are men and women cooperatively specializing in different sets of resources in order to optimize household production? To answer these questions we conducted the following tests:

1. *The risk-aversion/risk-proneness test.* The proportion of calories acquired by women in any foraging activity should be negatively correlated with measures of variance in mean return and positively correlated with the probability of a successful harvest. In order to compare variation across activities with very different mean returns, we rely extensively on the coefficient of variation, or CV (standard deviation divided by mean). As CV increases, there is more variation per unit return: generally a CV of about 1 or less is considered low variance, and a CV of greater than 1 is considered high variance. The probability of a successful harvest is measured as the frequency of bouts that result in 0 return. A positive result will support the risk model but will not necessarily be evidence of lack of support for the economy-of-scale model because variance may be correlated with harvest size or return rates.

To eliminate this possibility, we use an additional test that looks at variance across all harvest sizes. A risk-prone forager should, given the choice between two prey types with equal expected means, prefer the more variable one, while the risk-sensitive forager should make the opposite choice. In the economy-of-scale model, variance is not a significant predic-

Table 3. Division of Labor and Time Allocation by Men and Women

Foraging Activity	<i>n</i>		Sum Time		Sum kcal		% Time		% kcal		% kcal by Women	% kcal by Men	% Time by Women	% Time by Men
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
Goanna hunting	467	108	90,983	20,727	912,474	221,150	73.8	28.3	58.5	15.3	80.5	19.5	81.4	18.6
Bustard hunting	48	212	5,642	30,397	143,529	743,865	4.6	41.5	9.2	51.5	16.2	83.8	15.7	84.3
Kangaroo hunting	9	67	1,850	13,874	8,598	254,781	1.5	18.9	0.6	17.7	3.3	96.7	11.8	88.2
Perentie hunting	51	25	7,653	4,637	87,305	70,416	6.2	6.3	5.6	4.9	55.4	44.6	62.3	37.7
Fruit collecting	51	7	3,922	479	157,834	18,710	3.2	0.7	10.1	1.3	89.4	10.6	89.1	10.9
Root collecting	43	0	3,483	0	23,554	0	2.8	0	1.6	0.1	100	0	100	0
Cat hunting	19	6	4,167	1,152	43,319	34,268	3.4	1.6	2.8	2.4	55.4	44.2	78.3	21.7
Grub collecting	32	1	2,694	52	22,656	590	2.2	0.1	1.5	0.04	97.5	2.5	98.1	1.2
Seed collecting	10	0	1,890	0	65,393	0	1.5	0	4.2	0	100	0	100	0
Honey collecting	7	10	280	912	32,984	67,088	0.2	1.2	2.1	4.6	33.0	67.0	23.5	76.5
Nectar collecting	10	5	445	245	62,918	31,979	0.4	0.3	4.0	2.2	66.3	33.7	64.5	35.5
Other	3	5	187	758	NA	NA	0.1	1.0	NA	NA	NA	NA	19.8	80.2

Note: Sample covers 1,179 bouts over 196 foraging days over 690 days of fieldwork in June–July 2000, June–August 2001, January–August 2002, March–September 2004, and August–November 2005. Foraging groups solicited us for trips on approximately 56% of days we were available to hunt. NA = not available.

tor of time allocation; men are free to forage optimally for the highest-return resources, whose value compensates for their higher variance, while women are constrained to those of lower return (which have lower variance).

2. *The mean-variance test.* For a given mean rate of return in any habitat frequented by both men and women, men's harvests should exhibit greater variation than women's harvests. A positive result for this prediction will support the risk model, a negative result the economy-of-scale model.

3. *The time-allocation-covariance test.* For those foraging activities that show changes in variance over time and space, men's time allocation should covary positively and women's covary negatively with increases in variance. Men's and women's allocations should not covary with each other; as women spend proportionately more time acquiring a resource, we should not see any corresponding decrease in men's time on that same resource. A positive result for these predictions will support the risk model, a negative result the economy-of-scale model.

4. *The foraging-goals test.* Women's resource portfolios should maximize the probability of a harvest's meeting a nutritional threshold and minimize failure, while men's should maximize the probability of exceeding that threshold and accept more failure. While a positive result for this hypothesis will support the risk model, the same outcome may be expected under the economy-of-scale model. To distinguish between the two models, we need to examine how resources are distributed to consumers.

5. *The costly sharing test.* The risk model predicts that producers of high-variance resources should see a lower consumption benefit than producers of low-variance resources because a greater proportion of the harvest is shared with others. The economy-of-scale model predicts that producers of high-variance resources should keep enough or receive

enough from others to pay back the cost of increased risk. They should thus gain greater consumption benefits than producers of low-variance resources.

6. *The pair-bonding test.* Women more frequently share and form cooperative partnerships with other women than with a spouse. A positive result for this test will support the risk model, a negative result the economy-of-scale model.

The results of these tests were as follows:

Risk aversion/risk proneness. Both the proportion of calories acquired by women relative to men and the proportion of total time allocated by women relative to men (hereafter the division of labor) across foraging activities are highly correlated with measures of variance in that activity (tables 4, 5). The probability of success by bout is the strongest predictor of the division of labor, explaining 85% of the variance in time allocation and 93% of the variance in caloric contribution (fig. 3B). This means that as the probability increases of seeing the mean reward, women choose to participate more often (and men less often) in that foraging activity. As figure 3A shows, women's relative contribution decreases with CV in return rate: activities associated with CVs of 2 or more tend to be more important for men, those less than 1 tend to be more important for women. Activities associated with moderate CVs (between 1 and 2) are those that exhibit the greatest overlap between the sexes. The range of harvest sizes (in kcal) acquired in each activity is also a strong predictor of the division of labor (fig. 3C). The division of labor across activities does not appear to be correlated with average return rate (fig. 3D). These results lend support to the hypothesis that foraging differences are patterned by differential variance sensitivity—men make more variance-prone foraging decisions and women more variance-averse ones.

Mean variance. The risk model predicts that men have higher variance in return at all means compared with women,

Table 4. Measures of Variance in Foraging Activities

Foraging Activity	CV Harvest Size (kcal)	CV Return Rate (kcal/h)	Bout Success ^a	Pursuit Success ^b	Harvest Size Range (kcal)	Mean Prey Size (g)
Goanna hunting	0.859	0.807	0.911	0.891	12,663	455
Bustard hunting	1.689	2.649	0.465	0.314	37,691	4,940
Kangaroo hunting	3.001	2.776	0.224	0.312	70,557	21,505
Perentie hunting	1.144	1.338	0.671	0.478	14,742	2,102
Fruit collecting	0.667	0.652	0.983	–	9,375	–
Root collecting	0.805	0.569	1.00	–	1,552	–
Cat hunting	1.165	1.299	0.600	0.389	19,266	2,536
Grub collecting	0.564	0.511	1.00	1.00	1,304	12
Seed collecting	0.753	0.813	1.00	–	11,067	–
Honey collecting	0.822	0.596	0.882	–	14,000	–
Nectar collecting	0.798	0.407	1.00	–	17,029	–

^aThe proportion of bouts that resulted in any food at all acquired, which can be thought of as the proportion of time that individuals returned to camp empty-handed.

^bThe proportion of pursuits that captured prey.

while the economy-of-scale model suggests that men's and women's mean returns have different variance because women more often have lower mean returns than men. A risk-prone forager should, given the choice between two prey types with equal expected means, prefer the more variable one, while the risk-sensitive forager should make the opposite choice. We evaluate this prediction by examining mean daily foraging returns in the campset, where men and women are simultaneously present and able to choose both high- and low-mean and high- and low-variance resources. When the expected mean foraging return (x) is plotted against the variance (squared standard deviation) associated with that mean (y) across the campset, the resulting line represents all the combinations of mean and variance that each gender chooses. If men tend to make risk-prone choices and women to make more risk-averse choices, the intercept of the men's line will be higher than that of the women's. This will indicate that for a given mean, men prefer the option with higher variance and women prefer the lower-variance alternative (Winterhalder, Lu, and Tucker 1999). Alternatively, as the economy-of-scale model predicts, if women are simply choosing lower-mean and men higher-mean foraging activities, as if women were constrained from high-mean returns by some factors that are correlated with variance, there should be no difference in the intercepts of the two slopes, and the set of means and variances from women's harvests should be clustered in the bottom-left quadrant of the graph, while the set of men's means and variances should be clustered in the top-right quadrant.

The results of this analysis are plotted in figure 4. An analysis of covariance shows that the slopes of the men's and women's lines are parallel; that is, the variance increases with mean at the same rate for both men's and women's harvests. However, men's variance is significantly higher than women's at all means. This means that men's returns exhibit higher variance than women's even when harvest sizes and return rates are low, while women's returns, even very large ones,

are associated with lower variance than men's. Contrary to the economy-of-scale model, there is no clustering in the data points—women's lower variance in return is not a function of their being constrained to low-return foraging activities while men specialize in higher-return ones. Both sexes' means are distributed along the entire range of values. This offers strong support for the risk model and fails to support the economy-of-scale model.

Time allocation covariance. While the long-term structural pattern in the relative participation of men and women in any foraging activity is strongly predicted by the average probability of bout success, this relationship obscures a great deal of temporal variation (fig. 5). A stronger test of the risk model would examine the ability of measures of harvest variability to predict short-term fluctuations in women's and men's time allocation decisions across campsets. To evaluate this hypothesis, we examine risk and time allocation to goanna (sand goanna and perentie) hunting on each of the 24 campsets. We restrict our analysis here to goanna hunting because (a) it has the largest sample size of any foraging activity, allowing

Table 5. Correlations between Risk Variables and the Division of Labor

Variable	r^2 (Time)	P	r^2 (kcal)	P
Probability of successful bout	0.854	0.0001	0.928	0.0001
CV in harvest size	0.694	0.0009	0.879	0.0001
CV in return rate	0.902	0.0001	0.922	0.0001
Harvest size range	0.759	0.0003	0.861	0.0001
Mean harvest size	0.462	0.0128	0.436	0.0160
Mean bout returns	0.013	0.3207	0.092	0.3919
Men's proportional time allocation	0.158	0.1244	0.108	0.1708

Note: Correlations are weighted by the number of bouts contributing to the averages for each foraging activity. All measures of variance show significant correlations with the division of labor.

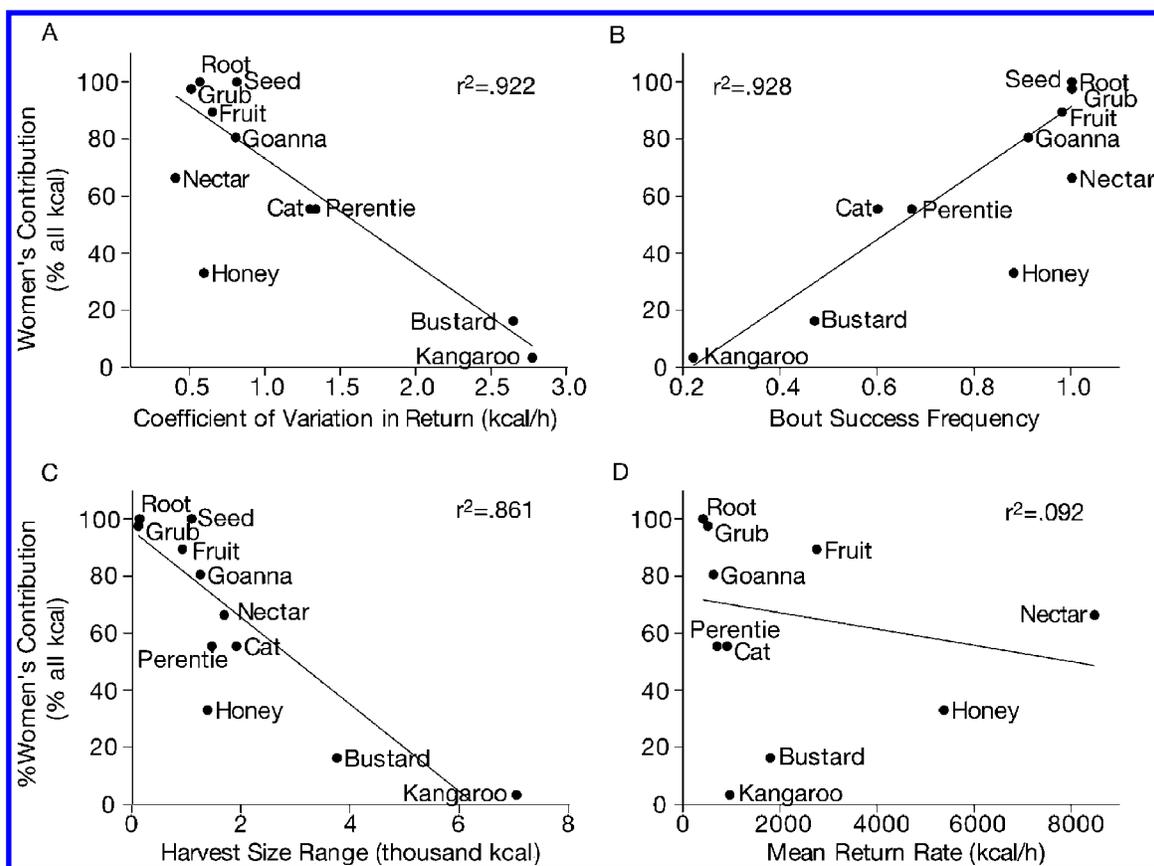


Figure 3. General linear model (regression) showing the ability of measures of variance and mean return to predict gender differences in relative production across foraging activities. *A*, A strong negative relationship between the coefficient of variation in mean returns and the division of labor (measured as the proportional contribution of women to calories acquired in each foraging activity). The CV explains 92% of the variance. *B*, An increase in the proportion of calories that women acquire as the chances of success in a foraging bout increase, with success frequency explaining 93% of the variance. *C*, A decrease in the proportion of calories acquired by women as the harvest size range increases. *D*, A poor fit between mean expected returns and the division of labor, showing that women are not more likely to predominate in activities with low foraging returns. The conspicuous outlier in *A* and *B* is honey collecting, which shows a much higher men's relative contribution than one would predict given its high success rate and low CV in returns. Its fit is better in the harvest-size-range model, suggesting that men may go for honey because it offers the chance of a particularly large harvest.

more accurate measurement of variation and average returns on each camp; (b) both men and women hunted goanna on nearly every camp; (c) both men and women show significant variation across camps in the time they allocate to goanna hunting; and (d) goanna hunting is both seasonally variable, with the method and size of available prey differing in the hot and cool seasons, and spatially variable, with certain locations having much greater abundance than others.

The risk model predicts that one of the costs of acquiring a high-variance resource is the trade-off between the occa-

sional bonanza and the risk of falling below a nutritional threshold. If women are indeed more sensitive to this trade-off than men, they should demonstrate temporal preferences for goanna hunting when variance is lower and when the probability of success is higher. The alternative expectation in this case, consistent with the economy-of-scale model, is that women are responding to seasonal changes in resource productivity (return rate) or to men's time allocation and not measures of variance. Women should allocate proportionally more time to goanna hunting when it offers higher returns,

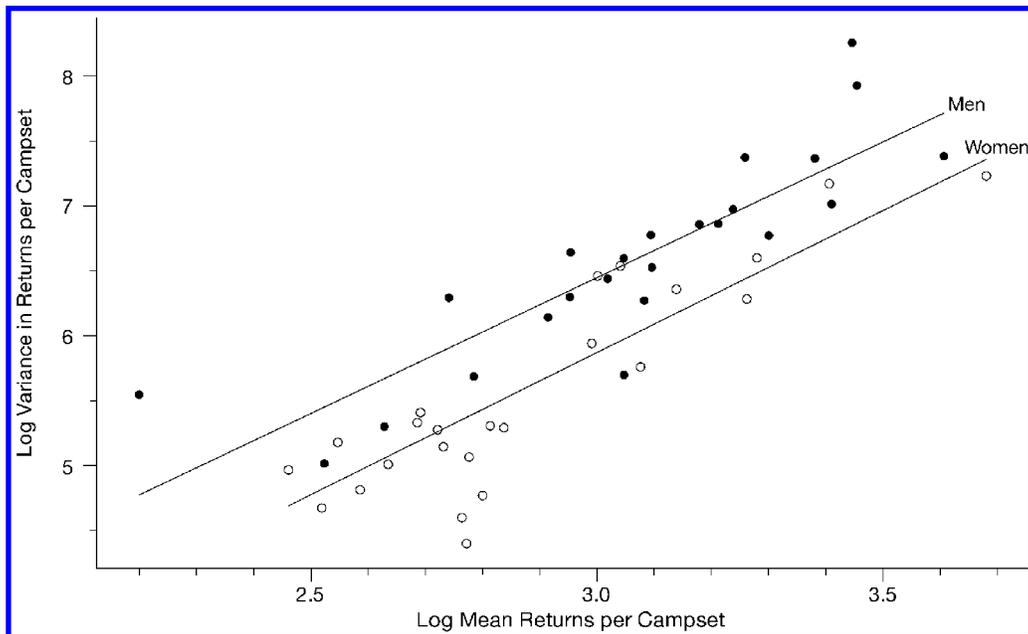


Figure 4. General linear model (regression) showing the relationship between mean daily return rate per campset and its associated variance for men (*upper line, black circles*) compared with women (*lower line, open circles*). The slopes of the lines are parallel ($\text{sex} \times \text{log mean}$, $P = .4373$), but the men's line has a higher intercept than the women's ($P = .0001$). This means that for every mean value, women's returns are associated with lower variance than men's, indicating that women are able to achieve returns as high as men's without the associated variance and that men often gain low returns but with more variance than women. Men and women both gain the same range of mean returns, but throughout this range men exhibit higher variance than women.

and women should avoid those activities that men prefer and vice versa. There should thus be negative correlations between men's and women's time allocation across all foraging activities.

How men should respond to changes in variance depends on whether they are interested in acquiring a bonanza harvest or whether they are attempting to show how skilled they are as hunters, able to succeed even when others fail. Resources that have a higher CV in harvest sizes across bouts and larger maximum harvest sizes are subject to greater demands for sharing as those who have none seek to acquire from those who have plenty. A forager who targets such resources becomes a source of public goods and can potentially gain socially, politically, and reproductively through such display (Hawkes 1991, 1993; Wiessner 2002; Smith, Bliege Bird, and Bird 2003; Smith and Bliege Bird 2005). Alternatively, a resource that is simply highly variable in terms of its chances of success or its return rates (but not necessarily in terms of its harvest size), when such variability is linked to intrinsic qualities of the forager (and not, e.g., to external forces such as weather or other stochastic events), could serve as an honest signal of some quality inherent to the forager (Bliege Bird,

Smith, and Bird 2001; Hawkes and Bliege Bird 2002). In this case, the benefits of acquisition could come more from the embodiment of information in the act of acquisition itself than from sharing the bounty subsequent to a successful harvest. If men are foraging in more risk-prone ways as a way to increase the chance of getting a bonanza harvest that can be shared with more people, then they should allocate more time to goanna hunting on camps where maximum harvest sizes are larger (see Bird, Bliege Bird, and Parker 2005 and Bliege Bird and Bird 2005 for details). If, however, men are targeting goanna in order to send signals of quality, they should spend more time hunting when failure rates are higher and returns are more variable across individuals. The alternative expectation in this case, consistent with the economy-of-scale model, is that time allocation to goanna hunting simply tracks temporal fluctuations in foraging return rates or women's time allocation.

Consistent with the risk model, women's foraging time covaries with goanna hunting variance: they spend less time hunting goanna as the variance in returns increases ($r = -.509$) and more time as success rates increase ($r = -.715$; see table 6). Contrary to the economy-of-scale model,

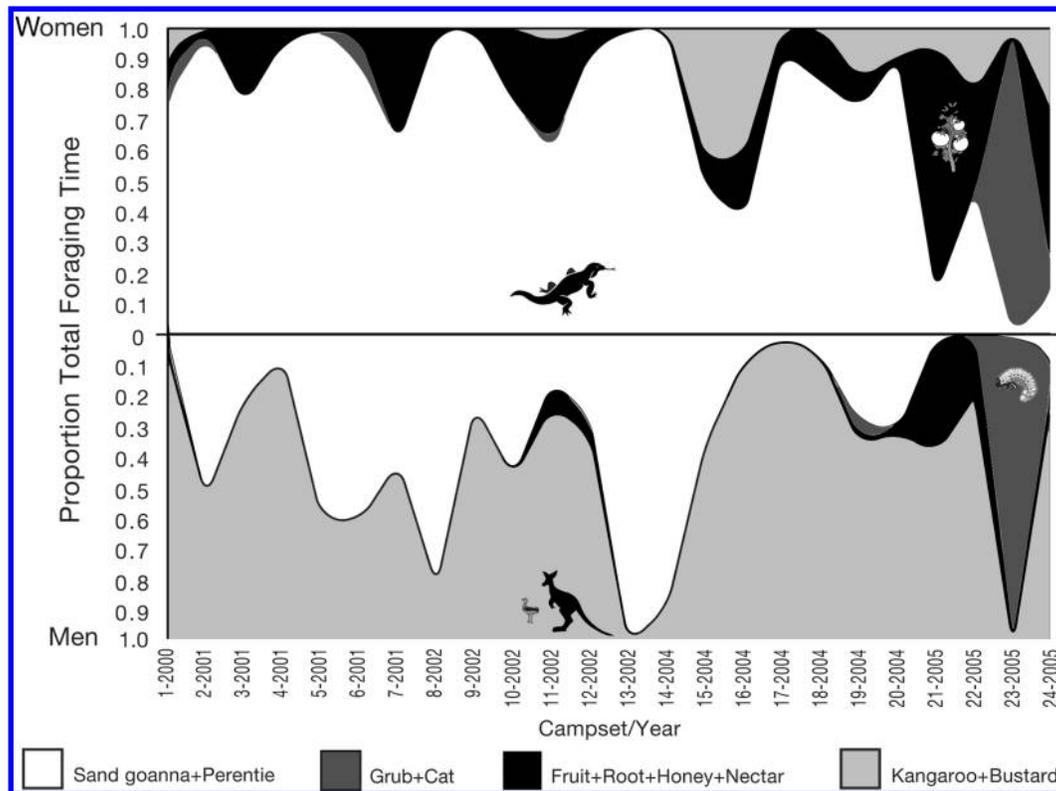


Figure 5. Spatial and temporal variation in men's and women's time allocation as a percentage of total foraging time per camp. A period of below-average rainfall and late summer rains in 2005 may be responsible for the precipitous drop in goanna hunting time—the rains did not come before the goanna denned for the winter, reducing their fat reserves and making them “too skinny” to hunt. Foragers then switched to alternative resources.

the percentage of total foraging time that women allocate to an activity covaries not negatively with men's but positively ($r = .539$, $P = .1347$), although the correlation is not significant (fig. 6), suggesting that some of the foraging activities more important to women over the long term are also those that tend to be more important to men.

We are also able to reject the economy-of-scale hypothesis for men: they do not vary their foraging time according to seasonal changes in the productivity of each activity (table 6). Contrary to the skills-advertisement hypothesis of the risk model, men do not hunt goanna more when the chances of success are low ($r = .297$) and when there is higher variation in return rates across foragers. But, consistent with the risk model's harvest-size hypothesis, men spend more time hunting goanna on camps where there is the possibility of getting a very large harvest ($r = .555$). The primary source of variation in harvest size is the seasonal pattern of the availability of very large goanna. During the hot summer season, sand goanna are tracked on the surface along with perentie, and a hunter can easily estimate the size of the animal by the nature of the track. In the cold season, perentie are unavailable (they

den in termite mounds and caves) and sand goanna burrow, making it more difficult to estimate their size. It thus seems likely that one of the main determinants of variation in men's time allocation to small, low-variance prey is the potential to acquire a harvest that can be distributed to more consumers, not because in doing so they can signal skill through acquisition.

These results provide additional strong support for the risk model, suggesting that differences in variance sensitivity are a more plausible explanation for variation in men's and women's foraging production and hunting time allocation than cooperation in an economy of scale. But why might men be more variance prone than women? The final set of tests is concerned with men's and women's foraging goals. Are men more variance prone because they benefit more from the social status and alliances created through sharing widely, while women seek the consumption benefits that resources supply?

Foraging goals. One way of indirectly assessing men's and women's foraging goals is to examine variability in total daily food production, summing over all hunting and collecting

Table 6. Correlations between Risk Variables, Return Rates, and Men's and Women's Proportional Time Allocation to Goanna Hunting

	% Total Foraging Time on Goanna			
	Men		Women	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Goanna return rates	-0.199	0.3504	0.083	0.6983
Bustard + kangaroo return rates	-0.094	0.6608	0.089	0.6799
Collecting return rates	0.292	0.1663	-0.225	0.2912
Goanna maximum harvest size	0.555	0.0059	0.398	0.0602
Collecting maximum harvest size	-0.385	0.0634	-0.461	0.0233
Goanna CV in returns	-0.122	0.5981	-0.509	0.0184
Bustard + kangaroo bout success	-0.414	0.0441	-0.287	0.1746
Goanna bout success	0.297	0.1913	0.715	0.0003

Note: Correlations showing positive or negative relationships between goanna hunting time allocation and return rates, maximum possible harvest sizes, bout success percentages, and the coefficient of variation (CV) in returns. Women spend more time goanna hunting when bout successes are more likely and less time when returns are more variable and collecting can potentially provide a big harvest. Men spend more time goanna hunting when harvest sizes are potentially bigger and less time when kangaroo or bustard success is more likely. A multivariate regression model incorporating both collection harvest size maximum and goanna success rate explains 59.7% of the variance in women's goanna hunting time allocation ($P = .0003$), while 37.7% of the variability in men's goanna hunting time allocation is explained by both goanna size range and the success rate of bustard and kangaroo hunting ($P = .0088$).

activities. According to the risk model, women's production is structured around the goal of maximizing the chance of meeting daily nutritional requirements and men's is structured on increasing the probability of a large harvest that can be widely shared. Here, we define "daily nutritional requirements" as a maintenance range between 500 and 4,000 kcal/day, or a harvest that feeds up to two adults. Figure 7 shows the frequency distribution of men's and women's daily foraging production in 500-kcal increments. Consistent with a prediction of a foraging goal involving competitive sharing, men have a much higher chance (30% vs. 10% for women) of getting a daily harvest larger than 4,000 kcal. But they also have a higher chance (39%) of acquiring a harvest below 500 kcal (compared with 18% for women). Women's daily foraging decisions give them the highest chance of acquiring a harvest within the maintenance range (73% compared with men's 31%). Men do seem to trade off a 20% increase in the chances of a large harvest for a doubled risk of falling below the maintenance threshold, while women trade off a 20% lower chance of a bonanza for a doubled probability of acquiring a harvest within the maintenance threshold. Men seem to act as if they ascribed increased value to larger harvests, women as if the value of larger harvests diminished relative to the costs of getting too little, consistent with a prediction of differential variance sensitivity due to differences in foraging goals.

Costly sharing. The risk model predicts that producers of high-variance resources should keep for themselves or their households at least as much as they give away to others. The risk model also predicts that acquiring high-variance resources comes at a cost to consumption over the long term. High-variance prey are distributed so widely that acquirers do not keep a per capita portion larger than anyone else, making low-variance prey a better option if one's goal is to seek the consumption benefits resources supply. Women thus prefer low-variance prey because they provide higher consumption benefits. The economy-of-scale model would predict instead that there is indeed more consumption benefit to be had from high-variance prey, either because acquirers keep a larger portion than others receive or because they are favored targets of reciprocal altruism.

To test this prediction, we used a data set made up of 103 distributions from 11 hill kangaroo hunts and 242 distributions from 19 goanna hunts to recipients other than the acquirer. For most animal prey, body size determines how the animal is distributed. For prey larger than about 2 kg, a hunter, especially if he or she is younger, is expected to make no claim to the carcass and play no part in its butchery or division: the kill is dropped at the edge of the hearth or bush camp, and an elder takes responsibility for cooking, butchery, and distribution. Processing for distribution is usually quite formal and proceeds in a manner similar to that described for other desert Aboriginal groups (e.g., Gould 1969, 1980; O'Connell and Marshall 1989). Perentie, cat, and bustard carcasses are typically divided in four parcels; plains kangaroo and hill kangaroo are usually butchered into nine initial portions. Kangaroo have the most formal butchery and primary distribution. Parcels are named in relation to the hunter, not the cook/distributor. The tail and head are often designated as the hunter's. The hunter's father-in-law (often classificatory "MB," *kaka*) or mother-in-law (classificatory "FZ," *yumari*) can claim the rump, an elder brother (*kurta*) or his wife (*nyupa*) a forequarter, and a brother-in-law (*makurta*) or married elder sister (*jurtu*) a rear leg. If these kin are not present, the cook/distributor gives the portion to any other adult at his discretion. Following the primary distribution, informal secondary distributions ensure that the portion is divided evenly among all consumers, young and old, at each hearth (Bird and Bliege Bird n.d.). The formality of the primary distribution functions to name those who can claim the benefits of being the generous provider of meat in secondary distributions, not to transfer ownership of the meat per se.

Sharing of small game and plant resources is somewhat different; goanna hunting provides a useful example. When foragers return to the bush camp, they gather around one or two cooking hearths depending on the size of the foraging party. Each hunter cleans her own goannas by hooking and twisting the intestines on a stick through a small incision under a forearm and then quickly sings the lizards on the fire and places them in a shallow roasting pit prepared next to the fire. After about 20 minutes, the goanna are cooked

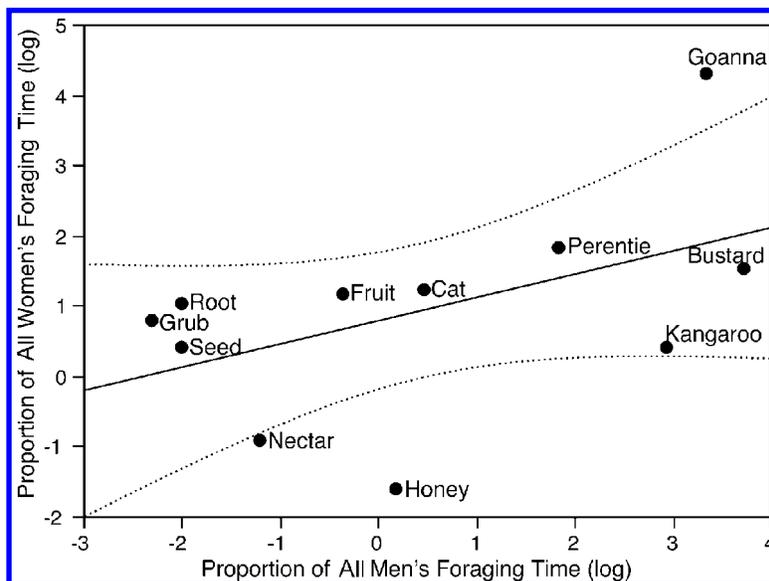


Figure 6. Men's and women's proportional time allocation to each foraging activity.

and primary distributions follow. Unlike the sharing of large game, in which primary portions are distributed to a possessor's hearth group, small-game sharing involves direct transactions, acquirers actively handing over whole goanna or portions to individual consumers. Older children receive directly, but smaller children are fed from portions given to their caretakers. Goanna are passed back and forth from hunter to hunter and from those who have more to those who have less. If few goanna were acquired and there are many consumers, each goanna may be carefully halved, one receiving a tail, another the body, both portions with large deposits of fat. Acquirers keep more for themselves when there are plenty of goanna to go around but are likely to keep little when goanna are few. Hunters often exchange identical goanna, as if reluctant to consume their own, and a hunter rarely keeps a particularly large one (>500 g). If there is more than one hearth group at the bush camp and significant asymmetries between hearths are obvious, "fairness" may demand secondary transfers between hearths. After these distributions, all eat their fill, and leftover portions are taken back to the recipients' households. No kinship rules guide the primary tier of distribution for small game (Bird and Bliege Bird n.d.).

Are high-variance prey such as kangaroo shared more widely than low-variance prey such as goanna? Kangaroo is always shared with nonacquirers; portions of primary shares average 2,403 kcal, distributed to an average of 9.6 other individuals per carcass. Goanna is shared in 82.6% of harvests; individual portions given to nonacquirers average 648 kcal ($n = 52$), distributed to 2.5 other individuals ($n = 19$ harvests). Per hunt, goanna is more narrowly shared. However, because goanna hunts are nearly always successful (9% failure

rate), women share with these 2.5 others nearly every day they hunt. Kangaroo hunts are less successful (75% failure rate), and, as a result, the average number of others distributed to per day is nearly the same for goanna (2.1 others/day) and kangaroo (2.4/day). Goanna hunters thus share more frequently and to as many potential others as kangaroo hunters over the long term, but their shares are a third smaller. Hunting higher-variance kangaroo results in (a) wider distributions per successful hunt and (b) larger portions that satisfy hunger and eliminate the need for others to work.

But do producers acquire kangaroo at a cost to themselves? Perhaps because kangaroo hunts produce so much meat, others can be satisfied with a relatively smaller percentage of the carcass and producers can actually keep relatively more for themselves than if they had acquired goanna, thus paying themselves back for the higher failure rate they accept in acquiring kangaroo. In order for hunters to compensate for kangaroo hunting's increased variance, they should end up with more food after all bush foods are distributed. To test this prediction, we summed the total amount of bush food that all adults present in the camp received from others and from self to determine their total "consumption portion" ($n = 111$ for goanna hunting, 124 for kangaroo hunting). On the days that kangaroo are acquired, a hunter's consumption portion is slightly smaller than a nonhunter's, but the difference is not statistically significant (1,551 g vs. 1,849 g of edible meat, $P = .5702$; fig. 8). Cook/distributors pay close attention to ensuring that every adult present, even those coresident with or kin to the hunter, receives an equal share in the primary distribution (see Bird and Bliege Bird n.d.). In comparison, goanna hunters can expect to consume more

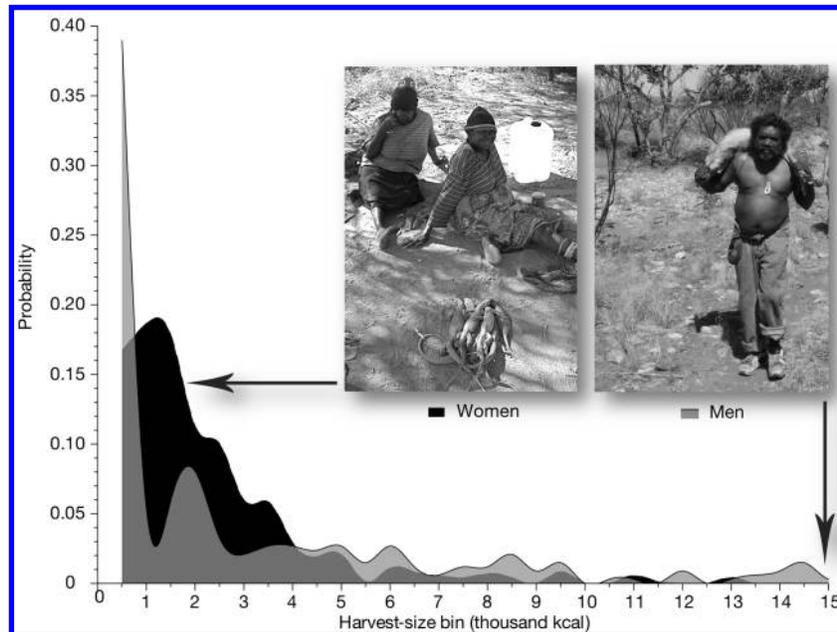


Figure 7. Probability distribution (smoothed) of daily harvest sizes (in kcal) for men's and women's foraging bouts in 500-kcal increments. Men have a higher chance of a harvest's falling within the first bin (0–500 kcal) than women, women have a higher probability of a harvest between 500 and 4,000 kcal, and men have a higher probability of a harvest larger than 4,000 kcal. The accompanying photos show a typical day's catch from successful men's (kangaroo) and women's (goanna) hunts, with arrows denoting where the catch falls on the probability distribution. The tail on the men's distribution has had to be truncated—it extends to 50,000 kcal with a probability of less than .02.

relative to nonhunters: their postdistribution consumption portions average 823 g ($n = 86$) compared with a nonhunter's 445 g ($n = 25$, $P = .0001$). They get more not because they receive more from others but because they are able to feed themselves in addition to receiving food from others.

Given that successful kangaroo hunters get to eat more than successful goanna hunters, is it really all that costly to hunt kangaroo? How much do hunters actually get to eat when we account for difference in hunting success rates? Even after accounting for the higher caloric content of a goanna share (goanna contain large fat bodies in the abdomen that they rely on during winter hibernation, making up about 10% of their body weight), the postdistribution consumption portion of a goanna hunter is still less than that of a kangaroo hunter: 1,720 versus 2,480 kcal. However, since kangaroo hunting successes are more infrequent, a goanna hunter's long-term average daily consumption portion will be 1,548 kcal/day, while a kangaroo hunter will gain only 620 kcal/day. Nonhunters (those who do not acquire anything) can expect 740 kcal/day of kangaroo and 841 kcal/day of goanna. Clearly, given this ratio of hunters to nonhunters, kangaroo hunters are operating at a cost to themselves—they would have a

larger share over the long term by remaining in camp and waiting for the goanna hunters to return.

Pair bonding. The risk model predicts that women more frequently share and form cooperative partnerships with other women as part of their strategy to develop cooperative social networks for child care and provisioning, especially intergenerational ones. The economy-of-scale model predicts that women subsidize the consumption losses of kangaroo hunters. Women should prefer to partner with a spouse or an adult son (since partnering with an unrelated man might signal they were having an affair), and men should be more likely to receive portions of goanna in the initial distribution. In order to address these predictions, we examined a subset of 43 goanna hunters for which we had information on cooperative hunting partnerships. The choice of partner is important for goanna hunting, because women tend to pool their harvest with their hunting partners before sharing with others. We did not include partners who might be part of a division of labor, remaining behind in camp to care for children or make a fire. For each of those 43 hunters, we constructed a matrix of all possible partners a hunter could have chosen on each foraging day and summed over all foraging

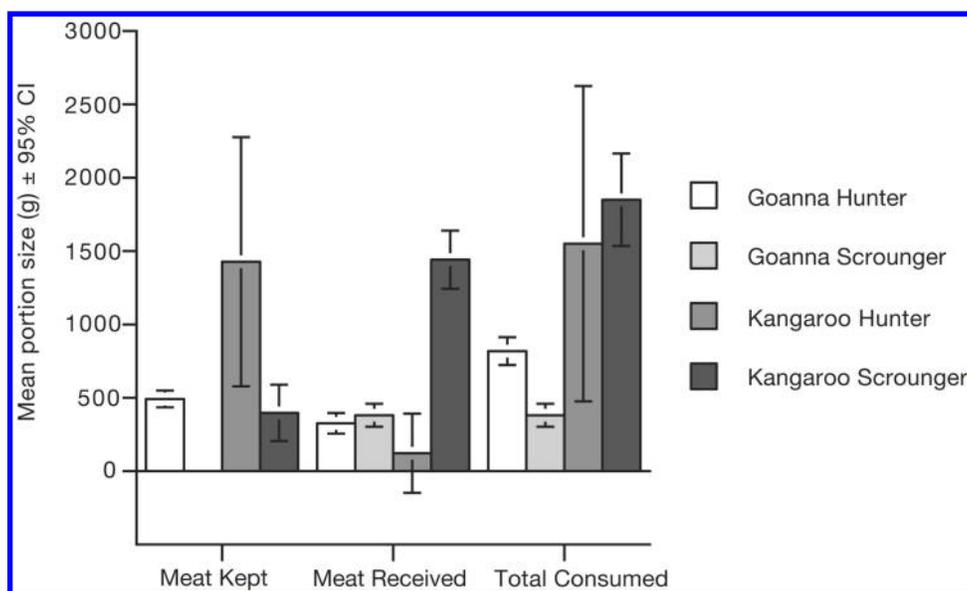


Figure 8. Difference in consumption benefit to hunters and nonhunters measured in grams of edible meat received per successful foraging day. The error bars show the 95% confidence interval for the mean; means with error bars that do not overlap are significantly different. A goanna scrounger did no goanna hunting that day or was unsuccessful at acquisition. A kangaroo scrounger did no kangaroo hunting but may have successfully acquired goanna or some other resource—thus, in contrast to goanna scroungers, kangaroo scroungers eat from their own harvests as well as from those of the kangaroo hunter. “Meat Kept” is the total portion the hunter kept to eat for himself; “Meat Received” is the sum of all portions the hunter received that were acquired by others; “Total Consumed” is the sum of amount kept and amount received for that foraging day. It generally overrepresents the actual amount consumed by the individual, as most consumption portions (especially kangaroo) are further divided as the meal progresses, especially on the request of children.

days to obtain an affiliation score (number of days cooperated divided by number of days available to cooperate) for each potential dyad. This resulted in a data set composed of 344 unique dyads of which 74 exhibited at least one instance of cooperation.

Women cooperate most often with other unrelated women and less often with a spouse, but most prefer kin and some prefer spouses if they are present in camp. Figure 9 shows both the percentage of days that dyads were available to cooperate and the average affiliation score for each type of dyad according to the sex of the partners and the kinship relation between them. Women are most often available to cooperate with unrelated women and men, but they do so 11% of the time. They cooperate 48% of the time that female kin are available and 45% of the time that a spouse is available. Most spouses are rarely together, though; five of the six observations of spousal cooperation are contributed by the same dyad, suggesting that there is no general trend toward spousal cooperation but a great deal of variation between couples. A

few routinely choose each other for cooperative goanna hunts, but most hunt separately, husbands usually going off to hunt kangaroo if the party is near a rocky outcrop, or if not, looking for parentie goanna or even choosing not to hunt and instead collecting wood for making spears, spear throwers, boomerangs, and other fighting implements. The majority of women form hunting partnerships with other adult women much more often than with their spouses.

Who were the preferred targets of goanna distributions? Eighty-nine percent of all transfers of goanna were between adult women or between women and children. Only 11% went to adult men. On average, primary portions were distributed to 45% of the women present in camp per day ($n = 10$ camp days) but to only 27% of the men. Men also were not getting more portions from more hunters: each man who received got an average of 2.2 portions/day, while each woman got 2.1 portions/day ($P = .8198$).

And who is doing the goanna hunting? The probability that a woman will hunt goanna if she is present in camp increases

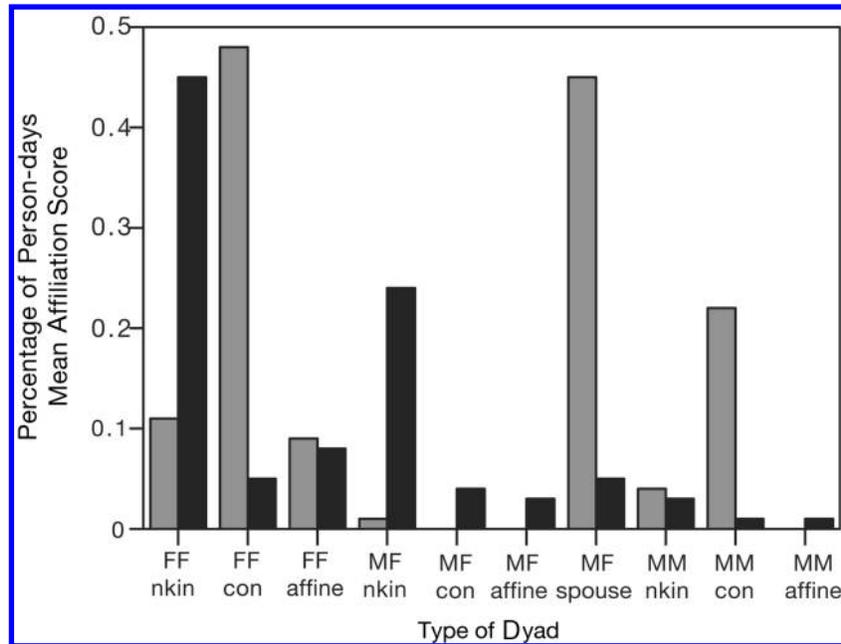


Figure 9. The mean percentage of all person-days that pairs of different types were together (*black bars*) compared with the mean percentage of time that they cooperated with each other when together (mean affiliation score, *gray bars*). Dyad types are indicated by gender of pair (FF [female-female], MF [male-female], or MM [male-male]) followed by genealogical kinship relation (nkin = nonkin, con = consanguineal kin, affine, spouse). The affiliation score is measured as the number of days cooperated divided by the number of days individual members of each dyad were in the same foraging camp and thus available to cooperate.

from .18 when she is under 20 to more than .67 when she is postmenopausal (see fig. 10). The probability that a woman will be involved in collecting activities, particularly grubs and fruit, decreases as she ages, from .23 and .32 (respectively) when she is under 20 to .05 when she is postmenopausal. Older women tend to be more involved in goanna hunting, younger women in collecting fruit and grubs and hunting bustard.

Contrary to the economy-of-scale model and consistent with the risk model, there is thus very little evidence that goanna hunters prefer to hunt and share with hunters of high-variance prey, and there is enough circumstantial evidence to suggest that women most often affiliate with each other, that shares of goanna go primarily to other women, and that older and younger women tend to prefer different sets of foraging activities.

Discussion

Our results are most consistent with a model of the foraging division of labor based on differential variance sensitivity rather than cooperative specialization. Under cooperative specialization due to comparative advantage, we might expect men to be more variance prone because they are specializing

in high-mean returns because of women's foraging constraints, but we found no such gender bias. We might also expect men and women to exhibit negative covariance between foraging times for similar or complementary resources, but we found no or at best positive covariance, indicating that as women increased time on a particular resource, men did too. Consistent with the risk model, 93% of the variability in women's relative contribution to any foraging activity was explained by the chance of harvest success; men had significantly higher variance at all mean return rates than women, and women responded dynamically to temporal and spatial variability in the reliability of hunting returns, spending more time hunting for small game when returns were more reliable. Men spent more time on small game when there was an increased chance of acquiring a very large harvest, regardless of the chances of failure.

Harvest-sharing patterns were also more consistent with the risk model, which predicts that men's and women's disparate foraging goals—women optimizing consumption benefits, men social benefits—create preferences for different foraging choices. According to the model, high-variance prey offer high costs to consumption but create social benefits through wide distributions of meat. Low-variance prey are

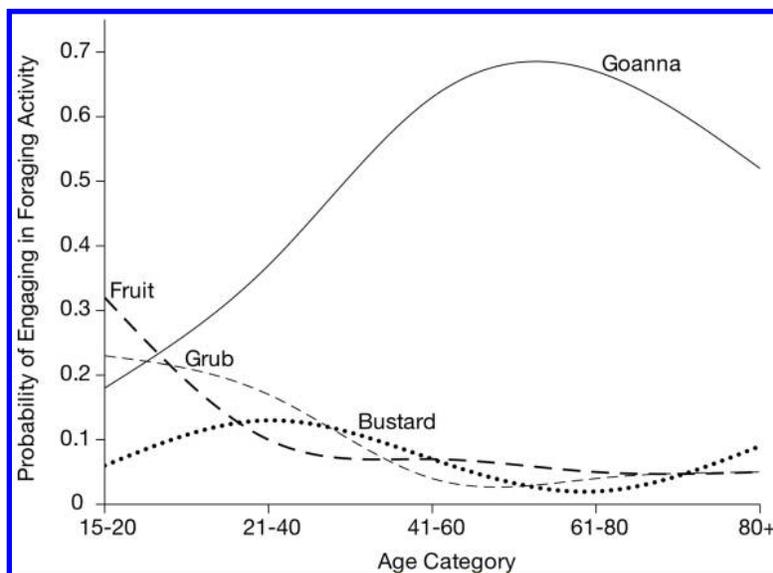


Figure 10. Smoothed probability plot showing the chances that a woman in each age category will engage in one of four foraging activities if she is present in camp. Such differences may reflect age-related changes in foraging strategy related to caring for children; younger women may prefer vehicle hunts and collecting because the costs of foraging with children are lower. Children can assist in spotting game on vehicle hunts and can productively acquire fruits, roots, and other sessile resources. Children do not walk fast enough to acquire the dispersed sand goanna, instead preferring to focus on a smaller species at higher population density (ridge-tailed goanna; see Bird and Bliege Bird 2005).

shared more narrowly, and more is kept for the acquirer's own consumption. Our results showed that the probability distribution of men's and women's daily acquisition return (in kcal/day) was consistent with a more low-risk strategy for women and a high-risk strategy for men. Women were much less likely than men both to fail to acquire a harvest on any foraging day and to get more than two adults could consume, while they were more likely to acquire a harvest within the maintenance range (500–4,000 kcal). We also showed that the consumption costs of acquiring high-variance prey lay not only in its greater uncertainty of success but also in its lower consumption return after all hunters had shared their catch. Men who hunted kangaroo did not keep proportionately more for themselves to repay the costs of extra variance. Nor were they paid back for hunting by receiving more meat from others than nonhunters. Small-game hunters did end up with more for their own consumption, keeping more of what they acquired while still receiving from the small-game production of others. A hunter could thus expect a larger consumption benefit over the long term by hunting and sharing small game rather than large game, given that others in the group were successfully hunting small game. Women also formed foraging parties and hunting partnerships more often with other women than with men, and thus low-variance prey were primarily transferred between older women and their younger

female partners and dependents, not between women and men.

In acquiring the rare, larger harvest, men make a bigger per-acquisition impact on the consumption of others, gain fewer consumption benefits, and depend less on the production of others. In acquiring the smaller, more consistent harvests and directing them mainly to other women and children, a woman contributes just as much to the consumption of others over the long term as a male hunter of high-variance prey, but in doing so she also can keep more for herself, which can then be distributed or consumed as she wishes. Rather than a division of labor that is the result of cooperative specialization and reciprocal sharing between men and women, here we see a suggestion that cooperation and sharing are more commonly occurring among women, whose foraging decisions differ with age. The differences between Martu men and women in choice of occupational portfolios associated with different levels of risk arise not because men and women are cooperatively specializing in resources with different types of risk but because women gain socially and reproductively through consistent provisioning of children and cooperative partners and men gain through the provisioning of less reliable bonanzas that contribute to the public good by periodically paying a cost that eliminates the need for others to work.

As Hawkes (1990, 1991; Hawkes, O'Connell, and Blurton Jones 1991) proposed for Ache and Hadza foragers, foraging decisions may be gender biased because men and women have different foraging goals that lead them to perceive the costs and benefits of risk differently. This is a very different hypothesis from one that explains the division of labor as a cooperative provisioning effort in which hunters are compensated for the variance associated with acquiring risky prey through reciprocal sharing. Martu hunters who target risky prey are not compensated through reciprocation (Bird and Bliege Bird n.d.), and hunters would consume more and have more control over larger portions of food were they to acquire low-variance goanna. Rather than suggesting that men hunt kangaroo in order to eat more, we suggest that Martu have it right when they describe what they do as "hunting to share." The fact that hunting and collecting *generosity*, not skill or production per se, is rewarded socially as *mirtilya* (productive and generous with *kuwiyi*) suggests that the benefits of risk lie in the fact that high-variance activities facilitate magnanimous display and fine-grained discrimination of underlying quality and motivation.

We suggest here that the price kangaroo hunters pay in accepting such risk is socially strategic: that hunters of high-variance prey forage for symbolic capital, not food per se (Bliege Bird and Smith 2005). Drawing on the ethnographic literature, we suggest that Martu men's foraging goals more often involve political strategies in which men use hunting for high-variance prey (kangaroo) as a way to rise in the ritual hierarchy. The cost of hunting lies not in the acquisition of the item or the signals of investment in skill and practice but in the way the item is distributed by a cook who did not hunt the animal and does not play favorites. Because the distribution of high-variance prey ends up being costly to the hunter, it can serve as a more honest signal of a hunter's absolute generosity and motivation to work for the public good (Smith and Bliege Bird 2005). We suggest that Martu men prefer to acquire resources that are highly variable and come in large packages because in so doing they demonstrate their honest disengagement with property, the generosity and magnanimity that, as Hiatt (1982, 14) suggests, are the "main measure of a man's goodness." The honesty of the display of generosity is maintained by the consumption costs the hunter bears. These social goals lead men to value larger harvests over smaller ones and to discount the costs of failure because they stand to benefit socially and reproductively from seeking the competitive rewards associated with harvest bonanzas that feed large audiences. Men cannot satisfy their foraging goals with smaller harvests because the benefits they seek are obtained only through competition. Competition to be the most "disengaged with property," or "competitive magnanimity," may be what drives the benefits for seeking larger and larger harvests. Only by producing and sharing more than their competitors can men claim the social distinction that will garner reproductive and ritual benefits, allowing them to rise in the ritual hierarchy and to marry well and often.

Martu women's foraging goals are also focused on sharing but of smaller, more consistent portions within a narrower kinship network. Their reliance on cooperative divisions of labor with other women leads them to bank on the consistency of the consumption benefits that resources supply, prompting them to discount larger harvests if they are associated with greater variance and to accept smaller rewards in exchange for a more likely return. Their focus on feeding a small social network rather than competing within a larger one as men do makes the benefits of larger harvests lower than the costs of failing to meet their consumption goals, and so they forage in more risk-averse ways. This focus on narrower, more directed sharing (albeit of the same amount of food over the long term as high-variance prey) forces women to make severe social trade-offs—while they can claim the status of *mirtilya*, they can generally do so only when they are older and able to focus on goanna hunting, which offers moderate levels of variance and risks of failure and a broader range of potential harvest sizes than most plant and insect foods (aside from honey).

The story we related at the beginning of this paper serves to illustrate the fact that for Martu it is the balance of costs relative to benefits associated with each strategy that structures gender difference. When women face high social costs to investment in a smaller, more reliable harvest, even they will be forced to choose riskier resources over creating large disparities in consumption by feeding only a select few members of one's close kin network. Such sharing is *malya*, selfish, because it is interested, directed, focused on benefits that accrue to the individual hunter. It is particularly *malya* in the contemporary settlement, when not every family has a female hunter who can get goanna and there are many others who potentially are hungry. Some cannot go out hunting: those who are in mourning, those without a working vehicle, those who are visiting and will not hunt or burn without owners present. Choosing to hunt goanna while in a larger social group, with its small harvests and directed sharing, deliberately creates consumption inequalities. Thus, Karimarra faced a dilemma—should she get goanna and feed her children and female friends or take the riskier alternative, which might feed everyone but carried with it the chance of failure? She chose to go hunting for bustard that day, got nothing, and came home just as hungry as everyone else.

This leads us to a discussion of continuity and change in Martu foraging. Most discourse on contemporary Aboriginal people emphasizes postcolonial sentiments about *former* foragers whose lives today are primarily defined by the globalizing and disenfranchising realities of institutionalized assimilation (the Stolen Generation). Indeed, Martu society in the broader community strains under the weight of violent racism and substance abuse, and Martu deal continually with paternalistic programs designed to encourage material prosperity and participation in "mainstream" social and economic life. Despite and perhaps because of this, there is tremendous resilience and autonomy that emerges in these remote com-

munities, a concerted resistance to the imposition of values defined by a society that knows very little about them. Emphasizing an identity as a “former forager” is a presumption that foraging is an evolutionarily stagnant stage; it disregards some of the most vibrant aspects of contemporary Martu identity as expressed in their hunting ethos and practice. When the teachers in the Parnngurr community school recently asked the local children how they wanted to define themselves on their new Web site, the children chose two activities: basketball and hunting.

But to what extent are our results generalizable to past foraging contexts? Did women always hunt so much, or are they able to devote more time to hunting now because they do not have to spend so much time harvesting and processing grass seed into flour for damper? Was men’s and women’s production always equivalent, or are men producing more now relative to women through the increased efficiency of vehicles and rifles? One of the most important changes has been the increasing use of the vehicle in hunting, particularly in changing search and pursuit success with bustard. On foot, encounters with bustard are rare, and a hunter has only a small chance of coming close enough to capture one. In a vehicle, one can often drive close enough for a rifle shot before they become skittish and take flight. Because most bustard hunting is done by men and more than 40% of men’s production is the result of bustard hunting, men’s historical production is likely to have been lower relative to women’s. But are women hunting more today than historically they might have? Given that women today forage for shorter daily bouts (3.17 hours/camp day) than they likely did in the past, it is possible that their absolute meat production has stayed relatively constant but their relative production has dropped as seeds have been replaced with wheat flour (O’Connell and Hawkes 1981). Women historically may have produced *more* meat relative to men than they do today and more food overall, consistent with Gould’s (1967) estimate of 90% of total production contributed by Pitjantjara women (see also Gould 1980). While women may be producing just as much meat, they may be spending more time now on higher-variance hunting than they ever did in the past, and, ironically, this may be more because of changes in their social environment than because of changes in technology and economy. Women would always have had the opportunity to come home and make a damper if unsuccessful at hunting, whether that damper was made with purchased or collected seed flour. But living in larger, more permanent social groups may make the costs of being *malya* harder to bear.

Broader Implications

While we have focused here on explaining aspects of Martu women’s hunting occupations, our data also have implications for understanding foraging divisions of labor in the more general sense. Foraging women allocate varying proportions of their subsistence effort to pursuing mobile prey: 19% of

total foraging time among the Gunwinggu (Altman 1984), 3% among the Ache (Hurtado et al. 1985), and 18% (of all labor time) among the Mossapoula Aka (Noss and Hewlett 2001). Kubo women captured 13% by weight of all pigs and cassowaries and most of the bandicoots (Dwyer and Minnegal 1991), and Agta women acquired approximately 40% of all animal prey (Estioko-Griffin and Griffin 1985). Inuit (Netsilik and Copper Eskimo) women participated in caribou drives and seal hunts (Jenness 1922; Damas 1969), while Ngatjatjara (Gould 1980), Tiwi (Goodale 1971), and Shoshoni (Steward 1938) women also devoted a substantial but unmeasured proportion of foraging time to hunting mobile prey. Many others, like the Hadza (Hawkes, O’Connell, and Blurton Jones 1997), did no hunting, acquiring only plant-based foods or immobile prey.

Why do Martu women hunt so much relative to other hunter-gatherer women, and why are they so much more productive relative to men, especially in contemporary Australia, where women seem to produce only 5%–10% of all bush foods (Sackett 1979; Altman 1987; Devitt 1988)? The answer to this question is necessarily complex, involving aspects of local ecology and ecosystem function, the continued maintenance of traditional burning practices, the increased competitiveness of social hierarchy in the permanent settlement, the shallower colonial history of marginalization and the lack of pastoralist incursion into the Western Desert, and differences in social structure, particularly with respect to women’s cooperative social networks and aspects of political autonomy (see also Tonkinson 1990). In part, Martu women may produce so much relative to men because they maintain cooperative partnerships with other women: daughters who remain behind to care for children and friends, sisters, and co-wives to cooperatively acquire resources—they must work longer in order to acquire the food to support these cooperative partnerships. Hunting also seems to be a specialty of older women who work to provision younger ones, and Martu children are and may always have been particularly productive foragers themselves (Bird and Bliege Bird 2005). Martu may hunt so much relative to other forager women because the Australian desert supports the highest biomass of herpetofauna in the world (Morton and James 1988) and some of the largest lizards, the Varanidae, which vary in size from 250 g to in excess of 8 kg. These high population densities result in low bout failure rates (if one pursuit fails, another is not far away). Martu women may produce so much relative to men because higher-variance prey, kangaroo and emu, are particularly scarce in the Western Desert, perhaps because of the lack of extensive mulga woodlands and limestone country. Bout success rates for Martu hill kangaroo hunters on foot are less than one-third that for hill kangaroo foot-hunters in Central Australia, where kangaroo may be more abundant, although seasonally their populations vary in boom-and-bust cycles related to rainfall (O’Connell and Hawkes 1984). Martu may devote so much time to hunting and collecting relative to other contemporary Aboriginal women, who produce very

little foraged food (see O'Connell and Hawkes 1984; Altman 1987; Devitt 1988), because they still practice mosaic burning, which critically affects both the productivity of goanna hunting and the density of edible plants and seed grasses (Bird, Bliege Bird, and Parker 2005). Because Martu are extremely remote from any pastoralist settlements or urban centers, they maintain relative autonomy in the application of fire and the management of traditional resources. Martu women thus operate within a unique combination of social and environmental contexts that together shape both their hunting decisions and their productivity. Although their particular context is unique, the broad social and environmental factors that make the risk model a good predictor of Martu division of labor may be shared by many other forager women, and, if so, the risk model may have general utility in explaining cross-cultural variation in the division of labor. Our tests of the risk model suggest that women may hunt more when prey are abundant, hunt failures are low, and harvest sizes predictable but, more generally, when the benefits of acquiring larger harvests are lower than the costs of failure. Men and women may differ most in their foraging occupations where men compete strongly to acquire social benefits through wide distributions of high-variance resources and women face high costs for a hunt failure.

Conclusions

The conventional wisdom surrounding the sexual division of labor is that it is organized around an economic contract between mated pairs in which the increased dependency of human children requires cooperative biparental provisioning and the constraints of being a human female give “comparative advantage” to men in hunting, making specialization in biparental care so efficient as to be “inevitable.” We suggest here that spousal cooperation in an economy of scale is not an important influence on the gendered division of labor among Martu. We find an alternative perspective more applicable: one that emphasizes the total social network of men and women over the primacy of the pair-bond, considering a new view of human social structure as profoundly affected by “cooperative breeding” —the social nature of caring for children (e.g., Hrdy 2005). Consistent with this perspective is that the degree of specialization in men's and women's foraging decisions is determined primarily by variance in acquisition and that dynamic variability in the division of labor is due to temporal and spatial variability in foraging returns (for women) and harvest-size variance (for men). Some of the variation in the extent to which women hunt cross-culturally may be explained by environmental variability in the variance associated with productive hunting activities, the importance to women's reproductive success of creating cooperative social networks and intergenerational partnerships through task specialization and the sharing of surplus, and the social benefits achieved through competition to share occasional bonanzas.

Acknowledgments

We acknowledge foremost our debt to Martu, particularly Nyalanka Japartujukurr, Nyerri Morgan, and Nyalanka's brothers and their families, who adopted us and made us part of their family. This is their work as much as ours, although the mistakes and misinterpretations are ours alone. We also thank Robert Tonkinson and Peter Veth, who introduced us to Martu, and we are especially grateful for Bob's 40-year history of ethnographic insight. Brooke Scelza, Eric Smith, and Chris Parker have provided tremendous help throughout this project, including organizing and conducting aspects of fieldwork. Brian Coddington, Sarah Robinson, Eric Smith, and ten anonymous reviewers made extensive comments that provided for significant improvements to the text. Funding from the National Science Foundation (BCS-0127681 and 0314406), the Leakey Foundation, and Stanford University made this research possible.

Comments

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Bliege Bird and Bird present the remarkable data that they have collected from firsthand ethnographic observations at different times of the year and over a five-year period. It is a wonderful source of reliable historic information about Martu people's foraging behavior. Bliege Bird and Bird suggest that between 20% and 50% of the total diet is based on bush foods, but they do not explain the basis for this suggestion and provide no detailed records of the nonbush foods eaten. This in itself is not a problem, but it does have implications for the appropriateness of using what amounts to a partial data set for testing two proposed models of hunter-gatherer behavior and for the interpretations of the broader implications of the results.

The “economy-of-scale” (cooperative specialization) model suggests that men and women collect different sets of resources that are shared by everyone in the group. The model refers to the overall food consumption of groups and thus cannot be effectively tested with a sample of the food consumed unless the sample can be somehow shown to represent all of the different kinds of foods eaten. For this study the food recorded was collected by small groups of people in the unique situation in which they were in the company of anthropologists offering a Toyota, which allowed expeditions outside the immediate vicinity of their home base. Therefore it is a very small subset of the food resources shared and consumed by these people, and it does not take into account other reliable foods that are usually eaten.

It is clear from the data collected that most of the time during these expeditions was spent hunting animal foods. Given that flour is reliably and, relative to meat, more cheaply obtained through the shop, perhaps this is not surprising, but it is not a representative sample of the foods eaten and shared. When people do not rely on foraged foods for most of their intake, when they do forage, their foraging goals are different from situations in which foraging is their only source of food. They may nevertheless still cooperatively share overall, but that is something that needs to be tested by taking into account the overall food intake.

These new goals are reflected in the better data fit to the “risk” model. Bliege Bird and Bird’s data show that when Martu people are taken on foraging expeditions, both men and women prefer to spend more time hunting animals than collecting plant foods and that men are more likely to make more “risky” foraging decisions that result in greater variance in their food acquisition than women. However, this risk is not the same as the risk taken when all food is from foraging because there are other foods that allay the risk. What it does show is that the tradition in which men concentrate on hunting large game and women on smaller game continues in the present, as does the importance of the formal sharing of bonanza catches, highlighting the continuity of tradition and independence described by Tonkinson (2007). The apparently greater contribution of women’s hunting compared to some other foraging groups may well be because, when provided with the opportunity to obtain bush food, an activity that people enjoy, they concentrate on meat because other foods are more cheaply available through store goods. The increasing independence of Martu women may also play a role (Tonkinson 2000). It would be interesting to obtain some recent comparative data for other Aboriginal groups.

None of this denies the importance of foraging to present-day Martu people, nor does it suggest that Martu are “former foragers” and that foraging “is an evolutionarily stagnant stage.” However, if we are to understand the gender division of labor associated with obtaining and sharing food resources, then we have to engage with the more complicated methods that require a much greater range of variables for testing models with contemporary groups of people who acquire their foods from both foraging and the market economy. Although Bliege Bird and Bird’s detailed records provide an important source of data about foraging decisions and the role of continued hunting and sharing traditions in the modern world, without information about the remaining 50%–80% of food the two models proposed cannot be tested, and their conclusions are not supported.

I also wonder why, in the last paragraph, Bliege Bird and Bird return to the very narrow interpretation of the sexual economic contract. While it is true that some of the earlier discussions about the sexual division of labor (such as Lovejoy 1981; Quiatt and Kelso 1985; and Lancaster and Lancaster 1987) suggest (perhaps because of the prevailing sexual politics) that mated pairs were the prime economic unit, a

cooperative-sharing model does not rely on such a narrow view—requiring only that the foods collected be complementary. In Australia, especially, there are long-term ethnographic observations that record the distribution of food beyond the nuclear family (see, e.g., Elkin 1951; Meggitt 1962; Gould 1969; Meehan 1977). Foraging units usually consist of much more than nuclear families (see, e.g., Hiatt 1962).

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The skillful way in which this article integrates qualitative ethnographic observations with quantitative tests of foraging models allows cultural anthropologists like myself to engage with its argument. This in itself is commendable. With few exceptions, the dialogue between “hunter-gatherers” students from different scholastic camps is very limited, despite the fact that we share face-to-face involvement with our subjects of study under conditions that impose a great deal of intimacy with them and require overcoming considerable logistic difficulties. We let our scientific paradigms rule over our shared experiences—quite unlike the ethos of the societies we commonly study.

The extensive involvement of Martu women in hunting makes this Australian Aboriginal case particularly interesting. And Bliege Bird and Bird draw the best out of their case: they use it, in this article, for engaging with the long-standing debate in hunter-gatherer research on the gender division of foraging labor. Their argument amounts to a spiral (up-and-back) reassertion of essentialist gender differences. If (grossly oversimplifying the evolution of this debate) the vision of “man the hunter” was followed by the countervision of “woman the gatherer,” then, by showing that in some cases both men and women hunt and gather, Bliege Bird and Bird now show that while both Martu men and women hunt, their styles are different, as are their goals and decision-making processes. And they ask, why? What explains these differences?

I shall not engage in my comment with their argument for the “risk-sensitivity” explanatory model over the “cooperative-specialization” model. I leave this to the commentators who work within their paradigms. Instead, I reflect on some of the terms that underlie their question and raise a related question that their impressive database may allow them to examine.

This debate has always focused on “who does what” in *pregiven* male/female gender terms. But consider the words of the Martu woman whom Bliege Bird and Bird cite in the course of arguing for long-term cooperation between co-wives: “My sister and I would hunt together. *One of us would go out with our husband to hunt meat while the other one would stay with the kids in camp and get plant food*” (emphasis added). This statement and the further references to joint

husband-wife hunting in the article resonate with my own experiences among the South Indian forest Nayaka. Nayaka husbands and wives often went foraging together; those who got engaged on and off with “wage gathering” in plantations favored work as a husband-wife team, and when one started to work in the plantation, often the other spouse did as well (Bird-David 1983, 1992). Marjorie Shostak’s (1981, 162) account of Nisa’s words comes to mind as well: “Nisa relates how her husband wanted her to be with him all the time saying ‘we two, just the two of us will go about together’; how ‘when he went to gather food, it was the two of us that went; when we went to get water, it was the two of us that went’; how he even wanted her to accompany him when he went hunting with his younger brother.” In all these cases, staying together while doing these jobs is emphasized, whereas a classic gender perspective would portray the situation in terms of who did what—and so in terms of separate individuals, clustered into gendered categories, and their technical pursuits.

Now, if I understand it correctly, the Martu data have been organized a priori in terms of separate gendered individuals. The authors observed “foraging parties” leaving the outstation (in the authors’ vehicle) that were of mixed gender: “typically consisting of 8 participants (2 men, 4 women, and 2 children).” The authors analyzed the “foraging bouts” of the individual participants, arriving at their sample of “1,196 adult foraging bouts (750 by women, 446 by men),” which separates the acts from their social context at the expense of information about companionship. My question is whether their excellent database allows them to go back and examine the companionship context. Is joint husband-wife foraging a common and favorite practice at the level of “foraging parties” and “foraging bouts”? How often do men alone, women alone, and men and women together engage in hunting? And, within these three different social contexts, who then does what? And what can explain what they do?

My sense—or, in the authors’ paradigmatic terms, my hypothesis—is that in these very small-scale societies the companionship context bears on the gender division of foraging labor in more significant ways than the classic terms of the debate on the gender division of labor allow us to realize. I would welcome any insights Bliege Bird and Bird can offer on the basis of their rich data.

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Bliege Bird and Bird are to be commended for an article that should be of wide interest within anthropology. They bring empirical evidence to bear on the division of labor, a long-held touchstone in many theories of human evolution. They suggest that competition within the sexes may be fundamen-

tally more important than cooperation between them in determining the subsistence patterns of men and women foragers. Empirically speaking, they operationalize a test of cooperative foraging behavior between the sexes as the key to the division of labor by comparing sex differences in hunting behavior relative to variance in success among Martu hunter-gatherers of the western Australian desert.

Bliege Bird and Bird find that breadth of women’s hunting activity is equal to that of men’s, suggesting that women are not restricting their choice of prey in response to the expected returns among men. Rather, women’s hunting effort declines as the degree of risk increases while men’s actually increases with variance in success. They relate this difference in hunting strategies to different social/reproductive strategies for men and women, with women acting to provide food for their children and men seeking to increase their social and political status by giving away larger amounts of food. Both sexes are acting out a cultural ideal of “competitive magnanimity” through “property disengagement” but differ in how they attempt to achieve it.

The fine-grained empirical evidence for describing hunting effort and returns among the Martu is of particular interest here. The ability to characterize and consider changes in hunting effort with regard to success and failure is central to testing any hypotheses about subsistence, including the sexual division of labor. However, while Bliege Bird and Bird paint a compelling picture of sex differences in hunting among the Martu and the cultural meaning built up around them, it is important to consider to what extent their conclusions can be generalized. The Australian Aboriginal groups are at one end of the hunter-gatherer socioecological spectrum. The density of big game for men is quite low, as they point out, while the degree of cultural ritualization and ideology embodied in “The Laws” is hypertrophied.

Importantly, Marlowe (2007) reports that the degree to which men hunt big game appears to vary in important ways across foraging groups. For instance, Marlowe (2003) reports that Hadza men increase their hunting effort when they have young children in camp, as if to compensate for their wives’ increased demand and reduced production. Have the Birds missed a similar phenomenon among the Martu, or is there important variation in the nonmaternal contribution to offspring provisioning across hunter-gatherers? In the case of the Martu, are older women, whose potential foraging cost/benefit calculation differs from that of younger women even when their genetic interests overlap, picking up the “slack” rather than men?

Moving beyond population variation to the species level, the socioecological framework here will be familiar to evolutionary anthropologists. The description of women as maximizing food availability for themselves and their offspring within small cooperative networks, independent of any male contribution, seems to fit chimpanzees as well. Add in the help of older females among the Martu and the picture is reminiscent of what has been reported among bonobos. Fi-

nally, consider intersexual competition for long-term reproductive partners among callithricids and you have primate examples for all of the elements of the human social system described by Bliege Bird and Bird.

If the basic sex difference in foraging behavior presented by Bliege Bird and Bird can be explained with reference to primate socioecology, so too may the biological mechanisms underlying sex differences in risk. Recent evidence based on studies of 2D:4D digit ratios, a marker of prenatal testosterone exposure, suggests that human sex differences in risk taking may be linked to testosterone exposure in utero (Dreber and Hoffman 2007). If so, male risk taking in foraging would reflect greater male risk taking in general, not a specific provisioning strategy. Furthermore, prenatal androgen exposure is a primate (mammalian) characteristic, so differential risk taking by the sexes presumably precedes human evolution.

By this logic, what is new in human evolution is the degree and amount of cooperation directed toward offspring, not sexual differentiation of foraging behavior. The evidence suggests that such cooperation encompasses males and their high-risk behavior as well as other females. In fact, fatherhood looks to be a biological, not a sociological, phenomenon. Not only do human fathers directly invest in offspring, but recent findings suggest that there may be evolutionary changes in the neuroendocrine mechanisms that promote paternal attachment to offspring (Gray, Parkin, and Samms-Vaughan 2007). Such evidence argues for the emergence of pair bonding relatively early in human evolution, even if economic differences in subsistence contribution did not develop until later (see Marlowe 2007 for a similar conclusion). The debate on the role of male provisioning in human evolution will continue, spurred on by Bliege Bird and Bird's contribution in this article.

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This analysis of Martu hunting builds on Bliege Bird and Bird's previous demonstrations of how much more can be learned about subsistence and social decisions by recognizing that nuclear family members do not have identical interests. The authors' wonderful graphics, explanations for hypotheses, ethnographic particulars, and concluding questions about regional and temporal variation indicate a commitment to breaching fences between behavioral ecology and the broader discipline. My comments are meant to follow their lead.

One question asked is whether men seek to acquire a bonanza or, alternatively, to demonstrate their skill. Need these be mutually exclusive? Hunting larger prey can be an especially effective means of signaling skill because of audience

expectations about the meat (Hawkes and Bliege Bird 2002). If all know that larger prey will be widely shared, then successful captures provide both information and consumption benefits. The audience has more reason for attention than when nothing but information is at stake. Tests here (table 6) show that men spend more time hunting goanna not when success rates are lower and variation higher but instead when a large harvest is more likely and larger prey are unavailable. This is consistent with the hypothesis that audience preference for consumption benefits affects the competitive arena for men.

Sharing is key. The authors cast the preference of Martu men for bigger packages of meat that are more widely distributed "by a cook who did not hunt the animal and does not play favorites" as a demonstration of "honest disengagement with property." This situates their findings in a history of discourse in hunter-gatherer studies. Woodburn (1982, 445) argued that the egalitarianism of "immediate return" hunter-gatherers has one primary consequence: "What it above all does is to disengage people from property, from the potentiality in property rights for creating dependency." Woodburn illustrated a key feature of immediate return systems with Hadza meat sharing: "The hunter's rights to the initiated men's meat are identical to those of each of the other initiated men. . . . The rest of the meat is described as people's meat and is distributed first at the kill site among those who have come to carry in the meat, then back at camp it is distributed among those who remained behind and then, finally, when it is cooked, it is consumed by those who happen to be present" (Woodburn 1982, 441).

Although Woodburn exempted Australian Aboriginal societies from his immediate return category, Tonkinson (1988a) argued the characterization applied to Martu as well. Unlike Hadza, Martu specify certain of the hunter's kin as proper recipients of shares, but meat is not the private property of the hunter in either case. He cannot use it any way he chooses.

Ideas about property rights help explain the sharing. Blurton Jones's model (1987) linking package size to the costs of excluding other claimants has been used effectively by Bliege Bird and Bird elsewhere. It could be helpful here.

Myers's (1988, 53-55) ethnography of neighboring Pintubi provides valuable clues, too. He registers his

discomfort with the notion of property itself: it is too concrete and specific a notion for the meanings that Pintupi give to "objects." . . . There is clearly a sense that objects might "belong to" someone . . . that X is the *walytja* [family] of a person . . . [as] one's parents are said . . . "to have," "to hold" or, more loosely "to look after" one. . . . The very notion of ownership as identification also provides a sense that rights to objects can and should be more widely distributed, in other words a willingness—not always ungrudg-

ing, of course—to include others with oneself as “co-owners.”

Myers (1986, 116) notes the emphasis on compassion, but “the value of compassion does not mean that Pintupi are never selfish. People sometimes hide possessions to avoid sharing, and giving is often prompted as much by veiled threats as by spontaneous generosity.” Food sharing in particular has “more the character of ‘mutual taking’ than of some idealized primitive communism” (p. 76). Using Myers’s Pintupi examples and many others, Peterson (1993) associated “demand sharing” in Aboriginal communities with the prohibitive social costs of refusal. Pintupi “who desire to enhance their reputations and esteem do all they can to ‘help’ others” (Myers 1986, 246)

Emphasis on generosity by their Martu hosts may have moved Bliege Bird and Bird to seek language better suited to magnanimous motivations than “tolerated theft.” But the absence of well-defined property rights combined with local notions of “looking after” (Myers 1986; Tonkinson 1988*b*) are two features of the patterns reported here—along with the important differences in lifetime agendas of women and men. All three are implicated in the “crossed purposes” between Western Desert people and Australia’s indigenous policy (Folds 2001) foreshadowed by Myers (1986). All three may help explain Karimarra’s worry about feeding visitors and “what it means when someone says ‘We hunt to share.’”

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Bliege Bird and Bird bring a considerable level of sophistication to the analysis of an impressive data set, collected over 24 months, made up of nearly 1,200 foraging trips. They contrast and test two models against their analyses of the data. The first is what they call an “economy-of-scale” model, according to which husbands and wives specialize in different types of resource in order to optimize household production. The second is the “risk” model, according to which the costs and benefits of variance in resource acquisition tend to affect individuals differently according to their foraging goals; gender differences result from incongruent foraging goals: women more often forage for consumption, men for the social utility of food.

A difficulty arises over the choice of models, however. The economy-of-scale model appears unrealistic in light of the comparative literature on Aboriginal economy, especially the assumption that the nuclear family household is the main basis for production. The limited data available suggest that the organization of production cuts across hearth groups. Altman’s research shows that some eastern Kunwinjku work

teams drew on people of a single hearth group or smaller group within a hearth group, while others cut across the hearth groups of a larger residence group (Altman 1987, 102–4, 118–20). Western Desert ethnography does not support a model based on the hearth group as a consumption unit. Hamilton (1980, 12), for example, writes that a woman had strong obligations to feed her mother and children but had a less clearly stated requirement to provide food for her husband, although he expected her to do so. Women shared food with close female relatives, infirm older women, and women who cooperated in looking after children. Women also provided food to their unmarried male relatives in the bachelors’ camp, receiving meat in return.

The risk model is a priori more consistent with Western Desert ethnography. Studies by Tindale, Gould, and Hamilton show that, among Pitjantjatjara and Yankunytjatjara and Ngaatjatjara people, foraging for vegetables by women and girls provided the bulk of the diet, although the contribution of small game hunted by women of the Western Desert may have been underestimated in Hamilton’s view. Dependable efforts of the women freed the men for more risky hunting activities. Only on the rare occasions of sustained, heavy localized rainfall in areas dominated by mulga scrub would game become abundant enough for men’s hunting to provide the bulk of the diet (see Tindale 1972, 249; Gould 1980, 62, 64, 78–79, table 7; Hamilton 1980, 10–11). It is no surprise, therefore, that the risk model is more consistent with the Martu foraging data.

A second difficulty lies with the assumption of very generalized foraging goals—women maximize consumption and the maintenance of cooperative networks; men compete with other men for political and economic advantage. Women optimize consumption benefits; men optimize social benefits. The ethnography of the Western Desert suggests quite specific foraging goals, especially for men, consistent with wider Australian patterns, especially the obligation to provision potential and actual affines. According to Gould (1980), for example, a Ngaatjatjara hunter’s wife’s father, father’s brother, and wife’s brothers had first choice of cuts of meat, followed by his older and younger brothers and finally the hunter himself. In return for meat, a daughter’s husband received vegetable food from his wife’s parents. A comparative study of Aboriginal economy (Keen 2004) shows that, in seven cases situated in widely separated regions, a potential or actual daughter’s husband provided meat for his wife’s parents and in most cases for the wife’s brother.

What seems to be required, then, is an ethnography of the variety of Martu foraging goals. If men, for example, are pursuing a variety of goals including provisioning potential and actual affines and trying to move through the ritual hierarchy, then the ways in which these goals intermesh and the implications of diverse goals for analysis in terms of risk need to be investigated and assessed.

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Rebecca Bliege Bird and Douglas Bird are going from strength to strength. This article provides answers to several perennial questions concerning hunting and gender in hunter-gatherer societies. The authors are perfectly aware that the Martu evidence they analyze is the outcome of complex interactions between numerous factors that make this situation unique; at the same time they provide models that can be tested elsewhere. I look forward to a far more interesting discussion of gender and hunting than we have experienced for some years.

My own research has been with Aboriginal people in savanna and floodplain ecosystems. I am struck by continuities in the culture of hunting across such disparate ecological zones, from Martu desert through open savannas and into the tropical floodplains. In all three regions the term for “good hunter” is neither aged nor gendered. Men, women, and children can all be defined as “good hunters.” *Mirtilya* is the Martu term for a skilled and generous hunter, as Bliege Bird and Bird explain. In the Ngarinman language of the northern savannas, the term is *mularij*, and it carries the same meanings of skill and generosity. In the floodplains of the Northern Territory, Mak Mak Marranunggu people’s term is *milityin*. (Martu and Ngarinman languages are in the same language family, but Marranunggu is in a completely different language family.) One of my teachers, a good hunter herself, explained *milityin* this way (Kathy Deveraux Pulum in Rose 2002, 70):

An exceptional[ly] good hunter-gatherer is known to have *milityin* powers. They are regarded highly for their hunting prowess in providing food for the camp. A *milityin* rarely comes back empty handed. At home in their element, they have the natural ability to find food. When hunting wild game, the *milityin* may not only have to consider where a barramundi or long-neck turtle may be resting in the middle of a hot day, but must take extra precautions for the big crocodile who regularly cruises up and down his territory. A *milityin* has to out-think and out-smart them all.

I hope that Bliege Bird and Bird will continue this work. Their engagement with ethnographic detail is extremely welcome, and their capacity to develop testable hypotheses gives the work an edge that has been sorely needed in much of the discussion of both gender and hunting. At the same time, there are some interesting comparative points to be developed within Australia, and thinking comparatively stimulates more questions. Jane Goodale’s work with Tiwi women of North Australia focused on the lives of women through time (in marked contrast to much of the work of that time that made generalizations about women without considering the fact

that women’s life circumstances differ at different ages). She was able to present in vivid ethnographic description some of the factors that Bliege Bird and Bird discuss. One of the points she made was that just as a woman is a multifaceted person (mother, daughter, etc.), men are also multifaceted, and so, too, are gender relations. Goodale brought an insightful analysis to bear on brother-sister and mother-in-law–son-in-law relationships. I would like to see what Bliege Bird and Bird could do with the idea that gender relations are not only about husbands and wives. They have taken initial steps here in demonstrating the falsity of the idea of complementary differentiation of hunting strategies in pursuit of overall benefit to the nuclear (or even extended?) family. But what would happen to the models if the men and women were examined as brothers and sisters rather than as husbands and wives? Or if they were examined as mother-in-law and son-in-law? Would complementarity emerge as a more salient value? I don’t have an answer, but I suspect we might gain an even more subtle understanding of gender differentiation and collaboration in hunting. I pose the question as a further step along the path of dismantling binary stereotypes of men and women, hunting and gathering.

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Bliege Bird and Bird offer a largely convincing argument in an ongoing debate within human behavioral ecology about the evolutionary origins of the gender division of labor in foraging societies. I argue that this article demonstrates the vitality and maturity of the human behavioral ecology approach and conclude by suggesting some future research directions that may further strengthen evolutionary-behavioral inquiry.

First, this article demonstrates human behavioral ecology’s capacity to make intellectual progress through repeated data collection, hypothesis testing, and reframing of problems. The debate over the gender division of labor was previously framed around the evolution of the human life history pattern and, specifically, whether long childhood evolved so that men could learn to hunt large game to provision children and women with child care constraints (Kaplan et al. 2000) or whether a long life span evolved so that grandmothers could cooperatively allomother children while men sought prestige through social stunts (Hawkes, O’Connell, and Blurton Jones 1997). While one camp provided good evidence that Hadza grandmothers provisioned their grandchildren with tubers (Hawkes, O’Connell, and Blurton Jones 1997), that Ache men were show-offs (Hawkes 1990), and that Hadza hunters rarely benefited materially from meat exchanges (Hawkes, O’Connell, and Blurton Jones 2001), the other camp provided equally convincing evidence that men reached their peak

hunting efficiencies after a lifetime of training (Kaplan 1997; Walker et al. 2002) and that contingent reciprocity evened out variance in hunting success among Ache (Gurven, Hill, and Kaplan 2002) and Hiwi (Gurven et al. 2000). The problem is, how does one compare sets of evidence?

Bliege Bird and Bird's article moves this debate forward by reframing the issue so that both arguments can be tested with the same evidence. Women tend to forage for low-mean, low-variance resources while men seek high-mean, high-variance resources. Is this because of differences in how men and women value variance or because of men and women's specialization in low- versus high-mean rewards?

Second, this article demonstrates human behavioral ecology's capacity to generate theory that explains cross-cultural diversity. The "ecology" in behavioral ecology refers to the expectation that behavior will differ in different social and natural environments, unlike sociobiology's attention to behavioral universals. The old question of why men hunt and women gather glosses over cross-cultural diversity in how much men gather and how much women hunt. The two explanations framed by Bliege Bird and Bird could potentially explain this variability.

It is important that Bliege Bird and Bird chose to test these explanations among Martu, a foraging society that deviates from our stereotypes of primitive foraging ancestors. In the previous incarnation of this debate, there was an implicitly sociobiological argument that either Hadza grandmothers or Ache big-game hunters more accurately represented our ancestors in the environment of evolutionary adaptedness. But why shouldn't human behavioral ecology explanations be equally valid in environments that include government outstations and Toyota Land Cruisers?

Third, it is delightful to witness the degree to which evolutionary explanations are converging on theory from cultural anthropology, uniting formalism and substantivism. Human behavioral ecology is born from formalist theory that posits humans as selfish, individualistic, calculating decision makers. Substantivists challenged instead that economic behavior is primarily social and structural and only secondarily material. Here, Bliege Bird and Bird argue that Martu men seek to recreate the social structure of Dreamtime Law through the acquisition of "symbolic capital" that comes from "disengagement of property," echoing Mauss's *The Gift* (1967 [1925]) and citing Weiner's (1992) interpretation of alienable and inalienable possessions. This seems to be part of a trend among evolutionary anthropologists to address sociality and culture through concepts of social learning (Boyd and Richerson 1988; Tucker 2007), social preferences (Henrich et al. 2004), social capital (Godoy et al. 2005), and social support (Hadley, Borgerhoff Mulder, and Fitzherbert 2004).

Fourth, this article demonstrates that human behavioral ecology is strengthened by good and responsible ethnography. Bliege Bird and Bird present Martu not as Pleistocene relicts or windows into the past (Schrire 1984) but as contemporary people coping with a history of discrimination and poverty.

They do not treat sociality abstractly but argue that Martu pursue social goals specific to their worldview, including Dreamtime Law and the stigma of being *malya* (stingy).

With an eye toward future directions, I argue that behavioral ecologists should move in two directions simultaneously. The first direction is into the mind, to better understand the mechanisms of human perception, cognition, memory, and learning and the dual inheritance of social and biological information. It would be interesting to know how Martu men and women learn to perceive and judge the mean and variance of different prey types and how much of their gendered behavior is the result of biologically determined sex versus socially learned gender norms. The second direction is outward toward household livelihood strategies (Ellis 2000). Martu gendered foraging production and social investment affect patterns of food insecurity and poverty. Thus human behavioral ecology can be applied to significant world issues (Tucker and Rende Taylor 2007).

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This empirical anthropological investigation of gender differences in foraging strategies makes a valuable contribution to the research literature in psychology and economics on gender differences in risk taking. As a cognitive psychologist with an interest in individual (including gender and cultural) differences and species similarities and differences in risk taking, I would like to raise three questions related to this topic that are of interest to my research community: (1) Are there gender differences in risk taking? (2) Why do they exist? (3) How do they come about? Let me address each of these questions in turn, first summarizing what the behavioral decision literature has to say about it and then commenting on what the data reported in this article contribute.

1. *Are there gender differences in risk taking?* Gender differences in risk taking appear to be well documented. Meta-analyzing 150 psychological studies, Byrnes, Miller, and Schafer (1999) find males to be significantly more risk taking than females in the vast majority of tasks. Economics field studies of investment behavior (Jianakoplos and Bernasek 1998) report similar results. Bliege Bird and Bird's article adds to this consensus with anthropological observations about greater risk taking in foraging among male Aborigines compared with female Aborigines.

2. *Why do gender differences in risk taking exist?* Evolutionary explanations or stories related, for example, to differences in child care constraints (the "economy-of-scale" model discussed in the article) are tempting, but gender differences in risk perception and risk taking do not appear to be essentialist. Slovic (1999) reviews evidence for the "white male" effect, that is, the fact that white males appear to perceive risks to

be smaller than either white females or male or female minority group members, and attributes these differences to perceived control over outcomes. Consistent with this story, managers often claim that they do not “take” risks but “manage” risk (March and Shapira 1987). Bliege Bird and Bird argue that gender differences in risk taking are related to differences in (foraging) goals and relate those to different social roles (going up the explanatory hierarchy) and to costs and benefits for different risky foraging options (going down one level). This proposed “risk” model for which empirical evidence is provided is very consistent with explanations for apparent risk taking in behavioral decision research. Weber and Milliman (1997) show that goals translate into aspiration levels and that differences in aspiration levels affect not only risky decisions, as postulated and modeled by prospect theory (Kahneman and Tversky 1979), but also perceptions of riskiness. To take an everyday example, pari-mutuel horse-betting patterns change over the course of the racing day, with bettors appearing risk averse in the morning, when they prefer horses with high chances of winning, but risk seeking in the afternoon, when they prefer long shots with high potential payouts. This pattern of behavior can be explained by changes in the goal of betting, from a desire to win in the morning to a desire to recoup previously incurred losses in the afternoon. In both cases bettors are risk averse, preferring what they consider the lower-risk horse. What changes is the perception of the relative risks and benefits of different horses, in accordance with changes in goals. Horses with a high probability of winning are the safer option in the morning, but in the afternoon they become a riskier option than long shots because they provide no possibility of recouping sizable losses and thus a chance of ending the day in the black.

3. *How are gender differences in risk taking mediated?* Consistent with the risk model of Bliege Bird and Bird’s article, behavioral decision research suggests that risk taking is mediated by perceptions of risk and benefit (Weber and Johnson 2008). The risk-return models of finance can serve as a starting point, with their assumption that risk taking reflects a trade-off between risk (or its associated affect of fear) and return (or its associated affect of greed) that different people resolve in different ways. The trade-off coefficient(s) in a regression of risk taking on perceived risk and perceived benefits can serve as a measure of the attitude toward risk, which turns out to vary between individuals but is slightly to moderately risk averse for most people, both men and women. Psychological models of risk-return trade-offs differ from those of finance by assuming that risk and return are not immutable attributes of a choice alternative’s outcome distribution (in particular, their variance and expected value, respectively) but are psychological constructs that can be perceived differently by different people and in different situational contexts. Multiple studies have shown group (including gender and cultural) differences in the perception of risks (Weber and Hsee 1998; Weber, Blais, and Betz 2002) and benefits (Hanoch, Johnson, and Wilke 2006). In addition,

nonconsequential or nonmaterial factors such as familiarity with risky choice options has been shown to affect risk perception and choice (Weber, Siebenmorgen, and Weber 2005). Gender differences in familiarity with risk taking and available options in specific domains can predict observed gender differences in apparent risk taking across domains, with women perceiving greater risks in financial, recreational, and ethical decisions but fewer risks in social decisions.

Reply

We wish we could address all of the reviewers’ insightful and encouraging comments but will limit ourselves to the main thrust of the article. Our argument is that, given that Martu choose to hunt on a regular basis, their subsequent decisions vary in systematic ways that are inconsistent with a model of household provisioning in which members have parallel interests in production and distribution. Our analysis is focused on the trade-offs that different individuals face in making decisions *while* foraging and the socioecological contexts that shape their variability. Time and resources are always finite, and for Martu access to government benefits, commercial food, and different technologies changes *but does not alleviate* the opportunity costs of foraging. We assume that (1) by foraging individuals trade off the opportunity to do something else, (2) if they choose to forage (and many Martu do daily), they do so because they perceive that they are better off as a result, (3) therefore subsequent variability in their decisions should be shaped by the costs and benefits of achieving their foraging goals, and (4) often there are conflicts of interest that surround such goals, leading to patterned differences in “aspirational levels” (*sensu* Weber’s comment) that affect risk-related perceptions and decisions. As such, Balme’s point that our conclusions are problematic because Martu are part-time foragers (who rely on rifles and vehicles) is a weak one. We agree that a more comprehensive account of Martu economic engagement is required to understand the gamut of decisions they make about work and consumption, but we argue that the costs of variance in the returns from different foraging activities structure decisions while foraging—these costs are still keenly felt in the modern context of “part-time” foraging.

Imagine a contemporary remote community, 400 km from the nearest town along dirt tracks and 800 km from the nearest (semi)urban center. Walk into our house here. We live with Bliege Bird’s classificatory mother, her son, her daughter, and her daughter’s three children. She is the third wife of the *ngurraru*, the senior lawholder for the Parnngurr area, and was 13 in 1966 when she left a full-time foraging life for Jigalong mission. The house is bare inside, except for mattresses and blankets. Everything else is outside, where it belongs, around the fire, bedframes and chairs. In the kitchen,

a fridge contains some “cough mixture with ammonia” and a kangaroo leg, still dripping blood. In the freezer section, someone has shoved 20 kilos of camel meat, wedged so tightly that an ax will be required to work it loose. In the corner, a white plastic bucket of flour, 12 kilos. There’s nothing else in the kitchen because storing for yourself would require you to refuse a constant flow of others, to be hard “like a rock” with no compassion (sensu Hawkes’s comment [Myers 1986, 113–16]), so people buy only what they need for the day. The shop often opens for a few hours in the morning, although it closes unexpectedly for weeks at a time. When it opens, if you’re Martu, your purchases are limited—fresh food, when rarely available, is extremely expensive. You receive \$250/fortnight in your pension, and when that bucket of flour is \$40, four apples cost \$8, and a tray of meat \$15, you’ve already spent 25% of your income. Fuel for the vehicle in 2007 was \$3.60/liter. People wishing to use a vehicle may spend their entire pension to fill up the tank and rely on others to purchase food.

Certainly, these new conditions change the nature of the trade-offs that people face in foraging. But still, our question remains: if you decide to forage, what are the opportunity costs of choosing activity X relative to activity Y? Some individuals may be more likely to choose activity X when “our” vehicle is in the community, but even so, what accounts for the systematic variability in their decisions on arrival at a foraging locale? Why, under those circumstances, do some Martu so often choose to hunt for sand goanna, while others more often hunt for hill kangaroo or bustard? We wouldn’t be surprised if some kinds of hunting (bustard in particular) increased with access to vehicles, but why do different persons routinely (consistently) hunt in different ways? It is important to stress that our vehicle is used in the same manner as all vehicles in the community, well described here by Hawkes and her quote from Myers (1988): we too would feel uncomfortable about strictly defining any vehicle according to standard notions of “property.” As with food sharing, Martu insist that rights to vehicles should, first and foremost, be about “holding” social relationships to include others with oneself as “co-owners” rather than “withholding” vehicles for exclusive purposes. We have argued here and elsewhere (Bird and Bliege Bird n.d.) that the ability to “disengage” with property (i.e., material egalitarianism) enhances a reputation of wide esteem (i.e., ritual hierarchy). And while “car sharing” is not without its grudges (and constant maintenance problems), if we were to strictly control access to our vehicle and attempt to exclusively mandate and direct its use in foraging, it would be a clear signal of our lack of interest in being part of the community. These are the “prohibitive social costs of refusal” that Hawkes (in her comment above), Myers (1988), and Peterson (1993) refer to. Being hungry in Parnngurr is not uncommon, and hunting with a vehicle is, for many, a necessity. But because you’re living in a permanent community, no one left at home is able to collect seeds or fruit or grubs nearby. Thus, when you choose a high-variance foraging ac-

tivity and fail, you come home at night to a house that might have no food, and you may have no money to buy food, and even if you do the store may not open in the morning. Why, under such circumstances, would you choose a high-risk foraging activity? We believe that Karrimara provides the answer in the anecdote we relate in the introduction to the article and that our data support her conclusion.

While new technologies and circumstances have changed the nature of economic pursuits (especially relative to commercial flour and wild seed collection [see O’Connell and Hawkes 1981]), Martu women insist that their attention to hunting is not a recent phenomenon. Women who are renowned for their hunting skill and generosity lay claim to *mirtilya* status, a cultural category that seems to have deep roots: we were intrigued by Rose’s comments that such categories are shared among other Aboriginal people from many disparate language groups. Hunting is (and was) a common occupation of women throughout Australia—not just among Martu (Kaberry 1939).

As Hawkes and Keen point out, because sharing and resource pooling occur well beyond a “nuclear family,” a production model that focuses only on husbands, wives, and their dependent children cannot hope to account for a division of labor: any gains in efficiency to specialization are realized only at the level of the pooling unit, which is determined by how extensively foods are shared, some foods being shared more widely than others. We agree with Keen; the classic economy-of-scale model is unrealistic because Martu simply do not form production and consumption units based on hearth groups—they are based on task-specific associations determined by things that always crosscut “household” residence. One of our main conclusions here is that because men’s and women’s foraging goals often (but not always) differ, women form cooperative partnerships with other women more often than with men. As Rose suggests, in our thinking about the division of labor, we would do best to closely evaluate the notion of pair-bonding and gender as structuring it and focus greater attention both on the goals of the individual forager and on cooperation within a broad network of social relations: here and previously (Bliege Bird and Bird 2005) we argue that divisions of labor get blurry or are far more situational (“I’ll get wood and prepare the roasting pit while you clean and prepare the goanna”), with more overlap in foraging goals. For Martu, a focus not on men as husbands but on men as sons and brothers is particularly relevant: a mother’s sons are among her most important relationships. Older women often focus on their female spouses (co-wives) or sisters (who are often both) as important cooperation partners, while younger women increasingly rely on relationships with their mothers because of the secular trend away from polygyny. While men mostly hunt alone, when they do cooperate they often do so with one of their initiation age cohort or a brother, adult son, or nephew, and some husbands and wives sometimes cooperate. The contexts that influence such variability are ripe for investigation.

This brings up the issue of cooperation and our conclusion that the division of labor is not structured by cooperative production arrangements between men and women. Keen's and Bird-David's comments suggest to us that our tests of the risk/cooperation models using data on cooperation were probably not sufficient (or defined clearly enough) to distinguish between the two hypotheses. Cooperation is to be expected when individuals share similar goals and, by setting aside the temptation to defect, do better than if they had chosen to work alone. The cooperative model of the division of labor (cooperate to achieve a similar goal through specialized labor) is a bit of a misnomer, because it predicts that men and women cooperate not by working together on a task but by working separately, seemingly contradicting our intuitive notion of what cooperation entails: cooperation here is evident only in the outcome, not in the process. That husband and wives do sometimes work together while hunting does not temper our rejection of the cooperative model of the division of labor but strengthens it. Witnessing men and women working together on a task, seemingly "cooperating" by doing the same activities, would actually lead us to reject the cooperative model as proposed. The context of husband-wife cooperation actually goes further to underscore our main point that it is a difference in foraging goals linked to variance sensitivity that structures gendered foraging. Martu men and women hunt together, but primarily for goanna. It is rare for them to cooperate in kangaroo hunting (1 out of 94 hunts), but then men hunt cooperatively with anyone only 12% of the time. The point is that seeing husband-wife cooperation in the same foraging activities suggests not that the division of labor is cooperative, but its opposite, that foraging goals likely structure difference, and that when men and women work together on the same tasks, they share the same goals. When Martu men and women hunt goanna together, they cooperate to provision smaller networks of kin and dependents with low-variance prey. When men and women cooperate in acquiring high-variance, politically motivated resources, it is probably because women share this goal, as Martu women do when there are many hungry visitors and the costs of appearing selfish by acquiring low-variance resources outweigh the costs of coming home hungry.

But why do men's and women's goals often differ? Campbell assumes that because there is a gender difference in risk preference, it must be because males and females have different reproductive strategies, controlled proximately by testosterone, which influences risk taking. However, as Weber shows, preferences for risk are dependent on context, constraints, and potential payoffs, and the same individual might make safe bets early in the day and risky decisions later on (and it may be that hormone levels respond to those contexts rather than determine them). We suggest that women more often prefer lower-variance resources because their social goals are best served with consistent provisioning and that the costs of failure are often too high. These costs and benefits are set (in part) by cooperative child care arrangements and political

maneuverings over status and marital arrangements, which are reflections of reproductive strategies. The fact that men and women often have differing reproductive strategies or, more fundamentally, that there are differences in what limits male and female reproductive success in any sexually reproducing organism contributes to the higher cost that some women face for high variance, *but it does not determine that cost*: the social and ecological opportunities and constraints men and women experience as they play out those strategies set the costs and benefits. As Keen points out in relation to highly specific foraging goals, those strategies are dynamic: even on a single day, there is no single "female" reproductive strategy (or foraging goal), no single "male" reproductive strategy, but a range of decisions. We thus agree with Bird-David: it would be helpful to move away from questions about "who does what" in *pregiven* male/female gender terms" and toward questions framed by how gender emerges from interactive agents facing different, often sex-linked, constraints set by local, frequency-dependent socioecological circumstances and how decisions, in turn, change, reify, and are constrained by gender. Decisions about risk flex to accommodate both changes in strategy and changes in payoffs—Martu women who don't want to appear selfish (or pass up an opportunity for social attention) pay that higher cost and may be more likely to pay it at some times in their lives than at others; men who have little to lose by not sharing widely can afford to hunt lower-variance prey (goanna) and may be more likely to do so when they are older and their social status is assured. We can easily see this adaptive flex among Martu, but in other places we might see less variability in costs and benefits and be misled into thinking that gender difference is determined by reproductive strategy. While differences in what limits reproductive strategies may set the stage, more proximate social and ecological determinants shape the show that is played upon it.

As Tucker points out, this attention to the particulars of relationships between social and ecological variables and patterns in strategic decision making is one of the great strengths of behavioral ecology, one that can be diluted by an overly enthusiastic generalism that threatens to reduce variability in behavior to univariate causes, a stance that we feel is better suited to fields such as evolutionary psychology. One of our goals in this article was to illustrate the potential of human behavioral ecology to contribute to the development of ethnography, to speak to a broader audience, to move away from the overdeductivism and essentialism that evolutionary approaches can sometimes foster (or be perceived to foster) and toward some common language for anthropologists of diverse theoretical stances to argue about problems of common interest. We may have succeeded in traversing a middle ground with our "essentialist particularism": our analysis can, on the one hand, be overly particularistic, not generalizable to a broader context, and, on the other, overly generalizing and essentializing, ignoring the variability within our constructed categories of gendered personhood. Our approach tries to

avoid the Procrustean application of models to data without consideration of local contexts. Our essentialism is driven by culturally meaningful, context-specific categories: classifications of foraging activities, gender roles, and political and social goals surrounding food sharing—all of them emically constructed. Our argument is thus processual in nature: the nexus of analysis is individual agents acting within a social and ecological web of significant relationships and conflicting interests that emerge from and constrain the decisions of those agents.

—Rebecca Bliege Bird and Douglas W. Bird

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