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Among foragers, men's foods are often shared widely outside the household, undercutting variation in the benefit their wives and children receive. This means polygyny may not be due to variation in household provisioning. Some have even suggested that bonds in general, whether polygynous or monogamous, may have less to do with male provisioning than male-male contest competition. However, an analysis of foragers in the Standard Cross-Cultural Sample reveals that male provisioning does affect the mating system. Societies with higher male contribution to subsistence are more monogamous. The author argues that women value male provisioning less where males bring in less food, which results in greater polygyny. Where it is difficult for women to acquire food, they value male provisioning more, forcing males to compete via food acquisition. Food sharing prevents the polygyny threshold from being reached but does not completely erase the benefit of pair bonding with a good forager.

Keywords: *foragers; male coercion; male provisioning; mating system; monogamy; polygyny*

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Provisioning by men has long been considered responsible for human pair bonds (Lancaster & Lancaster, 1983; Lovejoy, 1981; Westermarck, 1929). but this is no longer so clear. In many complex societies, it is easy to see how a woman benefits from the income her husband brings in, but among the simplest societies, those who practice no agriculture but get all their food from hunting, gathering, and fishing (foragers), the benefit a woman gets from bonding with a man is less obvious. This is because men's foods, especially big game, are evenly shared, and even though some men bring in much more than others, this variation gets smoothed out by the widespread sharing typical of foragers (Hawkes, O'Connell, & Blurton Jones, 2001a; Kaplan & Hill, 1985; Kitanishi, 1998; Peterson, 1993). If all women get the same amount of meat, it is not clear how the wife of a good hunter benefits over the wife of a poor hunter or a single woman for that matter. Indeed, some have suggested pair bonds may have nothing to do with men's household provisioning (Blurton Jones, Marlowe, Hawkes, & O'Connell, 2000; Gowaty, 1996; Hawkes, O'Connell, & Blurton Jones, 2001b).

To test whether pair bonds among foragers do have something to do with male provisioning, we could see if bonds exist where male provisioning exists and are absent where male provisioning is absent. But because bonds and some male provisioning exist in all human societies, that is not possible. It is possible however, to see whether the level of male provisioning influences the nature of bonds. If men's provisioning does not influence women's preferences for bonds, it is difficult to see how it would influence their preference for an exclusive bond (monogamy) or a bond they share with a co-wife (polygyny). Conversely, if male provisioning does influence the degree of monogamy and polygyny, it may also influence bonding in general for the same reason. To test whether male provisioning does influence the degree of polygyny, I analyzed the mating system of foragers in the Standard Cross-Cultural Sample (SCCS). Only foragers are analyzed because it is among foragers that the problem of food sharing exists and because they afford insight into the forces acting on the pre-agricultural mating system.

Among agriculturists, we can see why a woman would prefer not to share her husband's income with a co-wife. At the same time, we can see why she might choose to be the second wife of a rich man rather than the only wife of a poor man. If she can raise more children on her share of the rich man's income than she could with all the income of the poor man, the polygyny threshold has been reached, and it makes sense for women to marry polygynously (Borgerhoff Mulder, 1988; Orians, 1969; Verner & Willson, 1966). However, when polygynous women do worse than monogamous women, polygyny may be due to male coercion (Hames, 1996; Strassman, 1997), and this coercion might also explain the existence of pair bonds (Gowaty, 1996; Mesnick, 1997). The degree to which men control the allocation of resources varies greatly with mode of subsistence. Among many pastoralists, for example, a man who owns a thousand head of cattle can use some of them to buy several wives from their parents, but among foragers, there is nothing comparable to these cattle. Therefore, it makes sense to use societies without wealth to test ideas about pair bonds prior to agriculture.

To understand the mating system of foragers, I begin with female preferences, because females are the sex most in demand. Because women invest so much in gestation, lactation, and parental care to get children reared, they should avoid mating with men who have seriously deleterious genetic traits that are likely to be inherited by their offspring. Such avoidance is a noncontroversial form of female choice for inherent male qualities, or "gene shopping." Whether women are also gene shopping when they prefer the man they find best looking is more controversial because getting the necessary evidence to prove there has been female choice for "good genes" is extremely difficult (Andersson, 1994; Ryan, 1997). Nevertheless, I will consider this sort of female choice gene shopping and assume that, all else being equal, women should, to some extent, benefit from gene shopping.

Women should also benefit from being provisioned because it allows them to allocate less energy to foraging and more to reproduction (Ellison, 2001; Kaplan, Hill, Lancaster, & Hurtado, 2000). For example, a cross-cultural analysis of foragers revealed that greater male contribution to diet increases female fertility and reproductive success (Marlowe, 2001). In theory, women could gain this benefit without pair bonds, but it is just when they are nursing and infertile that women need provisioning most, and that is just when males who trade food for sex would be least interested in them. Bonds may therefore benefit women because caring for infants interferes with their foraging (Ember & C. R. Ember, 1979). Therefore, all else being equal, women should always benefit to some extent from "resource shopping," that is, from preferring men offering more resources.

How much emphasis a woman places on gene shopping or resource shopping should vary with the costs and benefits of each and the tradeoff between them, in her particular habitat. Where a woman finds it difficult to acquire enough food herself—where there are few edible plants to gather, for example—she should benefit more from male provisioning. Where there are more deadly pathogens, it might pay a woman more to mate with men who have good immune systems, one component of "good genes" (Hamilton & Zuk, 1982; Low, 1990).

When there is a higher pathogen stress, we might expect women to prefer to mate with the few men who appear to have the greatest pathogen resistance, because this increases their chances of having healthy, pathogen-resistant offspring. Among all 186 societies in the SCCS, there is a higher degree of polygyny where there is a higher pathogen stress (Low, 1990), and one study of 29 cultures found more emphasis on looks in mate preferences where pathogen stress is higher (Gangestad & Buss, 1993). Among foragers then, we might also predict that where there is a higher pathogen stress (a proxy for the importance of gene shopping), women benefit more from mating polygynously with the few most pathogen-resistant males or at least object to polygyny less. I therefore test whether, all else being equal, the degree of polygyny is higher where pathogen stress is higher (Hypothesis 1).

When men contribute very little to subsistence, women should place less emphasis on male provisioning (resource shopping) and more emphasis on gene shopping. They should object less to polygyny because sharing sperm (probably not a limiting resource) with a co-wife is less costly than sharing food. Women might actually prefer polygyny if men contribute so little food that women are subsidizing their husbands; a monogamous woman has to support one whole man whereas a woman with two co-wives only has to support one third of a man. Most mammals are polygynous and males provide no food or direct care; among monogamous species, males tend to invest more in parental care of one sort or another (Clutton-Brock, 1989, 1991; Kleiman & Malcolm, 1981; Whitten, 1987). Among humans then, if male provisioning is very low, we might expect women to mate polygynously, which is what I found for all 186 societies in the SCCS (Marlowe, 2000). I therefore test whether, all else being equal, the degree of polygyny is higher where men's contribution to subsistence is lower (Hypothesis 2).

Men's reproductive success should be enhanced by acquiring extra mates, so we should expect them to strive for polygyny, resulting in male-male competition. The intensity of this competition will depend on the operational sex ratio (OSR), which is the number of reproductive-aged women per reproductive-aged men. As the number of reproductive-aged women to men decreases, male-male competition should increase and result in less polygyny. As the number of reproductive-aged women to men increases, the degree of polygyny should increase because any unmated, fertile woman has no other marital option and should be readily accepted by any man. Unfortunately, there are no data in the SCCS on OSR. However, in line with this logic, Ember (1974, as cited in Ember & C. R. Ember, 1983) found that where male mortality was high due to warfare, there was a greater likelihood of polygyny. Ideally, OSR should be controlled when testing these hypotheses, but because OSR data are not available, I simply assume the null of no significant difference in OSR across the SCCS societies. This may be an incorrect assumption inasmuch as juvenile and adult (or overall) sex ratios can vary appreciably across cultures (Ember, 1974, as cited in Ember & C. R. Ember, 1983).

In this analysis, there is one main dependent variable, a society's degree of polygyny. There is one habitat variable, total pathogen stress, and one independent variable closely linked to the habitat, male contribution to subsistence (a proxy for male household provisioning). These variables are used to test Hypotheses 1 and 2 above. Despite the problems posed by food sharing among foragers, the results suggest provisioning by males does influence the nature of bonds and thus perhaps bonding itself.

METHOD

The SCCS includes 186 societies chosen to be a representative and independent sample of all geographic regions and cultural clusters (Murdock & White, 1980), thus it should not be necessary to control for phylogeny. I used the coded variables available on the World Cultures CD (2001).[1] I defined foragers as those who acquire less than 10% of their diet from cultivated foods or domesticated animals, where trade contributed little or nothing to the diet, and where hunting was not done on horseback (Murdock & Morrow, 1980) (see Appendix 1 for details). This sample includes those societies where subsistence is based on hunting, gathering, and/or fishing.

DEGREE OF POLYGYNY

For the degree of polygyny, I used the percentage of married women polygynously married, variable (v) 872 (White, "Polygyny: Form and Frequency," from the World Cultures CD, 2001), which I will call the percentage of polygynous women for short. In this sample, no data on polyandrous marriages are given, so I refer only to the degree of polygyny. The percentage of polygynous women and men are not the percentage of the total adult population that are polygynous, only the percentage of the married population, an important difference. The population of married women however, should come closer to being equal to the total population of reproductive-aged women than the population of married men does to the total population of reproductive-aged men because all reproductive-aged women should be in demand. Because we do not know whether each polygynous man has 2 wives or 10, the percentage of polygynous men does not tell us as much as the percentage of polygynous women about the skew in the mating system and the intensity of sexual selection (Hartung, 1982; Low, 1988). However, because the data on men are more reliable because some of the data on women are only derived using a formula (White, "Polygyny: Form and Frequency," from the World Cultures CD, 2001), I also used the percentage of married men with more than 1 wife (v871), which I will call the percentage of polygynous men[2] and report those results whenever they are different in terms of statistical significance.

Once we know the percentage of men and women married polygynously, we can calculate the percentage of all reproductive-aged men who are single (see Appendix 1), the best measure of reproductive skew if marriage reflects reproduction. I ignore the issue of premarital and extramarital reproduction because there are too few data on affairs. The OSR is the ratio of reproductive-aged females to males. If we assume an equal OSR (which is usually the case), then the higher the percentage of polygynously married women, the higher the percentage of single men, which means there will be greater sexual selection on males. The percentage of single men was also used to gauge the degree of polygyny and the intensity of sexual selection.

TOTAL PATHOGEN STRESS

The level of the total pathogen stress (v1260) (Low, "Pathogen Intensity Cross-Culturally," from the World Cultures CD, 2001) in each society's habitat was used as a measure of the degree to which females may choose mates on the basis of their good immune systems, which is only one aspect of what might constitute good genes but perhaps a very important one. Each society was scored by Low by summing up the prevalence of seven different pathogens (see Appendix 1).

MALE CONTRIBUTION TO SUBSISTENCE

The percentage of female contribution to subsistence (v885) (White, "Female Contribution to Subsistence," from the World Cultures CD, 2001) was subtracted from 100% to get the percentage of male contribution to subsistence, which was used as a proxy for male household provisioning.[3] It was used rather than female contribution because I am testing for the influence of male provisioning. This variable is only the mean level of contribution by men in the society, which is not the same thing as actual household provisioning, which would count only that amount going to mates and their children. Despite this caveat, it should still reflect the importance of male provisioning to females in one society compared to another. The percentage of the diet contributed by fishing, hunting, and gathering (Murdock, 1967) was used to shed some light on how male contribution might get translated into household provisioning. Because big game tends to be the most widely shared food, the amount of caloric benefit a wife stands to get from her own husband's provisioning may be lower or less predictable where hunting accounts for more of the diet.

Stepwise multiple linear regressions were used with one variable forced to enter per block. Level of significance was set at $p = .05$ for two-tailed tests.

RESULTS

There are 36 foraging societies in the SCCS by my criteria (see Table 1). Because the SCCS is a representative sample of cultural clusters and geographic regions, not just subsistence types, the foragers in the sample are unevenly distributed across regions. By the

TABLE 1
The Standard Cross-Cultural Sample (SCCS) Forager Sample

SCCS ID	*Society*	*Region*	*Polygynously Married Men / Women (%)*	*Reliability of Polygyny Data*	*Single Men (%)*	*Total Pathogen Stress*	*Male Contribution to Subsistence (%)*	*Diet Fishing (%)*	*Diet Hunting (%)*	*Diet Gathering (%)*
2	Kung	Af	10/19	1	9	10	40	0	20	80
9	Hadza	Af	6/12	1	5	16	40	0	40	60
13	Mbuti	Af	6/12	2	5	17	52	0	70	30
77	Semang	EE	1/2	1	0	14	80	30	30	40
79	Andamanese	EE	0/0	1	0	13	50	40	20	40
80	Vedda	EE	0/0	1	0	13	80	30	30	40
86	Badjau	IP	0/0	1	0	11	65	80	0	0
90	Tiwi	IP	70/90	1	66	12	40	20	30	50
91	Aranda	IP	60/78	1	44	9	40	0	40	60
118	Ainu	EE	1/2	1	0	9	52	40	30	20
119	Gilyak	EE	1/3	1	0	8	80	50	30	20
120	Yukaghir	EE	1/2	5	0	7	100	40	50	10
122	Ingalik	NA	4/8	5	3	7	77	50	40	10
123	Aleut	NA	—	—	7	90	60	30	10	
124	C. Eskimo	NA	5/10	2	4	7	85	60	40	0
125	Montagnais	NA	—	—	—	7	70	20	60	20
126	Micmac	NA	—	—	—	7	92	40	50	10
127	Saulteaux	NA	2/4	5	1	7	70	40	40	20
128	Slave	NA	2/4	5	1	7	80	40	50	10
129	Kaska	NA	2/4	5	1	7	65	50	40	10
130	Eyak	NA	—	—	—	7	80	50	30	20

(continued)

TABLE 1 (continued)

SCCS ID	*Society*	*Region*	*Polygynously Married Men / Women (%)*	*Reliability of Polygyny Data*	*Single Men (%)*	*Total Pathogen Stress*	*Male Contribution to Subsistence (%)*	*Diet Fishing (%)*	*Diet Hunting (%)*	*Diet Gathering (%)*
131	Haida	NA	—	—	—	7	80	60	20	20
132	Bellacoola	NA	5/10	5	4	7	80	60	20	20
133	Twana	NA	25/	—	—	7	75	60	30	10
134	Yurok	NA	4/8	1	3	7	57	50	10	40
135	Pomo	NA	2/4	1	1	7	62	30	30	40
136	Yokuts	NA	5/10	1	4	8	79	30	20	50
137	Paiute	NA	15/27	2	13	7	50	20	30	50
138	Klamath	NA	20/35	1	18	8	57	50	20	30
139	Kutenai	NA	10/19	1	9	7	70	40	30	30
162	Warrau	SA	23/37	6	17	14	72	20	30	40
173	Siriono	SA	11/38	1	28	16	80	10	50	30
178	Botocudo	SA	33/55	6	32	17	50	10	40	50
179	Shavante	SA	24/49	1	32	20	62	10	30	40
180	Aweikoma	SA	30/50	1	28	15	70	0	60	40
186	Yahgan	SA	5/10	5	4	7	55	70	20	10
n	36	36	31/30	30	30	36	36	36	36	36
Mean			12.4/20.1		11.1	9.9	67.4	35	34	29

NOTE: Af = Africa; EE = East Eurasia; IP = Insular Pacific; NA = North America; SA = South America.

time ethnographies were recorded, there were few, if any, foragers left in the Circum-Mediterranean region so it is not represented at all, although foragers made up a large fraction of all societies in North America, which consequently accounts for 50% of the sample. This may introduce problematic geographic bias, but it must be kept in mind that this bias is largely the result of the timing of ethnographic description. It would be impossible to construct a sample without geographic bias because we could never eliminate the problem of the Circum-Mediterranean region being unrepresented.

DEGREE OF POLYGYNY

The mean percentage of polygynous women is 20% (0% to 90%, SD = 24%) and for polygynous men, it is 12% (0% to 70%, SD = 17%). Remember, this is only the percentage of the married men and women, which is why the percentage of polygynous women is less than twice as high as that of men (if only 10% of all men were married, 100% could be polygynous, but of course the percentage of women can never exceed 100%). The mean percentage of single men is 11% (0% to 66%, SD = 16%). The majority of foraging societies are slightly polygynous (by Murdock's criteria of < 20%), even if we use the percentage of women, as I do here (see Figure 1). Although exclusively monogamous societies are rare, the majority of marriages within all but the most polygynous societies are monogamous (mean = 100% – 20% = 80% monogamous). Polygyny is not randomly distributed geographically and ecology is clearly important because the percentage of polygynous women is higher where the mean annual temperature is higher ($r = .371$, $p = .044$, $n = 30$).

TOTAL PATHOGEN STRESS AS PREDICTOR

Total pathogen stress is correlated with mean annual temperature ($r = .719$, $p = .000$, $n = 36$), and mean annual precipitation ($r = .496$, $p = .002$, $n = 36$). As predicted, the percentage of polygynous women is higher where total pathogen stress is higher ($r = .383$, $p = .037$, $n = 30$) (see Figure 2). As we should expect if women are gene shopping, total pathogen stress is even more highly correlated with the percentage of single men ($r = .400$, $p = .029$, $n = 30$). Total pathogen stress is not significantly correlated with the percentage of

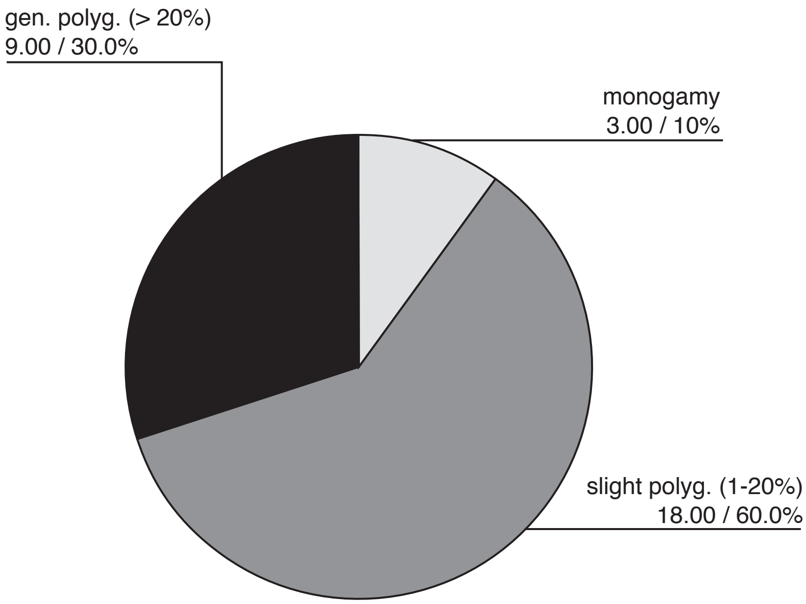

Figure 1: The Forager Mating System Measured by the Percentage of Married Women Polygynously Married (n = 30)

polygynous men (r = .249, p = .177, n = 31). Both total pathogen stress and percentage of polygynous women vary with latitude and are higher in the southern hemisphere (see Figure 3).

MALE CONTRIBUTION TO SUBSISTENCE AS PREDICTOR

Mean male contribution to subsistence is 67% (40% to 100%, SD = 16%). It is higher in colder climates where women have less plant food to gather, so it is negatively correlated with mean annual temperature (r = –.414, p = .012, n = 36). As predicted, the percentage of polygynous women is higher where male contribution to subsistence is lower (r = –.442, p = .014, n = 30) (see Figure 4).

Given that where it is colder, male contribution to subsistence is higher and total pathogen stress is lower, it is not surprising that they are negatively correlated with each other (r = –.333, p = .047, n = 36). This raises the question of which one best predicts the degree of polygyny. A multiple linear regression with both male contribution to subsistence and total pathogen stress forced to

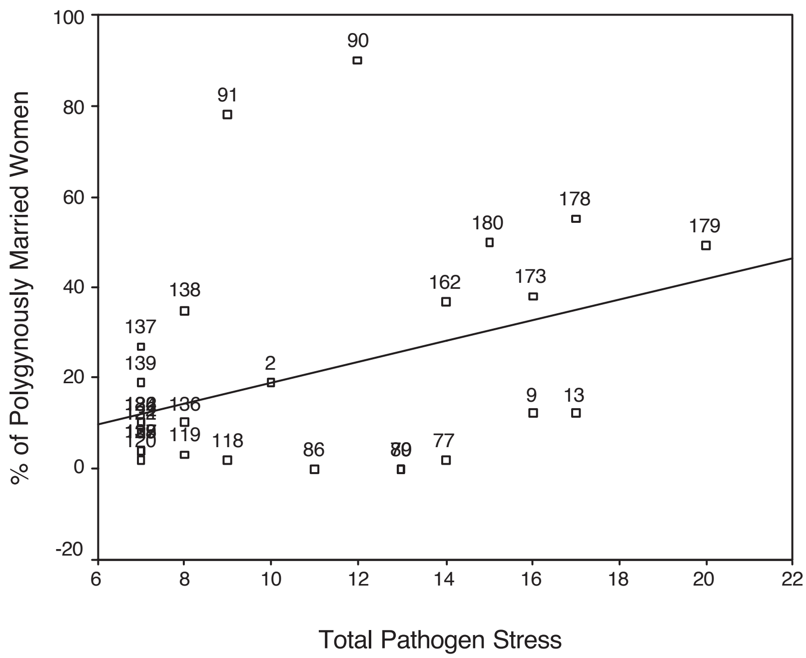

Figure 2: Percentage of Married Women Polygynously Married as a Function of Total Pathogen Stress (*r* = .383, *p* = .037, *n* = 30).

enter as independent variables reveals that the percentage of polygynous women is significantly predicted by male contribution to subsistence (β = –.372, p = .036, df = 27) but not total pathogen stress (β = .294, p = .092, df = 27). The correlation between total pathogen stress and polygyny among foragers is due in part to the fact that all three of these variables vary with the temperature of the habitat. Male contribution to subsistence also varies with latitude and is lower in the southern hemisphere (see Figure 5).

Male contribution to subsistence is higher where more of the diet comes from fishing (r = .461, p = .005, n = 36), lower where more comes from gathering (r = –.651, p = .000, n = 36) but not correlated with the amount that comes from hunting (r = .165, p = .336, n = 36). The less hunting contributes to the diet, the more fishing contributes (r = –.520, p = .001, n = 36) because at higher latitudes, fishing tends to replace hunting (Kelly, 1995).

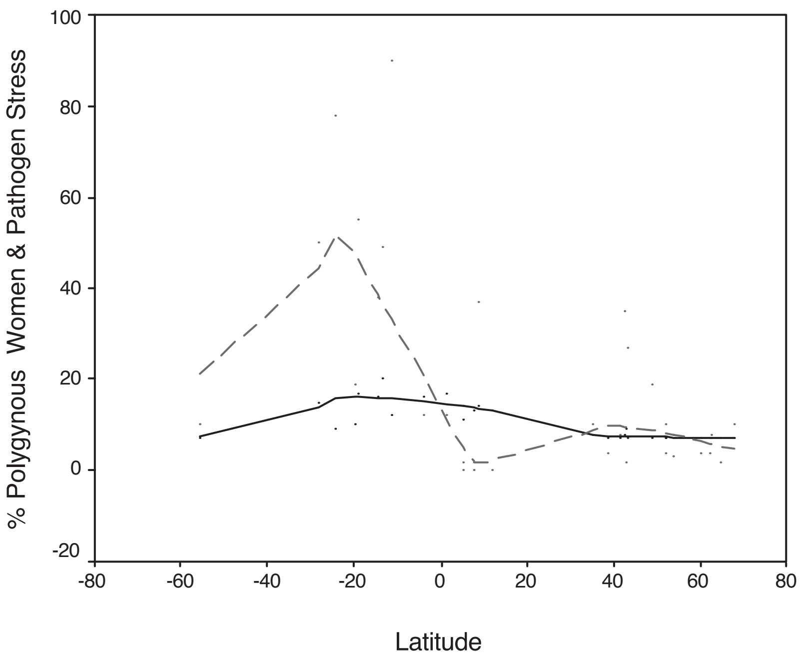

Figure 3: Percentage of Married Women Polygynously Married and Total Pathogen Stress as a Function of Latitude

NOTE: Negative numbers to the left on the X axis are the southern hemisphere and positive numbers, the northern hemisphere. Solid line = total pathogen stress; dotted line = percentage of married women polygynously married.

The percentage of polygynous women is higher where gathering contributes more to the diet (r = .477, p = .008, n = 30) and lower where fishing contributes more to the diet (r = –.550, p = .002, n = 30), which is where males contribute the most. When the percentage of the diet coming from hunting is controlled, higher male contribution to subsistence predicts a lower percentage of polygynous women even more strongly (β = –.487, p = .007, df = 27), suggesting that widespread sharing of big game may weaken the link between male contribution to subsistence and degree of polygyny.

To check whether the relationship between male contribution to subsistence and polygyny is an artifact of regional variation or phylogenetic correlation, I divided the sample into the Old World and New World. With this dummy variable entered in a linear

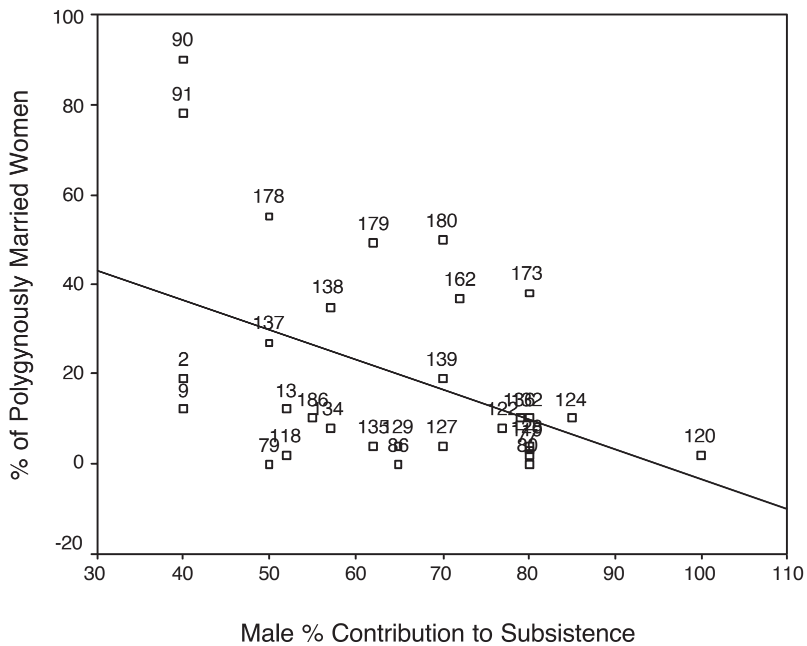

Figure 4: Percentage of Married Women Polygynously Married as a Function of Percentage of Male Contribution to Subsistence (r = –.442, p = .014, n = 30).

regression along with pathogen stress, male contribution to subsistence still predicts percentage of polygynous women ($\beta = -.423$, p = .019, df = 26). This negative relationship holds in both the Old and New World. The relationship between pathogens and polygyny, on the other hand, is different in the Old and New World. As expected, polygyny is higher where pathogen stress is higher in the New World, but surprisingly polygyny is negatively related to pathogen stress in the Old World. This is mainly because polygyny is high in Australia, even though pathogen stress is not so high and because polygyny is low in Southern Asia, even though pathogen stress is high.

The variable that is most strongly correlated with percentage of polygynous women is hemisphere (northern hemisphere = 1; southern hemisphere = 2). The percentage of polygynous women is higher in the southern hemisphere (r = .763, p < .000, n = 30). When latitude, pathogen stress, and northern/southern hemisphere are controlled, male contribution to subsistence is still negatively

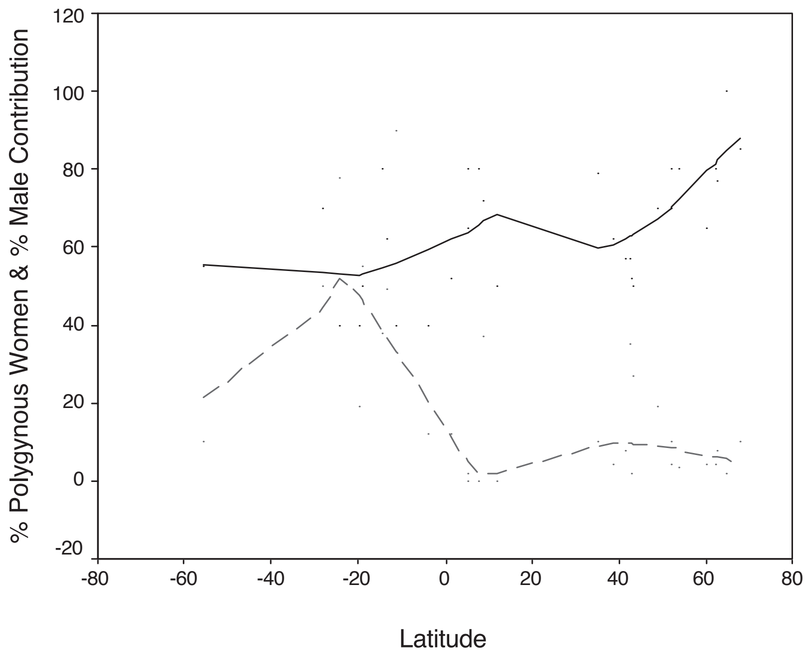

Figure 5: Percentage of Married Women Polygynously Married and Percentage of Male Contribution to Subsistence as a Function of Latitude

NOTE: Negative numbers to the left on the X axis are the southern hemisphere and positive numbers, the northern hemisphere. Solid line = male contribution to subsistence; dotted line = percentage of married women polygynously married.

related to the percentage of polygynous women (β = –.344, *p* = .016, *df* = 25), suggesting that this is not a spurious artifact of latitude and hemisphere, although hemisphere remains the strongest predictor (β = 980, *p* < .000, *df* = 25).

MALE COERCION AS PREDICTOR

Results suggest male contribution to diet is important, but what about male coercion? Two variables in the SCCS that might reflect male coercion are (a) arranged female marriage and (b) assault frequency (see Appendix 1 for coding details). I used general assault rather than wife beating because male coercion could affect the degree of polygyny whether directed at females or other males.

These two variables are even more highly correlated with polygyny (by any of the three measures) than male contribution to subsistence.

Among all 186 societies in the SCCS, there is greater polygyny where female marriages are arranged but not where male marriages are arranged (Marlowe, n.d.), suggesting that marriage arrangement is a form of male coercion and a way parents can benefit by supplying the most influential males with brides. Among foragers as well, there is a higher percentage of polygynous women where female marriages are arranged (r = .502, p = .009, n = 26). Assault frequency is also correlated with percentage of polygynous women (r = .672, p = .001, n = 22).

Another variable correlated with the degree of polygyny among foragers is warfare. Warfare has been coded into the frequency of internal warfare (within society) and external warfare (between societies) (C. R. Ember & Ember, 1992). External warfare is not correlated with the degree of polygyny (by any of the three measures), but internal warfare is positively correlated with the percentage of polygynous women (r = .413, p = .036, n = 26) and the percentage of polygynous men (r = .392, p = .043, n = 27).

It is easy to see how these three variables might be related to the degree of polygyny because they are likely related to the intensity of male-male contest competition and coercion. However, it is not clear whether they are causes or effects of polygyny. More violent males may be able to accumulate wives at the expense of other males, but likewise, once there are more bachelors in a society, we should expect them to become more violent in their competition for women, whether this violence is aimed at other men or women in their own camp (assault frequency) or the neighboring camp (internal warfare). In a multiple regression analysis, degree of polygyny (however measured) better predicts assault frequency and frequency of internal warfare than vice versa, controlled for pathogen stress. It appears therefore that assault and internal warfare are more effects than causes of polygyny. Nevertheless, the causality probably runs both ways and this may be what explains the degree of polygyny as much as, or more than, female gene shopping in those societies where males contribute little to the diet. It is interesting that total pathogen stress is positively related to arranged marriage, assault frequency, and internal warfare, but these are all negatively related to male contribution to subsistence. In fact, controlling for Old/New World and pathogen stress, where male contribution to subsistence is greater, assault frequency is lower (β = –.515, p = .009, df = 21), which is discussed below.

DISCUSSION

The fact that there is a higher percentage of polygynous women where male contribution to subsistence is lower may strike some as counterintuitive. On reflection, this should not be surprising, because among most mammals, males do no provisioning at all and polygyny is the rule. The polygyny threshold model applies only to variation in male resources within a society, not variation across societies as analyzed here. If men brought in 0% of the diet, there would be no within-society variation in male contribution, but above this, there is no way to know anything about within-society variation from across society mean levels, at least not without sophisticated modeling of the probabilities. But if our null assumption is that across societies there is no significant difference in within-society variation, then a society's mean level of male contribution to subsistence should be a good measure of the mean benefit of resource shopping for women in that society.

The amount of male provisioning in polygynous societies is probably even less than it appears in these data if we consider that the lower mean level of male contribution in more polygynous societies will be even lower once it is divided among co-wives. For example, if men in a society with mean male contribution of 40% eat 25% and provide the remaining 15% to wife and children, then the man with two wives provides each with only 7.5%. If men eat more than they bring in, then women would actually benefit by sharing with co-wives the burden of feeding their husbands.

The negative correlation between male contribution to subsistence and polygyny suggests that where men contribute little, women are either gene shopping or are indifferent to the outcome of male-male contest competition and mate guarding or prefer males who succeed in male-male contest competition. Among some Australian foragers, 90% of women could be married polygynously, even though men provided little food (see Figure 4). Females were betrothed at birth in some Australian societies, and marriages were arranged between elderly men, some of whom might obtain up to 10 wives, whereas younger men had none (Goodale, 1971; Hart & Pilling, 1960). Affairs with young men were said to be frequent in some of these societies, which suggests women were not gene shopping for these old men, but if women gained enough reproductive success through successful sons, they may have been indifferent enough to allow such a mating system to evolve.

Only 27% of the variance in the degree of polygyny is explained by the two independent variables, total pathogen stress and male contribution to subsistence, leaving a considerable amount unexplained. Notice that the three African and the two Australian societies all have about the same low level of male contribution to subsistence, yet there is a low level of polygyny in Africa and the highest level in Australia, and this is despite the fact that total pathogen stress is higher in Africa. Clearly, other things are involved. The Australians, whether in humid or arid habitats, simply had a higher degree of polygyny and arranged marriage than other regions. However, despite the fact that cultural inertia and diffusion make the data noisy, the same negative associations (though *ns*) between mean annual temperature and male contribution to subsistence and between male contribution to subsistence and degree of polygyny hold in both the New and Old World and in the northern and southern hemispheres, implicating ecology.

The fact that the degree of polygyny is more strongly correlated with arranged marriage and assault frequency than male contribution to subsistence might mean that male coercion and contest competition over mates is more important than male provisioning. But male violence and arranged marriage are unsatisfying as fundamental explanatory factors. Violence (including internal warfare) and arranged marriage are surely strategies males use to achieve polygyny at the expense of their rivals, but we must ask why this strategy is not attempted everywhere with roughly equal intensity and with roughly equal success. Extrinsic factors that vary from habitat to habitat, such as climate, available food resources, and pathogens provide more satisfying explanations not only of the variation in polygyny but probably also the variation in other social traits like male violence and arranged marriage.

The mating system may be most monogamous where there is more fishing and male contribution to subsistence is highest as fish are not shared as much as big game because they come in smaller, more predictable packages subject to less scrounging. This would make fishing a better strategy for household provisioning than hunting. The evening out of men's resources through food sharing may prevent the polygyny threshold from being reached and might explain why most marriages are monogamous in all but a few forager societies, but it leaves us with the question of why males bother to compete for food if sharing eliminates their mating advantage. Once female choice pushes males toward provisioning competition, although there may be only a slight benefit to the woman married to the best forager, even a slight advantage counts and could be enough to maintain the female preference for providers, which means there is a slight advantage for the better male forager, which should spur on competition among males for acquiring more food.

If women prefer provider males, perhaps males always try to get as much food as they can and this simply varies with habitat, for example, where it is colder there are few plants for women to gather so by default men account for more of the diet (Lee, 1968). If females do more resource shopping in those habitats where foraging is difficult for them, we could expect men to respond by working harder to get food. But could men contribute more in those warmer habitats if they wanted to? There may be something else driving men's foraging strategy and setting the level of male contribution.

Even though pathogen stress no longer predicted polygyny once male contribution to subsistence was included, it is conceivable that it is actually driving the mating system. Men might be able to contribute much more in warm climates but choose not to because women place more importance on gene shopping when they can get food for themselves. Men might abandon the provisioning strategy and focus more on direct contest competition over mates where women place less importance on resource shopping. The negative correlation found between male contribution and assault frequency (controlling for pathogen stress and Old/New World) is what we would expect if different relative advantages in different habitats cause males to pursue either of two alternative strategies: (a) competition in foraging success or (b) direct contests over mates. The way this would work is illustrated in Figure 6.

CONCLUSION

The benefits of male household provisioning among foragers are much less straightforward than once assumed. It is surprising, therefore, that the same relationship between percentage of polygynous women and male contribution to subsistence that exists among nonforagers (Marlowe, n.d.) was also found among foragers. One possible interpretation of this is that, despite the extensive food sharing among foragers, male contribution to subsistence still accurately reflects household provisioning. Polygyny is probably rarely due to the polygyny threshold because demand

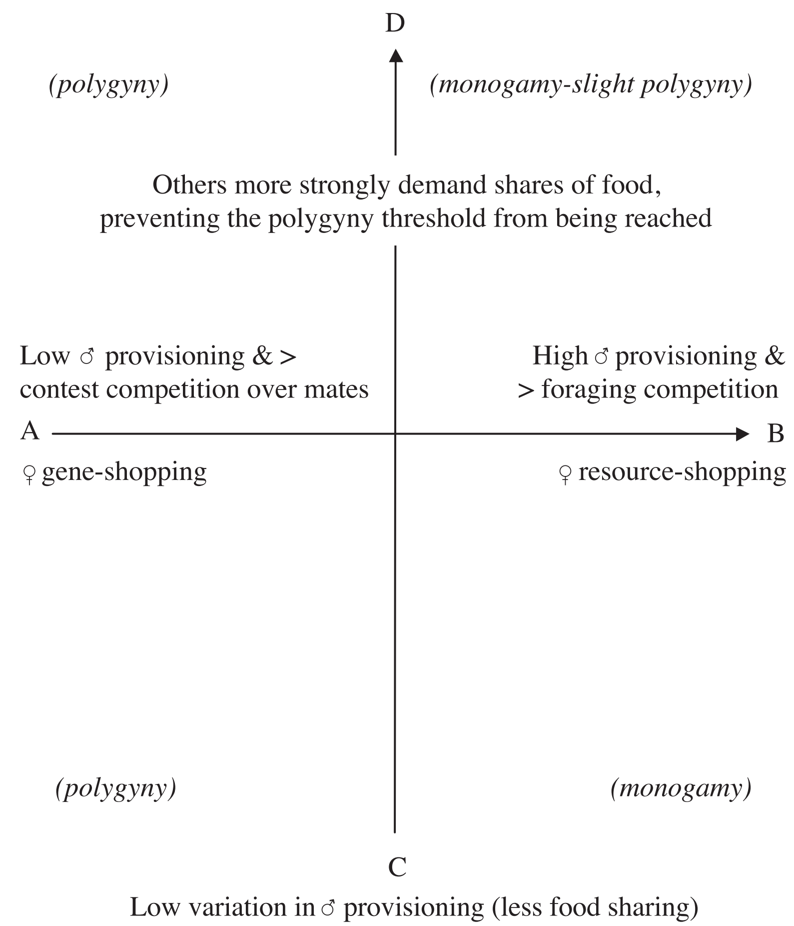

Figure 6: A Model of Forager Mating Systems

NOTE: Along one axis (A-B) is the mean level of male provisioning, and along another axis (C-D) is the degree of variation in that level. When males provide most food but there is little variation, monogamy prevails because women resource-shop and the polygyny threshold is not reached. When males provide most food and some provide much more than others, better providers might achieve polygyny (except there is stronger demand for them to share food, minimizing variation). Where males provide little food, females gain more from gene shopping and prefer to mate polygynously or are indifferent to the outcome of male-male contest competition.

sharing of food minimizes the variation in male resources. Nonetheless, male contribution to subsistence has an important effect on the mating system because where it is higher, there is more monogamy. This could be because, even after food has been shared, the wife of a good forager gets a little bit more than the wife of a poor forager, provided she does not have a co-wife. Polygyny likely results from male intimidation and manipulation of other males, along with female indifference or active gene shopping. It is possible that pathogen stress is an important determinate of the level of male contribution to subsistence and it is worth noting that male contribution to subsistence does not erase the effect of pathogen stress on degree of polygyny in all 186 societies in the SCCS; both are about equally strong and significant predictors (Marlowe, n.d.). When men provide less food, male coercion and mate guarding are more important; when men provide more food, women prefer providers and this spurs on foraging competition among men.

Appendix A
Codes and Variable Numbers for the Standard Cross-Cultural Sample (SCCS) on the World Cultures CD[1]

SCCS Forager Sample: All those societies where < 10% of the diet comes from agriculture or animal husbandry, excluding mounted hunters, and including only those with trade accounting for no more than < 50% and no more than any single local source (v = variable) (select cases = v3 < 4 & v5 < 4 & v858 < 5 & v1 < 6).

Region (v200): Af = Africa; EE = East Eurasia; IP = Insular Pacific; NA = North America; SA = South America.

Mean Annual Temperature (v186): Degrees centigrade for location of society.

Percentage of Married Women Polygynously Married (v872): Not the percentage of all women but the percentage of all married women with co-wives.

Percentage of Married Men with More Than One Wife (v871): Not the percentage of all men but the percentage of all married men with more than one wife.

Reliability of Polygyny Data (v873): White's codes for v871 & v872: 1 = direct percentage: good quantitative data; 2 = direct percentage for male polygyny, female polygyny estimated for minimum of two wives per man, where if P = % men married polygynously, then Q = 2P/100 + P is the % of women married polygynously; 3 = percentage of female polygyny estimated from ratios of men with different numbers of wives, provided by ethnographer; 4 = lower of two or more censuses used, or estimates where there is some other reason to believe that true percentage are higher for both males and females; 5 = estimates from 0% to 5% male polygyny inferred from statements about limited polygyny; these are doubled for female percentage (a minimal estimate); 6 = uncertain coding.

Percentage of All Men Who Are Single: My calculation uses the following formulas: 1. (100 – polygynously married women) = Percentage of monogamously married women; 2. (100 – polygynously married men) = Percentage of monogamously married men; 3. Percentage of all men monogamously married = (Percentage monogamously married women) / (Percentage of monogamously married men) (because these are equal when the OSR is equal); 4. Percentage of all men who are nonmonogamous = 1.0 – Percentage of all men who are monogamously married; 5. Percentage of all men who are polygynous = (all nonmonogamous men) / (Percentage of polygynously married men + .0000001 [to avoid dividing by 0]); 6. Percentage of all men who are single = all nonmonogamous men – Percentage of all polygynous men.

Total Pathogen Stress (v1260): Low's coding of seven types of pathogens (leishmanias, trypanosomes, malaria, schistosomes, filariae, spirochetes, and leprosy) each scored as 1 = *absent*, 2 = *present*, or 3 = *present and serious.* The total equals the sum of all seven types.

Male Contribution to Subsistence (100-v885): 100% – % female contribution to subsistence. The percentage of female contribution to subsistence comes from White, who used Murdock's *Ethnographic Atlas* data (White, "Polygyny: Form and Frequency," from the World Cultures CD, 2001).

Percentage of Fishing, Hunting, and Gathering (v203, v204, v205): From the *Ethnographic Atlas* (Murdock, 1962-1971 on CD), gathering = v203 × 10; hunting = v204 × 10; fishing = v205 × 10, to give the percentage of the diet from 0% to 100%. The three do not always total 100%. The remainder is the amount contributed by trade and/or agriculture.

Arranged Female Marriages (v740 recoded so that 1, 2 = 1; 3, 4, 5 = 2; 6 = 3): 1 = individual selects or parental approval highly desirable; 2 = individual suggests partner and then others arrange, individual choice or arrangement are alternatives, or parents choose but individual can object; 3 = parents choose, individual cannot reject.

Assault Frequency (v1666): ranges from 1 = *low* up to 9 = *high*, assumed to reflect male assault of males and females, even if it also reflects female assault of males and females.

Frequency of Internal Warfare (v1649): Ranges from 1 = *seems to be absent or rare* up to 17 = *seems to occur constantly any time of year.*

Frequency of External Warfare (v1650): Ranges from 1 = *seems to be absent or rare* up to 17 = *seems to occur constantly any time of year.*

Notes

1. The World Cultures CD is available from Bill Divale at divalebill@aol.com.

2. I did not use White's figure for percentage of polygynously married Warrau women (95%), which seemed questionable. Instead, I used White's formula for calculating percentage of polygynously married women from the percentage of polygynously married men, and I used 23% for the percentage of men polygynously married (Layrisse, 1980, pp. 60-69). (as seen in Electronic Human Relations Area Files [EHRAF]). Layrisse says 23% of marriages were polygynous. Another source (Hill, 1956) says 7.1% of marriages are polygynous and that most marriages are monogamous. White coded Warrau polygyny data with the lowest reliability (the only other such society was the Botocudo, which I did use because I had no other source). When the Botocudo and Warrau are excluded, the results reported here still hold.

3. I used the *Ethnographic Atlas* (EA) percentage of female contribution to subsistence rather than the Standard Sample because as the authors (Barry & Schlegel, 1982) noted,

> The EA measures have several advantages. They are obtainable from the entire sample of 1,267 societies (Barry, 1980), which include all 186 societies of the Standard Sample. The EA measures may be more accurate because the percentage female codes were directly based on each of the five food sources in the same set of codes. The EA scores are easier to calculate and correspond closely to the scores used by Sanday (1973). (p. 187)

In a few cases, values were missing in the EA coding, and for these, I used the SS numbers.

References

Andersson, M. (1994). *Sexual selection*. Princeton, NJ: Princeton University Press.

Barry, H. (1980). The ethnographic atlas XXVIII: Part 2. *Ethnology*, *19*, 367-385.

Barry, H., & Schlegel, A. (1982). Cross-cultural codes on contributions by women to subsistence. *Ethnology*, *21*, 165-188.

Blurton Jones, N. G., Marlowe, F., Hawkes, K., & O'Connell, J. (2000). Paternal investment and hunter-gatherer divorce rates. In W. Irons (Ed.), *Adaptation and human behavior: An anthropological perspective* (pp. 69-90). New York: Elsevier.

Borgerhoff Mulder, M. (1988). Is the polygyny threshold model relevant to humans? Kipsigis evidence. In C. G. N. Mascie-Taylor & A. J. Boyce (Eds.), *Mating patterns* (pp. 209-230). Cambridge, UK: Cambridge University Press.

Clutton-Brock, T. H. (1989). Mammalian mating systems. *Proceedings of the Royal Society of London*, *236*, 339-372.
Clutton-Brock, T. H. (1991). *The evolution of parental care*. Princeton, NJ: Princeton University Press.
Ellison, P. T. (2001). *On fertile ground*. Cambridge, MA: Harvard University Press.
Ember, C. R., & Ember, M. (1992). Warfare, aggression, and resource problems codes. *Behavior Science Research*, *26*, 169-186.
Ember, M., & Ember, C. R. (1979). Male-female bonding: A cross-species study of mammals and birds. *Behavior Science Research*, *14*, 37-56.
Ember, M., & Ember, C. R. (1983). *Marriage, family, and kinship: Comparative studies of social organization*. New Haven, CT: HRAF Press.
Gangestad, S. W., & Buss, D. (1993). Pathogen prevalence and human mate preferences. *Ethology and Sociobiology*, *14*, 89-96.
Goodale, J. C. (1971). *Tiwi wives: A study of the women of Melville Island, North Australia*. Seattle: University of Washington Press.
Gowaty, P. A. (1996). Battles of the sexes and origins of monogamy. In J. M. Black (Ed.), *Partnerships in birds: The study of monogamy* (pp. 21-52). Oxford, UK: Oxford University Press.
Hames, R. (1996). Costs and benefits of monogamy and polygyny for Yanomamo women. *Ethology and Sociobiology*, *17*, 181-199.
Hamilton, W. D., & Zuk, M. (1982). Heritable true fitness and bright birds: A role for parasites? *Science*, *218*, 384-387.
Hart, C. W., & Pilling, A. R. (1960). *The Tiwi of North Australia*. New York: Holt, Rinehart & Winston.
Hartung, J. (1982). Polygyny and inheritance of wealth. *Current Anthropology*, *23*, 1-12.
Hawkes, K., O'Connell, J., & Blurton Jones, N. G. (2001a). Hadza meat sharing. *Evolution and Human Behavior*, *22*, 113-142.
Hawkes, K., O'Connell, J., & Blurton Jones, N. G. (2001b). Hunting and nuclear families: Some lessons from the Hadza about men's work. *Current Anthropology*, *42*, 681-709.
Hill, G. W. (1956). The Warao of the Amacuro Delta (EHRAF edition, Vol. 2001). Caracas: Universidad Central de Venezuela.
Kaplan, H., & Hill, K. (1985). Food sharing among Ache foragers: Tests of explanatory hypotheses. *Current Anthropology*, *26*, 223-246.
Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology*, *9*, 156-185.
Kelly, R. L. (1995). *The foraging spectrum*. Washington, DC: Smithsonian Institute Press.
Kitanishi, K. (1998). Food sharing among the Aka hunter-gatherers in northeastern Congo. *African Studies Monographs*, *25*, 3-32.
Kleiman, D. G., & Malcolm, J. R. (1981). The evolution of male parental investment in mammals. In D. J. Gubernick & P. H. Klopfer (Eds.), *Parental care in mammals* (pp. 347-387). New York: Plenum.
Lancaster, J. B., & Lancaster, C. S. (1983). Parental investment: The hominid adaptation. In D. Ortner (Ed.), *How humans evolve* (pp. 33-58). Washington, DC: Smithsonian Institute Press.

Layrisse, M. (1980). *Vital statistics of five Warao sub-tribes* (EHRAF edition, Vol. 2001). Los Angeles: University of California, Los Angeles, Latin America Center Publications.

Lee, R. B. (1968). What hunters do for a living or how to make out on scarce resources. In R. B. Lee & I. DeVore (Eds.), *Man the hunter* (pp. 30-48). Chicago: Aldine.

Lovejoy, O. (1981). The origin of man. *Science*, *211*, 341-350.

Low, B. S. (1988). Measures of polygyny in humans. *Current Anthropology*, *29*, 189-194.

Low, B. S. (1990). Marriage systems and pathogen stress in human societies. *American Zoologist*, *30*, 325-339.

Marlowe, F. (2000). Paternal investment and the human mating system. *Behavioural Processes*, *51*, 45-61.

Marlowe, F. (2001). Male contribution to diet and female reproductive success among foragers. *Current Anthropology* 42:755-760.

Marlowe, F. (n.d.). *The human mating system*. Manuscript in preparation.

Mesnick, S. L. (1997). Sexual alliances: Evidence and evolutionary implications. In P. A. Gowaty (Ed.), *Feminism and evolutionary biology* (pp. 207-257). New York: Chapman and Hall.

Murdock, G. P. (1967). The ethnographic atlas: A summary. *Ethnology*, *6*.

Murdock, G. P., & Morrow, D. O. (1980). Subsistence economy and supportive practices: Cross-cultural codes 1. In H. Barry & A. Schlegel (Eds.), *Cross-cultural samples and codes* (pp. 45-73). Pittsburgh, PA: Pittsburgh University Press.

Murdock, G. P., & White, D. R. (1980). Standard cross-cultural sample. In H. Barry & A. Schlegel (Eds.), *Cross-cultural samples and codes* (pp. 3-43). Pittsburgh, PA: University of Pittsburgh Press.

Orians, G. H. (1969). On the evolution of mating systems in birds and mammals. *American Naturalist*, *103*, 589-603.

Peterson, N. (1993). Demand sharing: Reciprocity and the pressure for generosity among foragers. *American Anthropologist*, *95*, 860-874.

Ryan, M. J. (1997). Sexual selection and mate choice. In J. R. Krebs & N. B. Davies (Eds.), *Behavioural ecology: An evolutionary approach* (pp. 179-202). Oxford, UK: Basil Blackwell.

Sanday, P. R. (1973). Toward a theory of the status of women. *American Anthropologist*, *75*, 682-700.

Strassman, B. (1997). Polygyny as a risk factor for child mortality among the Dogon of Mali. *Current Anthropology*, *38*, 688-695.

Verner, J., & Willson, M. F. (1966). The influence of habitats on mating systems of North American passerine birds. *Ecology*, *47*, 143-147.

Westermarck, E. (1929). *Marriage*. New York: Jonathan Cape and Harrison Smith.

Whitten, P. L. (1987). Infants and adult males. In B. Smuts, D. L. Cheney, R. M. Seyfarth, R. W. Wrangham, & T. T. Struhsaker (Eds.), *Primate societies* (pp. 343-357). Chicago: University of Chicago Press.

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