

MONOGAMY

Mating Strategies and Partnerships in Birds, Humans and Other Mammals

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2003

 **CAMBRIDGE**
UNIVERSITY PRESS

CHAPTER 12

Social monogamy in a human society: marriage and reproductive success among the Dogon

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INTRODUCTION

In studying monogamy versus polygyny in humans, one can consider the diversity of marital and mating arrangements within societies or between societies. This chapter will focus on the diversity that occurs within a society, by asking two empirical questions: (i) what predicts who is monogamously or polygynously married for both males and females? and (ii) what are the consequences of both marriage types for reproductive success? Data are not available on extra-pair copulations (EPCs) or on genetic paternity in the study population. Therefore, throughout this chapter, the terms ‘monogamy’ and ‘polygyny’ refer to the number of concurrent spouses. This usage for the term ‘monogamy’ is akin to ‘social monogamy’, or ‘pair living’ as described in species for which actual mating behaviour has not been quantified.

The study of socially monogamous partnerships in a population that has both monogamous and polygynous unions helps to control for the cultural and historical complexity that obscures cross-cultural comparisons. In essence, a society with both monogamy and polygyny provides a natural experiment since these two types of union can be contrasted while holding constant a wide array of confounding variables. As demonstrated in this volume, much has already been learned about the occurrence of monogamy from parallel examples of intraspecific variation in other species. Ideally, this variation permits monogamy to be linked to relevant socioecological causes while holding phylogeny constant.

Attempts to explain the evolution of monogamy are often predicated on the assumption that monogamy is a trait that has been favourably selected. However, in humans and many other species, monogamy and polygyny are expressions of phenotypic plasticity (Vehrencamp & Bradbury, 1984). A diversity of mating arrangements arises within the species reaction norm, such that the

same individual can be monogamously mated in one year and polygynously or polyandrously mated in another. One implication is that in seeking to understand monogamy, neither the origin nor the maintenance of a trait is at issue. Instead, the critical questions have to do with whose fitness interests are served by alternative outcomes (monogamy, polygyny, polyandry), and when interests conflict, who wins, who loses, and what are the compromises?

Human behavioural ecologists have reached no consensus on the costs and benefits of alternative mating systems for males and females. One school accepts the fundamental argument of the polygyny threshold model (PTM), which is that polygyny results from female choice (non-humans: Verner, 1964; Verner & Willson, 1966; Orians, 1969; humans: Borgerhoff Mulder, 1988, 1990; Josephson, 1993; Winterhalder & Smith, 2000; and see Hames, 1996). Another school questions the utility of the PTM, given the confusion about what it actually predicts and whether its assumptions are reasonable. In the parent field of animal behaviour, the PTM could be described as a morass (see Altmann *et al.*, 1977; Vehrencamp & Bradbury, 1984; Davies, 1989).

Perhaps the foremost problem is that the PTM ignores the potential for conflicts of interest between members of the two sexes (non-humans: Downhower & Armitage, 1971; Irons, 1983; Davies, 1989; humans: Chisholm & Burbank, 1991; Strassmann, 1997*b*, 2000; Sellen *et al.*, 2000). A useful theory of human mating systems should address the possibility that a male who marries polygynously may thereby gain higher fitness, even if each of his wives achieves lower fitness than she would under monogamy. If monogamy is advantageous for female fitness, it is unlikely that polygyny can be satisfactorily explained by female choice. Rather than focusing only on differences in male mate value, a useful theory should also examine the numerous constraints

on female options, such as differences in female quality (see Altmann *et al.*, 1977).

In 1986 I initiated a longitudinal investigation of the evolutionary ecology of the Dogon of Mali, West Africa. A primary motivation for this research was the expectation that a focus on conflicts of interest between the sexes would clarify the potential costs of polygyny (and advantages of monogamy) for female fitness. Prior to fieldwork, my goal was to test the following hypotheses.¹

- 1 Males potentially gain higher fitness under polygyny than under monogamy (Trivers, 1972).
- 2 In a male-dominated society, husbands are able to pursue their own fitness interests at the expense of those of wives. Thus, polygynous males are wealthier in terms of total resources, but poorer on a per capita basis. Due to the dilution of wealth under polygyny, females in polygynous marriages experience lower fertility and offspring survivorship.
- 3 On account of the reproductive costs of polygyny for members of their sex, females constrained by their own low mate value (especially older, less fecund, or less well nourished women) are obliged to accept polygynous marriage.

SITE, TIME, AND DOGON SOCIOLOGY

The geographic origins of the Dogon are unknown, but since the fifteenth or sixteenth centuries they have lived along the Bandiagara Cliff, a sandstone fault in a region of rocks and thorn savanna 250 km south of Timbuktu (Pern, 1982). This escarpment, 260 km long by about 500 m high, provided a safe refuge from raids by neighbouring pastoralists, the Fulani and Mossi. The first French arrived at the end of the nineteenth century and the Dogon of Tabi took a last stand against the colonial government in the revolt of 1920 (Cazes, 1993). During the period of French occupation, which lasted until Malian Independence in 1960, intertribal conflict was suppressed. Dogon settlements then spread away from the cliff to undefended sites on the plateau and out onto the sandy plains below.

The Dogon are organized into clans that are comprised of men from one or more villages who bear a common 'surname'. The Dolo clan lives in the 11 villages of Sangha, situated just above the cliff face at the edge of the plateau. The study village, Sangha Sangui (14° 29' N, 3° 19' W), is further subdivided into four

patrilineages, each of which traces its ancestry to a single male founder within the Dolo clan.

Due to the expansion of the population and the poor quality of the habitat, arable land is a scarce resource. It is also exclusively in male ownership. A man and his married sons and all of their wives and children form an economic group. I call these groups of economically interdependent individuals work-eat groups (WEGs) since they work together in the same millet fields and eat together from the harvest. After the death of the oldest male, extended families used to remain together in WEGs that could exceed 100 individuals, but in recent times, the patriarch's sons by different wives usually stop working together and even sons who are full siblings usually separate some years after their father's death. The WEGs in Sangui at the time of this study ranged in size from one to 41 individuals and included both nuclear and extended families.

Arable land, especially millet fields, is the major resource critical for survival and reproduction. In an eight-year prospective study, the wealth rank of a child's WEG was a major predictor of survivorship adjusting for other significant predictors such as monogamy and a child's sex and age (Strassmann, 1997*b*, 2000). A woman has access to millet for herself and her offspring only through males. As a girl she is dependent on her father, then her husband, and ultimately her nephew or other male members of her natal patrilineage. After the masked dances that honour her husband after his death, an elderly widow usually returns to her natal patrilineage to work a small parcel of land either by herself or in the company of a grandchild. Widows who supported themselves in this manner headed the 13 poorest WEGs in Sangui. Across all ages women spent 21% more time working than men, and men spent 29% more time resting (Strassmann, 1996).

Co-wives are never sisters, and related women, such as first cousins, are forbidden from marrying into the same patrilineage. The result is male solidarity based on kinship and weakened alliances among female kin. Co-wives are rivals but equals. Custom dictates that a husband should sleep with his wives on alternate nights, but this rule is open to ambiguity and disputes. He owes each of his wives an equal share of poor quality millet to store in her granary; the first wife cuts the pile and the second wife is first to choose. The good quality or 'male' millet, he keeps under lock and key in his own granaries (Strassmann, 1997*b*).

The Dogon have a system of arranged marriages that operates alongside a more flexible system of spousal choice. Parents or grandparents choose a girl's first husband, but after divorce she exerts her own choice. As is typical in West Africa, most divorce is female initiated and not greatly stigmatized (Strassmann, 1997b, 2000). Boys have at least one, and in rare cases up to three spouses chosen by their relatives. To acquire an additional wife they must coax away the wife of another; thus, a non-arranged wife is referred to as 'cut-off' (*ya kezu*). Bride price is not practised, but the young fiancé of a nubile girl helps out his future parents-in-law in the fields and offers small gifts such as firewood and chickens. Because of this obligation, an arranged wife is called a 'work wife' (*ya bire*). A levirate wife (*ya pami*) is a woman married to her deceased husband's brother. The Dogon practise patrilocal residence, but it is considered preferable for a young woman to take up residence with her husband's patrilineage only after the birth of two offspring. If either infant survives, he or she will be raised by the maternal grandparents (Paulme, 1940; Strassmann, 1997b, 2000). A wife becomes *tanga* once she resides with her husband's family full-time; beforehand, as a *tanganu* wife, she resides with her natal family.

Abortion and infanticide are extremely rare among the Dogon, but not unheard of in cases of illegitimacy (Paulme, 1940; Strassmann, 1992, 1996¹). Dogon males attest to an abhorrence of cuckoldry and all little girls in the study village undergo clitoridectomy. No man in the data set had ever formally adopted a genetically unrelated offspring, but in a couple of instances a new wife was allowed to bring with her a daughter from a previous marriage. This temporary arrangement was accepted as daughters ultimately marry outside the lineage and do not threaten the key concern, which is to prevent unrelated males from gaining access to the land owned by the patrilineage. When one man is cuckolded, his entire lineage is cuckolded because descendants of the 'imposter' will inherit resources that otherwise would have gone to the descendants of the original lineage (Strassmann, 1992, 1996¹). Thus, Dogon patrilineages can be seen as coalitions of related males who are organized into socially and spatially cohesive units for the purpose of resource defence.

In humans ovulation is concealed and there are no reliable cues of paternity (Alexander, 1979; Alexander & Noonan, 1979; Strassmann, 1981); nonetheless,

knowledge of the timing of menstruation can be helpful in paternity assessments. Dogon women are therefore required (via supernatural threats and social reprisals) to advertise the timing of menstruation to their husband's entire lineage (Strassmann, 1992, 1996¹). This advertisement takes place at a menstrual hut and there is usually one hut per patrilineage.

A Dogon woman aged 25–30 typically experiences nine months of pregnancy, some 20 months of lactational amenorrhoea, and has a monthly probability of conception of 0.2 after the resumption of cycling (Strassmann & Warner, 1998). Thus, she has only about five months of cycling between births. If the duration of her marriage is 0.5 standard deviations shorter than the mean for her age, or if her husband is less than 35 years of age, or her past fecundity was 0.5 standard deviations higher than the mean, then her monthly probability of conception is about 0.3 (Strassmann & Warner, 1998). Women in this category have only about three months of cycling between births. It is the comparative rarity of menstruation in the absence of contraception that makes it so informative, even in the absence of precise knowledge of the timing of ovulation within a given cycle.

Husbands and other patrilineage members perpetually monitor female reproductive status and know that a wife who is cycling is potentially fecundable, whereas a wife who is pregnant or in lactational amenorrhoea is not. They keep a watchful eye on their fecundable women, who are less likely to successfully deceive them about paternity. Menstrual taboos might also help to deter EPCs, as male offspring of ambiguous paternity become outcasts, while their mothers lose social status (further details in Strassmann, 1992, 1996¹, 1997b).

The optimal fertility level can be defined as the number of livebirths that maximizes reproductive success. Among the women of Sangui, the predicted maximum reproductive success of 4.1 surviving offspring was attained at a fertility of 10.5 livebirths, which was similar to the modal fertility of ten births. Eighty-three per cent of women had seven to 13 births. Their predicted reproductive success was within the confidence limits (3.4–4.8) for reproductive success at the maximum. Thus, the fertility behaviour of Dogon women appears to make adaptive sense (Strassmann & Gillespie, 2002). Among females, variation in offspring mortality rather than fertility was the primary determinant of lifetime reproductive success (Strassmann & Gillespie, 2002).

METHODS

Study population

I gathered the data for this study during 35 months of fieldwork in Sangui between 1986 and 1998. In January 1988 the total population of the village was 460 inhabitants and by June 1998 it had increased to over 600. The data set is the entire population of one village, rather than a random sample of multiple villages. This approach enhanced data quality by making it possible to know all members of the community personally and to gain as much knowledge as possible by direct observation and measurement rather than interviews.

The analyses included men from age 25 to 74 years (the oldest male) ($N = 72$ in 1988, $N = 82$ in 1998). Rarely, a man younger than 25 years had a *tanganu* wife or two, but on account of the pronounced age difference among spouses none of these young women had given birth. The modal age at first birth for Dogon women is 19 years due to the late onset of menarche at about age 16 years and prolonged adolescent subfertility (see Strassmann & Warner, 1998). Thus, for the men of my data set, any paternity before age 25 years would have happened in the context of extra-pair copulations (EPCs) and was not quantified. The sample size and age range for women varied by year (1988, 1998, or 1988–98) and whether the particular analysis included all married women (*tanga* and *tanganu*), *tanga* women only, cycling women only, women who last gave birth ten years prior to the interview, and so forth (details below).

Cooperation was essentially 100% as no one declined to participate. Subjects were remunerated through small cash payments (US \$1.00 for measuring a family's cereal fields with their assistance, US \$0.20 for women's marital and reproductive interviews). I also provided habitual first aid to the village and emergency transportation to the hospital in Mopti. Through the American Embassy in Bamako, I obtained financing for a small development project requested by the village: a dam and dyke for retaining rainwater for the onion gardens.

Wealth

I calculated five wealth variables: hectarage in cereal crops (millet, sorghum, rice, fonio), hectarage in onion gardens, estimated value of cereal harvest, value of livestock (mostly sheep and goats), and estimated revenues

from commerce. I ranked each WEG with respect to the others across these five variables and then averaged the five ranks. In previous research, I developed seven economic indices that differed in how they weighted the various wealth variables (Strassmann & Warner, 1998). However, none captured the relative wealth of different families better than the unweighted average rank. The wealthiest family had a rank of 59 and the poorest a rank of one. I then excluded from the sample the 13 poorest WEGs because they were headed by widows and did not have any married adults, which left a total of 46 WEGs. I also excluded a solitary, unmarried male, who was the only person in his WEG, because he could not be accurately classified as either monogamous or polygynous.

Fields were measured with a compass and metre tape and areas calculated from a trigonometric program for a hand calculator. The estimated value of the harvest was obtained by counting all baskets of grain as they were brought back to the village. The fields are on the opposite side of a stream and foot traffic had to funnel across a bridge. I posted an observer at this bridge throughout the 1987 harvest season, then weighed representative baskets and bundles of each size. Livestock were counted and revenues from commerce, which make up only 5% of the village economy, were estimated by a Dogon man familiar with the various merchant activities (such as butcher, fish seller, onion middle-man). The total estimated value of the economic resources of Sangui in 1987 was about US \$50 000. Further details regarding the procedures for measuring WEG wealth are found in Strassmann and Warner (1998).

Interviews

I conducted the interviews for this study in the local language (Sangha-Sò, a dialect of Toro-Sò) after I had lived in the village for more than two years. Few Dogon know their birth dates, so age had to be estimated from interviews. Fortunately, the Dogon belong to age classes that span only one birth interval ($2\frac{1}{2}$ years) and individuals know their own birth order within their age class; thus, relative age could be established with precision. An exception is a resident manual labourer who had a missing value for age because he came from outside Sangha.

I asked each married man to name his age-mates in order of age. I then used the known birth dates for a few individuals, who were born at the time of a datable

event, to convert relative ages into chronological ages. To determine female ages, I asked each woman to name her closest male and female age-mates in the village. Female ages were then established by reference to the male chronology.

Other data obtained from interviews included marital and reproductive histories, including the putative reproductive success of both males and females based on self-reports. I knew most of these reported offspring because personal interactions, formal censuses, and quantitative behavioural scans made me familiar with the family composition of each WEG. However, putative offspring whom I did not observe directly included daughters who had married outside the village, sons who had left for the city, and offspring born to women before they married a man of Sangui.

Female reproductive success is defined as the number of self-reported offspring who survived to age ten years. Ten is an appropriate age cut-off because 20% of offspring did not survive to age 12 months and 46% did not survive to age five years (Strassmann, 1992), but few deaths occurred between age ten and sexual maturity. Male reproductive success is defined as the number of putative offspring who were still alive at the time of the interview, adjusted for the father's age. It would have been preferable to count offspring who survived to age ten years (Strassmann & Gillespie, 2002), but males professed little knowledge of offspring's ages at death. Deceased mothers and mothers who had divorced out of the village were not interviewed, so mothers' assessments regarding age at death could not be substituted. When both parents were still resident in the village, it was possible to compare the self-reports of mothers and fathers. There were no discrepancies, which is probably not altogether surprising. I interacted with the families on a daily basis and knew the names of their resident children, which meant that such offspring could not be invented or forgotten without my noticing it. Nonetheless, given the lack of genetic data, it is appropriate to refer to reproductive success in this study as 'putative'.

I also asked each individual about religious preference (indigenous religion, Islam, Catholicism, Protestantism, or none), number of years of schooling if any, and number of months of urban work. I collected data on each man's patrilineage from interviews, but in most cases these affiliations were also evident from the spatial location of compounds.

Monogamy versus polygyny

I defined a WEG as monogamous if the ratio of married women to men was 1.0 and polygynous if this ratio was greater than one. For the marital status of males, I compared both the total number of concurrent wives (which was public knowledge) and the total cumulative number of wives ever impregnated (based on self-reports). Unless otherwise indicated, the data on males refer to 1988. I assigned females the marital status that applied to them in two of three interviews for the ten-year period from 1988 to 1998.

Statistics

I used linear regression when the dependent variable was quantitative and logistic regression (Hosmer & Lemeshow, 1989) when it was binary. I also calculated the Pearson partial correlation coefficient between wealth and number of wives, with age controlled. When the relationship between age and a dependent variable was non-linear, I included both age and age squared in regression models. Analyses were carried out in the statistical software program SPSS 10.0.

Body mass

I measured each woman's height and weight to compute her body mass index (wt [kg]/height squared [m]) as described previously (Strassmann & Warner, 1998).

RESULTS

Marriage system

Variance in the putative reproductive success of males was greater than that of females (Figure 12.1). Such a pattern has been found in most mammals and was formerly used as the criterion for defining a mating system as polygynous (e.g., Daly & Wilson, 1983, pp. 83, 151–2). If the data set were from a closed breeding system, the mean reproductive success of males should have equalled that of females, rather than being twofold higher. However, Sangui has superior streamside land and more Sangui men have multiple wives than do men in most surrounding villages. Thus, the higher reproductive success of Sangui males may be balanced by the lower reproductive success of males from other villages. Moreover, Figure 12.1 includes only individuals who are age 42 years and older, which corresponds to the age at last birth for females. Males who survived

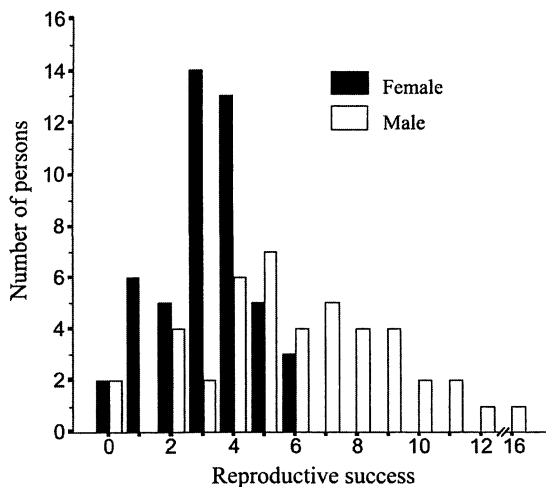


Figure 12.1. Variance in putative reproductive success for males ($N = 44$) and females ($N = 48$) in 1988. Reproductive success refers to the number of offspring alive at the time of the interview in 1988 for both males and females 42 years and older. The mean (\pm SD) number of offspring alive for males was 6.14 (\pm 3.27) and the median was 6.00. For females, respective values were 3.19 (\pm 1.50) and 3.00.

to this age will have enjoyed a female-biased sex ratio resulting from excess male mortality. They are also eight years older than their wives, on average. The difference in age at marriage combined with the population age pyramid further skews the operational sex ratio towards females (Dorjahn, 1959; Pison, 1985; Chisholm & Burbank, 1991; Strassmann, 1997b, 2000).

Although the marriage system could be described as polygynous, about half of the married males were in socially monogamous unions (54% in 1988, 56% in 1998). Data are not available on extra-pair paternity, so these percentages do not refer to genetic monogamy. In Sangui in 1988, 8% of the men age 25 years and older had no wives, 49% had one wife, 31% had two, and 10% had three wives concurrently ($N = 72$ men). Ten years later, the number of wives per man age 25 years and older was almost unchanged. Eight per cent had no wife, 51% had one, 31% had two, 8% had three and 1% had four wives ($N = 82$ men). Only 36% of married women (*tangu* and *tanganu* wives combined) were in socially monogamous marriages in both 1988 and 1998 (Table 12.1). An even smaller percentage of women (21%) were in WEGs in which no man had more than one wife.

Table 12.1. Number (and percentage) of married women by marital status

| Wife | 1988 | 1998 |
|--------|-------------|-------------|
| Sole | 36 (36.0) | 42 (35.9) |
| First | 30 (30.0) | 33 (28.2) |
| Second | 28 (28.0) | 33 (28.2) |
| Third | 6 (6.0) | 8 (6.8) |
| Fourth | 0 (0.0) | 1 (0.9) |
| Total | 100 (100.0) | 117 (100.0) |

Table 12.2. Predictors of WEG polygyny: 0, monogamous; 1, polygynous ($N = 46$ WEGs)

| Predictor | Coefficient | Odds ratio | P |
|--|-------------|------------|-------|
| Indigenous religion (0, no; 1, yes) | 2.18 | 8.82 | 0.028 |
| Wealth rank (46 = highest) | 0.24 | 1.27 | 0.002 |
| Intercept | -8.00 | - | - |

Goodness-of-fit statistic: 32.2. -2 log likelihood = 34.7.

Work-Eat Groups (WEGs)

If the WEG boss practised the indigenous Dogon religion instead of Islam or Christianity, the odds that the WEG was polygynous instead of monogamous increased 8.8-fold ($P = 0.028$) (Table 12.2). After adjusting for religion, the odds that the WEG was polygynous also increased with wealth. Specifically, as WEG wealth increased by one rank (out of 46), the odds that the WEG was polygynous increased by 27% ($P = 0.002$) (Table 12.2). WEG religion (traditional or other) and wealth rank were not significantly correlated (Spearman's $\rho = 0.32$, $P = 0.138$, $N = 46$). After WEG wealth was standardized by the energy requirements of the WEG (based on its age and sex composition), the finding that wealthier WEGs were more likely to be polygynous continued to hold (Table 12.3). Thus, monogamous WEGs were more likely to have a boss who identified himself as a Muslim or Christian and monogamous WEGs were poorer both absolutely and on a per capita basis.

Table 12.3. Predictors of WEG polygyny: 0, monogamous; 1, polygynous (N = 46 WEGs). In this model, wealth rank is standardized by the energy requirements of the WEG as described in the text

| Predictor | Coefficient | Odds ratio | P |
|-------------------------------------|-------------|------------|-------|
| Indigenous religion (0, no; 1, yes) | 2.62 | 13.64 | 0.028 |
| Standardized wealth rank | 0.22 | 1.25 | 0.001 |
| Intercept | -8.22 | - | - |

Goodness-of-fit statistic: 25.4. -2 log likelihood = 26.6.

Table 12.4. Predictors of polygyny defined as the number of wives a man was married to concurrently (N = 71 men, R² = 0.28)

| Predictor | Coefficient | SE | P |
|----------------------------|-------------|-------|-------|
| Age (years) | 0.109 | 0.193 | 0.026 |
| Age squared | -0.001 | 0.002 | 0.012 |
| Wealth rank (46 = highest) | 0.024 | 0.007 | 0.001 |
| Intercept | -1.493 | - | - |

Males

The analyses of males included both the number of wives a man was married to simultaneously, which was factual public information, and the cumulative number of wives a man said he had impregnated, which was non-verifiable. After adjusting for a man's age and age squared, as the wealth rank of a man's WEG increased by ten units, he acquired 0.24 extra concurrent wives. Together, the age and wealth variables explain 28% of the variance (Table 12.4). The percentage of variance explained decreased to 22% when the dependent variable was the total cumulative number of wives supposedly impregnated. In the latter model (not shown) the coefficient for wealth rank is nearly identical (0.023), but the P-value decreases from 0.001 to 0.06.

The Pearson partial correlation coefficient between the number of concurrent wives and wealth rank after controlling for a man's age and age squared was 0.38 (P = 0.001). For the reported cumulative number

Table 12.5. Predictors of the putative reproductive success of males (N = 71 men, R² refers to adjusted R²)

| Predictor | β^a | SE | P |
|---|-----------|-------|--------|
| Model 1 (R ² = 0.31) | | | |
| Age (years) | 0.607 | 0.200 | 0.003 |
| Age squared | -0.005 | 0.002 | 0.014 |
| Number of wives (concurrent) | 1.766 | 0.478 | <0.001 |
| Intercept | -13.372 | - | - |
| Model 2 (R ² = 0.35) | | | |
| Age (years) | 0.889 | 0.187 | <0.001 |
| Age squared | -0.008 | 0.002 | <0.001 |
| Wealth rank (46 = highest) | 0.107 | 0.029 | <0.001 |
| Intercept | -20.741 | - | - |
| Model 3 (R ² = 0.35) | | | |
| Age (years) | 0.777 | 0.204 | <0.001 |
| Age squared | -0.007 | 0.002 | 0.002 |
| Number of wives ^{b,c} (concurrent) | 1.246 | 0.502 | 0.016 |
| Wealth rank ^b (46 = highest) | 0.008 | 0.031 | 0.013 |
| Intercept | -19.595 | - | - |

^a All coefficients are for an increase of one unit in the independent variable.

^b Correlation between number of wives and wealth rank: Spearman's rho = 0.37, P (2-tailed) = 0.001.

^c If the cumulative number of wives (based on self-reports) is included instead of concurrent wives, then the coefficient becomes 1.136 and adjusted R² becomes 0.47.

of wives the partial correlation coefficient was 0.23 (P = 0.06).

After adjusting for age and age squared, a man got 1.3 extra offspring for each additional wife that he said he had married cumulatively (not shown) and 1.8 extra offspring per concurrent wife present at the time of fieldwork (Table 12.5). For an increase in wealth of ten ranks out of 46, he got 1.1 extra offspring (Table 12.5). Sangui has four different lineages, the oldest of which possesses most of the high quality riparian land that is immediately adjacent to the village. Nonetheless, when lineage membership was included in the model as a categorical variable, it did not predict a man's putative reproductive success. Nor did his religion, schooling, or whether he had worked in the city.

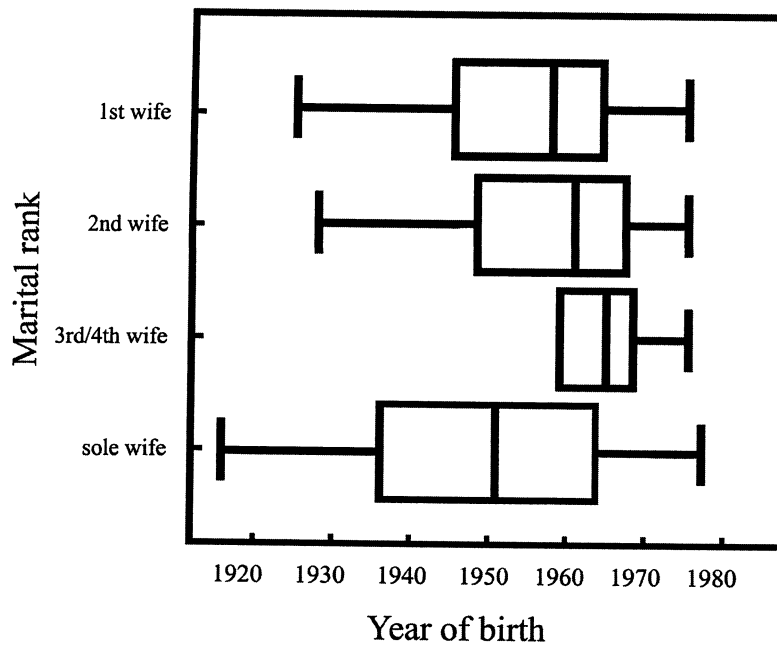


Figure 12.2. Boxplots of female marital status by age ($N = 143$ *tanga* women). Data are for 1988, 1994, and 1998 combined, and refer to the marital status in which a woman spent the most years.

Females

Monogamously married women were slightly older than polygynously married women (Figure 12.2). This result was the opposite from that predicted. Using a *post hoc* test for multiple comparisons (Bonferroni), the mean (\pm SEM) difference in year of birth for sole wives and first wives was 5.01 ± 3.13 years ($P = 0.67$). The difference between sole wives and second wives was 8.61 ± 3.03 years ($P = 0.03$), and the difference between sole wives and third or fourth wives was 13.33 ± 5.06 years ($P = 0.06$). At $P = 0.05$, only the difference between sole wives and second wives was statistically significant, but the trend was for wives of successively higher order to be progressively younger (Figure 12.2).

The body mass (weight over height squared) of monogamously and polygynously married women was indistinguishable (Table 12.6). However, after controlling for whether a woman was cycling (as opposed to pregnant or in lactational amenorrhoea), the sample size was small ($N = 24$). If age and body mass are indicative of mate value, then I found no evidence that mate value was higher for women in monogamous unions. They did, however, have higher reproductive success. After adjusting for other significant covariates, women who spent most of the decade between 1988 and 1998 in monogamous marriages had approximately

Table 12.6. The relationship between female marital status and body mass, defined as weight (kg) over height squared (m^2) ($N = 24$)^a

| Predictor | Coefficient | SE | <i>P</i> |
|---------------------------|-------------|-----|----------|
| Age (years) | 0.0 | 0.0 | 0.91 |
| 1st wife ^b | -0.6 | 1.0 | 0.52 |
| 2nd/3rd wife ^b | -1.0 | 0.9 | 0.29 |
| Intercept | 21.6 | - | - |

^a Data are for women who were not pregnant or in lactational amenorrhoea at the time of measurement in 1987 (based on urinary steroid hormone levels).

^b Reference category: sole wife.

one more offspring who survived to age ten years than did women who had been in polygynous marriages (Table 12.7).

To evaluate the effect size of one extra offspring, it is helpful to consider the mean (\pm SD) number of offspring who survived to age ten years for all women who last gave birth at least ten years prior to their last interview. Lifetime reproductive success calculated in this way is 3.58 ± 1.79 offspring. Thus, one extra surviving offspring for women in monogamous marriages, after

Table 12.7. *Predictors of female reproductive success (offspring survivorship to age ten years) (N = 104 women, R² = 0.14)^a*

| Predictor | Coefficient | SE | P |
|---------------------------------|-------------|-------|-------|
| Mother's year of birth | 0.011 | 0.013 | 0.391 |
| 1st wife ^b | -1.071 | 0.409 | 0.010 |
| 2nd, 3rd, 4th wife ^b | -1.215 | 0.408 | 0.004 |
| Arranged wife ^c | -1.780 | 0.769 | 0.023 |
| Non-arranged wife ^c | -1.670 | 0.759 | 0.030 |
| Intercept | -15.874 | - | - |

^a This analysis uses the Kaplan Meier method as described in Strassmann and Gillespie (2002).

^b Reference category is sole wife. First to fourth wives did not differ significantly from each other.

^c Reference category is levirate wife. Arranged and non-arranged wives did not differ significantly from each other.

adjusting for covariates, represents a substantial gain in reproductive success over that of women in polygynous unions.

The reproductive success of women in arranged marriages did not differ significantly from that of women in non-arranged marriages, but levirate wives had 1.8 more offspring.

DISCUSSION

The human mating system examined here echoes that of polygynous species in general in that variance in reproductive success was greater among males than females. The data support the hypothesis that polygynous WEGs were wealthier than their monogamous counterparts, but there was no evidence for the dilution of wealth under polygyny. *Assuming that all else is equal*, females should prefer wealthier males, but nearly three-quarters of the variance in the number of wives cannot be attributed to wealth differences. Therefore, resource defence provides a partial but not sufficient explanation for Dogon polygyny.

Controlling for age, the Pearson partial correlation coefficient between the wealth rank of a man's WEG and the number of wives he was married to concurrently was 0.38 ($P = 0.001$); cumulatively the coefficient was 0.23 ($P = 0.06$). In a meta analysis, W. Irons (unpublished data), rated the quality of research design for studies

of the Kipsigis, the Mukogodo, and the Mormons as particularly high. These studies are also among the few that report effect sizes for the association between wealth and polygyny and therefore provide a useful basis for comparison. In the Kipsigis, who are agropastoralists of Kenya, the Pearson correlation coefficient between wealth and polygyny in six cohorts of men ranged from 0.13 (n.s.) to 0.91 ($P < 0.001$) per cohort with a mean \pm SD of 0.48 ± 0.26 (Borgerhoff Mulder, 1987). In the Mukogodo pastoralists of Kenya, the partial correlation between livestock wealth and number of wives for all men of six cohorts was 0.41 ($P < 0.001$) and the correlation for individual cohorts ranged from 0.07 (n.s.) to 0.57 ($P < 0.05$) with age controlled (Cronk, 1991). In nineteenth century Mormons of Utah, the partial correlation between wealth and number of wives was 0.17 ($P < 0.006$) to 0.27 ($P < 0.001$) controlling for a man's age and rank (Mealey, 1985). Thus, the partial correlation coefficient of 0.38 between wealth and concurrent wives for the Dogon (controlling for age) is similar to the coefficients for these other three populations.

Returning to the linear regression results, age and wealth explain 28% of the variance in number of wives in the study village. But what explains the remaining 72% of the variance? The answer may be other indicators of male mate value. In a survey of 37 societies, females in every sample ranked 'kind and understanding' and 'intelligent' as more important than earning power (Buss, 1989). Part of the emphasis on wealth in human behavioural ecology may stem from the fact that wealth is more quantifiable.

In the Dogon, it would be interesting to test the role of masked dancing as a male display comparable in function to the peacock's tail or the bowerbird's bower. The house of eight storeys mask could break the dancer's neck and may be a costly signal of male quality. Even more dangerous is the stilt-walker mask, in which the man's legs are lashed to tall sticks. Masked dancing is a performance that is intently watched by the women, who can identify the individual dancers. It is tempting to speculate that the weight and difficulty ratings for individual masks might correlate with the dancer's number of wives or offspring. Doubtless many other male qualities also contribute, perhaps even the indigenous explanation that if a man is to retain multiple wives he will require 'unusual patience'.

The data support the hypothesis that polygynous males had higher reproductive success than

monogamous males. For each extra concurrent wife, a man gained 1.8 extra offspring (after adjusting for age). In contradiction to the notion of equal female reproductive success under monogamy and polygyny (first critiqued by Altmann *et al.*, 1977), females in polygynous unions appeared to incur a cost. This cost was approximately one fewer surviving offspring out of a mean of 3.6 surviving offspring per woman. Consistent with the absence of a hierarchy among co-wives by order of marriage, the cost was approximately the same for first wives and higher order wives. It is possible that the apparent cost of polygyny merely reflects a tendency for lower quality women to enter polygynous marriages, but in that case one would not expect first wives to bear the same fitness cost as second and subsequent wives. Moreover, contrary to my original expectations, I could detect no superiority in the mate quality of women in monogamous versus polygynous unions.

The mean year of birth for monogamously married women was 1950 and that of third and fourth wives was 1964. The finding that polygynously married women were generally younger suggests two hypotheses for future research. One is that the prevalence of polygyny has increased over time, despite the lack of evidence for this between 1988 and 1998. Another hypothesis is that older women were more likely to have lost their former co-wives via death or divorce and their husbands had not succeeded in replacing them.

The ideology that males should marry females younger than themselves, coupled with the population age pyramid, assures that the number of women exceeds the number of men on the marriage market. The result is demographic pressure for polygyny as a male strategy throughout West Africa, despite essentially universal marriage and no major perturbation of the sex ratio (such as warfare) (Dorjahn, 1959; Pison, 1985; Chisholm & Burbank, 1991; Strassmann, 1997*b*, 2000). This male strategy is tempered by a female strategy of combating polygyny through divorce. Among the Dogon, female–female competition is rife in polygynous marriages. When a woman loses a child or fails to conceive, she and her husband frequently blame her co-wife. Distrust of a co-wife was cited by women as the main precipitating factor in 10% of all divorces ($N = 88$ divorces) (Strassmann, 1997*b*, 2000). Thus, female–female antagonism contributes to Dogon monogamy.

Two previous prospective studies help shed light on the reproductive cost of polygyny. The first of these used

the monthly probability of conception as the dependent variable. After controlling for age of each spouse, marital duration, parity, and nursing status, whether a woman was monogamously or polygynously married did not affect her monthly probability of conception (Strassmann & Warner, 1998). Only one woman in the village had primary sterility, and contrary to my expectation, polygynously married women were not less fecund. The second study examined the odds of death for 176 children who were prospectively followed for up to eight years (Strassmann, 1997*b*, 2000). Controlling for age, sex, economic status, and the ratio of children to adults in the family, the odds of death were 4.6-fold higher as the ratio of married women to men in the WEG increased by one extra woman per man ($P < 0.005$). The new analyses presented here suggest that the high child mortality under polygyny translates into lower reproductive success for mothers. I cannot, however, exclude the possibility that women in polygynous unions recoup this fitness cost in the grandoffspring generation through ‘sexy sons’ (Weatherhead & Robertson, 1979; Hartung, 1982; Josephson, 1993).

Rather than being of high genetic quality, as envisioned for birds (Weatherhead & Robertson, 1979), the sons of polygynists might command more material resources. However, sons are in competition for the same limited inheritance of fields, which may explain why polygynous fathers are less likely than monogamous fathers to invest in the health of sons, but are equally likely to invest in daughters (author’s unpublished data). Polygynous males produce a surplus of sons relative to the available resources, whereas daughters marry out of the lineage and therefore do not compete over land. Further data are required before a conclusion can be reached about fitness effects in the grandoffspring generation; nonetheless, many sons of polygynists may be obliged to accept monogamy.

Levirate wives in this study had higher reproductive success than did wives in arranged or non-arranged marriages. A plausible explanation is that widows who have many surviving offspring marry their husband’s brother so as to continue raising them, whereas widows with fewer children are more likely to remarry elsewhere (Strassmann & Gillespie, 2002). Further data are needed, however, on the causes of variance in reproductive success among women.

Several of the factors that have been mentioned in connection with monogamy in other species also

characterize the Dogon. These include extensive male paternal investment, especially through patrilineal inheritance of millet fields, the critical resource for survival and reproduction (Strassmann, 1992, 1997b). Females are dependent on male investment since they do not control critical resources of their own. Females are vulnerable to male coercion, as demonstrated, for example, by female compliance with menstrual taboos imposed by males (Strassmann, 1992, 1996¹). Mate guarding among the Dogon is extreme, and includes excision of the clitoris, whereas in other primates genital mutilation is found only in the context of aggression. However, the above observations characterize the Dogon as an ethnic group. They apply to individuals in both socially monogamous and socially polygynous unions, and thus did not prove helpful for teasing apart these two kinds of marriage in this human society.

CONCLUSION

- 1 Among the Dogon of Sangui, about half of all males and a third of all females were in socially monogamous marriages. As is true for polygynous species, the variance in putative reproductive success was greater among males than females.
- 2 Controlling for age, monogamously married men were significantly poorer, but wealth differences explained only 28% of the variance in the number of concurrent wives. These results agree with other studies of mate choice in humans, which demonstrate that wealth is but one criterion for a desirable spouse. Among the Dogon, it is unclear what aspects of male mate value may account for the remaining 72% of the variance in number of wives. The partial correlation coefficient between wealth and number of wives (0.38, $P = 0.001$) was similar to that of other polygynous societies. Resource defence clearly contributes to polygyny among the Dogon, but further research is needed on other causes.
- 3 Females in monogamous and polygynous marriages did not differ significantly with respect to body mass or fecundity. Thus I found few correlates of monogamous marriage for females. Instead, polygyny is facilitated by the 8-year difference in age at marriage between the sexes. Countervailing pressures for monogamy include female–female antagonism

and the inability of some males to support more than one wife and her offspring.

- 4 For each extra wife that a man married, he gained 1.8 extra offspring, controlling for age. Thus, monogamously married men had lower reproductive success. Wealthier males had higher reproductive success above and beyond the additional wives that they married.
- 5 Monogamously married women had higher reproductive success as measured by offspring survival to age ten years. Compared with women in polygynous marriages, they raised one extra child each. Monogamy is advantageous for females even after controlling for wealth, which may be due to the dilution of paternal investment under polygyny.
- 6 The polygyny threshold model is consistent with the common sense notion that when all else is equal women prefer wealthier men, but the argument that polygyny results from female choice disregards the demonstrable costs of polygyny for female fitness among the Dogon. Moreover, nearly half of women in polygynous marriages were first wives and I learned of no instance of a woman encouraging her husband to marry again. The ideology that age at marriage should be markedly lower for women serves the interests of wealthier, more desirable males because it constrains the options of females, channelling many into polygynous unions. Thus, Dogon polygyny provides an interesting example of how normative beliefs are compatible with the reproductive interests of high status males.
- 7 Conflict exists both within and between the sexes over the optimal mating system; identification of the causes of this conflict is a useful theoretical starting point for understanding monogamy versus polygyny in humans.

Note

- 1 Strassmann, B. I. (1985), *The Ecology of Polygyny among the Dogon*, Grant Proposal to the L. S. B. Leakey Foundation, and (1986), *The Ecology of Polygyny among the Dogon*, US National Science Foundation Grant (BNS-8612291).

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