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Reproductive decisions in the Nama:
coping with risk in an arid environment

by Guy Cowlishaw

This report is split into two Sections. Section 1 briefly outlines the findings of my primary area of research, namely the analysis of reproductive decisions in Nama pastoralists. Section 2 describes the findings of my secondary area of research into cultural phylogenies and cross-cultural analysis. I assume that the reader is familiar with my first- and second-year progress reports, which describe how and why the project has developed in the way that it has since my initial grant application. In particular, my primary focus of risk-coping strategies and their influence on reproductive behavior among Nama women has become the role of kin-support networks, since such networks are acknowledged as playing a primary role in risk reduction in many societies (e.g. Weissner 1982, Cashdan 1985). With respect to the suggested ESRC End of Award Report headings, each Section contains within it the relevant summary *Background*, *Objectives*, *Methods* and *Results*, but due to the need for brevity and the interdisciplinary nature of this study this material has been integrated in the relevant sections (meanwhile, *Activities*, *Outputs* and *Impacts* are all currently in preparation).

1. Reproductive decisions in the Nama

Detailed data were collected on over 300 Nama women and their families living in approximately 200 rural farming (pastoralist) households across the former district of Namaland in southern Namibia during two field trips (in 1996 and 1997). An understanding of contemporary Nama society in Namibia is not possible without knowledge of the history of these communities: I therefore provide a brief account in an Appendix to this report.

1.1. Life history patterns of Nama women

Before examining patterns of reproductive behaviour in contemporary Nama society, it is necessary to describe the basic 'strategy sets' that are available to women. Initially, during childhood, most women attend school (82% of the present sample), although attendance rarely extends beyond primary school (only 24% attended secondary school). Subsequently, at adulthood, women tend to follow one of two life history patterns: a 'domestic' pattern or a 'farming' pattern. In the 'domestic' pattern, the women leave the rural homestead and work as domestics on local commercial farms or in nearby urban centres (54% of women had experienced wage labour during their lifetime, and of these 95% had worked solely as domestics). Although these women might possess a share in the family herd back home, they do not become farmers until they leave wage-employment, an event often precipitated by marriage, retirement or family illness. In the 'farming' pattern, women never enter wage employment (46% of the sample) and remain as farmers their entire lives, although these women usually only become household heads when they marry or when their parents become too frail to manage their own household.

Marriage is monogamous and rarely occurs more than once in a lifetime. In the present sample, 57% of women were married (although 9% of these women were separated/divorced from their spouses and a further 16% were widowed). Only 16% of women who had been divorced or widowed had re-married. The median age of first marriage was 29 years (mean 30.6 ± 0.74), with a range between 15-61 years. Bride price is largely symbolic, if it occurs at all. Across 131 respondents with completed reproductive histories, fertility ranged from 0-18 children born alive. The median family size was seven (with a mean of 6.53 ± 0.35). The age-specific fertility rates are shown in Figure 1. Given the high fertility rates and low marital rates, it is unsurprising to find that many children are born outside of marriage. The absence of a correlation between age and completed family suggests no detectable change in fertility over this century (Spearman's correlation: r=0.11, n=131, p=0.20). Childhood mortality is relatively high, with 5% of children dying in the first month of life, and 11% dying within the first six months.

1.2. Determinants of women's fertility and reproductive success

With this background established, the next step of this analysis is to identify correlates of women's reproductive success.

Measuring women's evolutionary reproductive success

The primary paradigm for the interpretation of human behaviour in this study is that of evolutionary theory. According to this theory, human beings, like all other living organisms, will behave in such a way as to maximize their long-term number of descendants. Since Nama society is a pre-demographic transition society, characterized by high fertility rates and relatively high mortality rates (cf. Borgerhoff Mulder 1998), the number of children a woman gives birth to is likely to be a good correlate for the number of long-term descendants. This assumption was tested and supported in the present population: among Nama women, the number of children born is strongly correlated to the number of grandchildren born (r_s=0.70, n=293, p<0.001) and currently alive (r_s=0.71, n=295, p<0.001). Consequently, through the rest of this analysis, a woman's fertility will be equated with her evolutionary reproductive success.

Correlates of reproductive success among Nama women

To determine what factors influence the reproductive output of Nama women, it is first necessary to control for the effects of age (see Figure 1). For the purposes of this analysis, the median cumulative fertility of women in each 5-year age-class was calculated (note that for post-menopausal women this value is identical to the completed family size). The residual fertility of each woman was then calculated as the deviation from the median fertility for all women of that age-class (this technique follows Mace 1996, except that I have further standardized the residual fertility to possess maximum and minimum values of +1 and -1 in each age-class, to avoid the analysis being weighted by the progressive increase in deviation from the average with increasing age). Patterns of variation in residual fertility were then investigated for their possible determinants (Table 1).

The results indicate that women who are wealthier have more children, a pattern that has also been reported in other African pastoralist populations (Kipsigis: Borgerhoff-Mulder 1989; Gabbra: Mace 1996). Although it might therefore seem surprising that parental and marital wealth do not also show such an effect, evidence indicates that there are strong links

between these variables: parental wealth is strongly correlated with wealth at marriage (p<0.001), and wealth at marriage is strongly correlated with present wealth (p=0.001). Unusually, although not unexpectedly (see above), marriage has no detectable effect on residual fertility, although women who married men who had higher income jobs at marriage tended to experience lower fertility than those who married other men. One possible explanation might be that this is the first sign of a demographic transition taking place, but that it is restricted to this sub-group of women because the transition is being precipitated by Nama-speakers who have had access to higher education and higher income positions in local urban centres and this particular socio-economic profile has been largely restricted to men (see Kaplan et al. 1995, Borgerhoff-Mulder 1998 for discussion of the potential role of competitive labour markets in driving demographic transitions).

The final issue to investigate here is the role of kin support networks in protecting women from environmental and economic risks, that might otherwise lead to a reduction in wealth and fertility. The results of Table 1 suggest that there is no simple relationship between the number of maternal siblings and residual fertility. However, the effects of such networks might only be detectable under certain circumstances. One hypothesis would be that if women are wealthy and/or have large maternal sibling networks then they will be able to reproduce relatively successfully, but that women who have neither may find it difficult to maximize their reproductive output. A comparison of women in these two situations reveals that women who are disadvantaged in this way do indeed show lower fertility rates (Mann-Whitney test: U=1469, p=0.045): Figure 2. In the next section, the ways in which siblings and other kin help one another is investigated.

1.3. Patterns of resource exchange in kin support networks

While kinship and exchange have become major themes in social anthropology (e.g. Parkin 1997), social scientists have developed highly sophisticated methods of social network analysis (e.g. Scott 1991). Recently, efforts have been made to bring together these two research areas (e.g. Schweizer and White 1998), but applications of evolutionary theory to issues of kinship, networks and exchange have been extremely rare. This is surprising given the powerful theories that have been developed in evolutionary biology to explain patterns of cooperation and altruism (especially the theories of 'kin selection' and 'reciprocal altruism').

The data collected in this study, which quantitatively describe patterns of giving and receiving of both food and money between respondents and other individuals, will provide the basis to make a detailed application of such theories to patterns of exchange in Nama society. They will also permit a detailed analysis of the structure of kin support networks, the direction and quantity of flow of resources in these networks, and the determinants of these patterns. However, for the purposes of this report, the primary focus is the mechanism through which kinship networks might influence the reproductive success of Nama women.

The preceding analysis suggests that kin-support networks might play an important role in allowing poor women to achieve rates of reproduction that are equal to those obtained by wealthier women, but that poor women who do not have such networks are unable to do this (cf. Bereczkei 1998, for a similar finding in Hungarian gypsies). To what extent can we establish that this pattern is indeed the result of help given by siblings? A simple analysis of the material resources received by four different categories of relative (sibling, parent, child and foster child) during a woman's reproductive years indicates that across this period she receives significantly more help overall from her siblings than from any

other category (Table 2). Indeed, the help received from siblings is approximately the same as that received from all other types of relative combined. This provides clear evidence of the direct mechanism through which a large cohort of siblings might positively influence a woman's reproductive rates.

1.4. Patterns of child fosterage

The raising of a relative's child is a common facet of kinship support networks in traditional societies around the world. However, child fosterage has received surprisingly little attention from evolutionary anthropologists, especially given the trade-offs likely to exist between raising one's own children and the children of others (indeed, most previous work has focused only on fostering by post-reproductive women, e.g. Hill & Hurtado 1996). In Nama society, women begin fostering children before they cease reproduction themselves, although fostering rates do not peak until after menopause (Figure 1). In total, 56% of the respondents possessed foster children. Women were more likely to raise foster children if they were married and/or were heads of household: only two of 78 respondents (3%) who had foster children were neither. Among those women who fostered, the median number of foster children adopted was 3 (mean of 4.43 ± 0.27) with a range of 1-18). Most foster children are fostered before they are one year old (72%). The reasons for fostering each child given by the respondent were highly variable, but parental marital status appears to be of key importance: in 80% of cases the biological parents of the foster child were unmarried.

A break-down of the relatedness of foster children to foster mothers indicates that more closely related individuals are more frequently fostered and that foster mothers prefer to adopt the children of their female relatives than their male relatives (Table 3). In order to establish that this pattern is not the result of differential availability of children in different relative groups, the number of grand children and sibling's children were calculated and compared to the number that were fostered (Table 4). The results indicate that (1) there is a clear preference for children's children over sibling's children, and (2) within each group, there is a strong preference for the children of female relatives than male relatives. How might these findings be interpreted in evolutionary terms? First, the preference for children's children over sibling's children is likely to reflect the higher coefficient of relatedness among the former (since many siblings are only half-brothers or half-sisters). Second, the preference for the children of female relatives reflects the greater certainty that potential foster mothers have that their investment will be in biological relatives. Bearing in mind that the vast majority of foster children come from unmarried couples, foster mothers may be unwilling to invest in the children of male relatives when those relatives may have little paternity certainty in their children (cf. Hartung 1985).

Does the experience of being fostered reduce reproductive success among Nama women? The overall effect is negligible (see Table 1 above), but analyses for post-menopausal women shows that those who were fostered are likely to have fewer children than those who were not (Mann-Whitney test: U=1056, p=0.05). This effect might not be seen in the full sample because the effect is relatively small and therefore only detectable by the end of a woman's reproductive career. The causes and implications of this pattern are still under analysis, but one possible explanation is that women who are fostered are less likely to grow-up with their siblings, and their kinship networks become substantially reduced during adult life.

1.5. Wealth, fertility and land tenure systems

Although there is little variation in subsistence practices among Nama farmers (Namaland is too arid to permit anything but the grazing of small stock), there are distinct differences in land tenure patterns. Nama farmers who herd livestock in the former white commercial farms of Namaland (the 'Odendaal' farms) can use the extensive fencing systems that exist on this land to control grazing competition from other herders and to rotate grazing for his/her own herd. In contrast, Nama farmers who herd livestock in the former Reserves of Namaland have no access to fencing and therefore cannot implement rotational grazing nor control competitors for grazing. Consequently, the Reserve land is potentially vulnerable to a Tragedy of the Commons.

However, recent comparisons of the agricultural productivity of commercial ranching and traditional pastoralist production systems have indicated that the latter may be considerably more productive (per unit area) than the former (review in Scoones 1995). These findings have stressed that communal land is not necessarily synonymous with an open-access property system, and that communal farmers can develop sophisticated means of managing key grazing areas. The implication of this observation for Namaland farmers is that households herding livestock in the Odendaal farms may not be at such an advantage over those in the Reserve areas after all. Although recent surveys of livestock management practices in communal areas throughout Namibia concluded that indigenous range management systems were no longer functioning, elements of range management skills and systems were found to be widespread (Fuller & Turner 1996). The purpose of this section of the study is to investigate the consequences of the two divergent land tenure systems for household wealth (as a measure of the opportunities and constraints on successful pastoralism in the two land types) and women's reproductive performance in Nama society.

In the first case, there is no evidence that households differ in wealth or herd size between the two land types (Table 5). Indeed, even in terms of household mobility (which we might have expected should be more flexible in the Reserve areas) there is no apparent difference: the dates of arrival of respondents at their present grazing post are similar in both areas (1985 in the Reserves, 1989 in the Odendaal farms: Mann-Whitney test: U=4683, n= 204, p=0.24). Overall, these data suggest that differences in land tenure do not lead to marked differences in household wealth, probably as a reflection of the flexible farming strategies of Nama households.

In the second case, given the absence of wealth differentials between the two land types, we might also expect no difference in women's fertility in the different areas (see above). However, women on Odendaal farms have significantly lower fertility. The other differences in life history and socio-economic conditions associated with women on the Odendaal farms are that they are (1) more likely to be married to men who were on high incomes at the time of marriage, (2) more likely to have been involved in wage employment themselves, and (3) less likely to have attended school. The key result here is likely to be the husband's employment pattern. The influence of Nama men who had high-income employment at the time of marriage on women's reproductive rates has already been discussed (see above), and due to the prominent position such men enjoy in Nama society they are also likely to have greater access to farming posts in the Odendaal farms (which tend to be associated with high-status families). This combination of factors could explain the observed patterns.

2. Phylogenies, culture and human evolution

Evolutionary biologists demonstrate patterns of shared ancestry between populations through phylogenetic trees. Recently, these methods have been used with great success to shed insight into the evolution of human diversity, where the relationships between different human populations have been described using phylogenies based on genetic and linguistic data (Cavalli-Sforza et al. 1994 and Ruhlen 1987, respectively; see also Cavalli-Sforza et al. 1992). Although one problem with such phylogenetic analysis is that they fail to account for 'horizontal transmission' (or 'diffusion'), the spreading of genes and languages between neighbouring populations (phylogenies only consider 'vertical transmission' from one generation to the next), the methods to deal with this problem are still poorly developed (Cavalli-Sforza et al. 1994), making conventional phylogenies the best methods available to examine the evolutionary relationships between populations.

The development of cultural phylogenies is also important for understanding contemporary patterns of human cultural diversity, because cultural practices may reflect shared ancestry rather than adaptation (e.g. Mace and Pagel 1994, 1997). This issue further relates to 'Galton's problem', the statistical non-independence of cultures: e.g. anthropologists interested in whether inheritance and marriage systems are associated might correlate the two in a cross-cultural analysis, but different cultures cannot be treated as statistically independent because they are differentially related to one another. With a knowledge of their historical relationships, these problems can be overcome through techniques developed by evolutionary biologists (Harvey & Pagel 1991).

The purpose of this Section is twofold: (1) to investigate the patterns of evolutionary history between human populations that are obtained through phylogeny construction based on a novel dataset that does not include either genetic or linguistic data (Section 2.1) and (2) to use the phylogenetic comparative method to investigate the extent to which the findings of the present field study of Nama risk-coping strategies might be extended to other cultures across Africa (Section 2.2).

2.1. A cultural phylogeny of the world Standard Cross-Cultural Sample

To evaluate the historical relationships between human societies independently of genetic or linguistic data requires a novel database. The World Ethnographic Sample (WES) constitutes such a database. The WES, previously published as the *Ethnographic Atlas* (Murdock 1967), provides summary codes for variation in a range of cultural features for over 800 societies worldwide (where each code is drawn from detailed ethnographies). For the purposes of this study, the size of the database was reduced to make it more manageable for phylogenetic analysis. The identity of the societies chosen for phylogeny construction was based on the Standard Cross-Cultural Sample, SCCS (Murdock & White 1980): a set of 186 societies that constitute a representative selection of the world's cultural diversity (that has formed the basis of cross-cultural analysis in anthropology over the last two decades).

In total, 47 cultural traits for each society were included in the analysis (linguistic traits were excluded, while genetic traits do not exist in this dataset); these traits are further subdivided to produce 85 traits, or 'characters', in all. The identity of these characters, which can be grouped into six broad groups (following Guglielmino et al. 1995), are listed in Table 6. These characters were used in a procedure called 'parsimony analysis' to construct an Adams semi-strict consensus tree of the 186 societies. Parsimony analysis was

specifically chosen because its underlying assumptions are best suited to cultural evolution. Namely, it is a tree-building technique which assumes that dramatic changes in cultural behaviour are intrinsically unlikely events (i.e. the data are best explained by that model which minimises the number of evolutionary steps between two or more lineages). In this analysis, 100 trees were constructed, and the shortest tree obtained required 3965 steps to build.

The structure of this tree establishes a working hypothesis for the historical relationships between the world's different cultures (that is not dependent on linguistic or genetic patterns). This structure will be compared to the structures of the genetic and linguistic trees below. First, however, it is informative to examine which cultural characters show the greatest variability on the tree. The retention index r of a character, which ranges between 0-1, reflects the extent to which the character is retained on a tree once it has evolved (e.g. Quicke 1993): characters which score close to one tend to be retained by descendent cultures. The distribution of values of r for the 85 characters in this tree (Table 6) indicates that high retention ($r>0.70$) is associated with agricultural practices ($r =0.72$), animal husbandry practices ($r =0.70$, 0.74 and 0.82). and in specialisations in metal working ($r =0.86$, 0.86). In contrast, low indices ($r <0.30$) tend to be associated with characters under the headings of 'family and kinship' (25% of all characters) and 'various' (50% of characters) (note that indices of 0 are discounted here, since 0 values indicate there is no variation in the character in question). Overall, there are significant differences in the distribution of non-zero retention indices across character groups (one-way ANOVA: $F_{5,72}=7.37$, $p<0.001$) (ANOVA is used here since the distribution of retention indices does not differ from normal: Lilliefors tests $p>0.05$ in each group). Post-hoc Bonferroni tests show that both Economy and Labour character groups possess consistently higher mean retention indices than the other groups (0.56 and 0.57 respectively, compared to a range of 0.35-0.38 in the other four characters).

These results suggest that developments in subsistence and technology are rarely lost once acquired. This finding is consistent with archaeological and historical evidence for innovations in agriculture, animal husbandry and metal working as the driving force behind the dramatic spread of certain human populations, e.g. the Bantu expansion across Africa (e.g. Shillington 1989; for a recent popular review on a global scale, see Diamond 1997).

Comparison of phylogenies constructed from cultural and genetic similarity
Since the cultural tree constructed in this study consists of 186 world populations, and the existing genetic tree consists of only 48 world populations, the first step in this comparison was the collapsing of adjacent branches on the cultural tree to match those on the genetic tree (e.g. the 22 North Amerind societies on the cultural tree were collapsed as far as possible to match them with the single branch for the North Amerinds on the genetic tree). The primary clades of this tree (Figure 3) were then compared with those of the genetic tree (Cavalli-Sforza et al. 1994), where primary clades were defined as those that were three branching points (nodes) away from the root. On the genetic tree, this resulted in four clades: an African clade, a west Asian clade, an east Asian clade (that includes the Amerindians), and a southeast Asian clade (including Australasians). In contrast, even at this extremely crude level, the three primary clades of the cultural phylogeny show no consistent grouping. Although the first clade is predominantly North Amerind, and the

African groups are largely limited to the second clade, there is an enormous amount of variability that leads to some genetic groups containing representatives in all three cultural clades (e.g. the South Amerinds). The distribution of societies across the primary clades of both trees is detailed in Table 7.

The results of this comparison indicate that cultural characters may be unreliable indicators of the evolutionary history of human cultures. Perhaps the most likely explanation for this failure is that cultural characters evolve much more rapidly than genetic characters. Indeed, this has been one of the problems that has bedevilled attempts to look at ancient linguistic evolution: while it has been possible to trace recent historical relationships between societies using linguistic similarity, the deeper connections between the major language groups, e.g. the Nilo-Saharans, the Niger-Kordofanians and the Khoisan in Africa, have remained ambiguous (Ruhlen 1987). This suggests that phylogenetic trees built on cultural characters might shed more light on patterns of recent evolution: this possibility is investigated below.

Comparison of phylogenies constructed from cultural and linguistic similarity
Do trees constructed on the basis of cultural and linguistic similarity show similar patterns, and can the former help to resolve the large number of polytomies (multiple branches from a single node) on the latter (polytomies normally reflect a lack of resolution in the phylogenetic data)?   Ruhlen's (1987) linguistic tree, developed on evolutionary principles (but by subjective assessment) tends to provide a great deal of detail towards the tips of the tree, but less detail towards the root. To investigate whether the cultural tree does show similarity to the linguistic tree, a sample clade of African societies from both sources was compared (Figure 4).

Surprisingly, even at this scale, the differences between the two trees are marked: the clade from the cultural tree contains mostly Niger-Kordofanian speaking-groups but also includes four societies from two completely different language families. Moreover, even within the Niger-Kordofanian societies the pattern of relationships proposed on the basis of linguistic similarity are quite different from those based on cultural similarity. One possible explanation of this is the confounding effects of horizontal transmission: perhaps the position of societies on the cultural tree is more strongly influenced by current geographic neighbours than by historical ancestors. This is particularly feasible given that language might be expected to evolve according to a neutral mutation rate (e.g. Mace & Pagel 1994), while cultural traits should be under stronger natural selection, such that neighbouring societies will share similar adaptive responses to their environment.

To investigate this possibility, the latitude and longitude of each society was compared, with the expectation that societies on the cultural tree would tend to be in closer geographic proximity to their neighbours than those on the linguistic tree. In fact, the reverse tends to be the case (Figure 4), e.g. societies on the neighbouring branches to Ashanti, Suku and Bemba tend to be much closer geographically to these societies on the linguistic tree. This raises the interesting possibility that the relative importance of horizontal transmission to vertical transmission in cultural evolution is more important for languages than supposed previously.

In conclusion, the cultural tree fails to identify the distinct clades that are identified by genetic, morphological and linguistic analyses. This indicates that more research is required into the reliability of cultural phylogenetic trees before they can be used as valid models for

the historical relationships between human societies. Nonetheless, the current evidence suggests that cultural phylogenies might make an important contribution to our understanding of both (1) the historical relationships between societies that have a recent shared evolutionary history and (2) the way in which closely related societies are shaped by both the inheritance of cultural patterns from ancestors and the diffusion of cultural patterns from neighbours.

2.2. Cross-cultural analysis of a risk-coping strategy

The purpose of this Section is to use a phylogenetically-based cross-cultural analysis to investigate the extent to which one of the primary risk-coping strategies of the Nama farmers in this study, namely the use of kin support systems as protection against risk and poverty, might also be adopted by other societies in Africa. Although one previous cross-cultural study has already been conducted of cultural responses to risk (Low 1990), that analysis did not investigate this issue, nor did it take into account the confounding effects of shared evolutionary history among societies.

For this analysis, the importance of kin support systems in survival and reproduction was considered to increase with the degree of co-residence between kin (since this reflects the accessibility of kin helpers). Accordingly, if kin support systems are an important coping strategy in response to risk, the degree of co-residence among kin should increase in more uncertain environments. Analysis of the available data for patterns of kin co-residence (i.e. family organisation) and environmental variability (i.e. latitude) in societies in the *Ethnographic Atlas* (see Table 8 for methodology) indicates that this is precisely this pattern that exists across sub-Saharan Africa (Spearman correlation: r_s=0.17, n=408, p=0.001) and across Africa as a whole (r_s=0.11, n=517, p=0.01). Moreover, if kin support systems are a generalised response to risk, then this pattern should be independent of other cultural factors such as subsistence practice, settlement pattern, community size, societal complexity and environment type (tropical or non-tropical): once again, this is the pattern observed (Table 8).

The association between co-residence of kin and environmental variability appears to be a robust one. However, there are two problems here: (1) simple correlations across societies are confounded by shared ancestry (see Figure 5), and (2) latitude is a crude measure of unpredictability. The simplest procedure for controlling for shared ancestry is to conduct a series of comparisons between pairs of sister societies that vary in the characters of interest. In order to identify these pairs, it was first necessary to establish the evolutionary relationships between the societies used above. Character values were then mapped on to those societies that could be placed on this phylogeny, and sister taxa with different values were identified (these pairs are listed in Table 9). To deal with the second problem, data on local rainfall patterns were also collected and coefficients of variation calculated (a standard measure of environmental risk: see Table 9).

Analysis of differences between these pairs indicates that there remains a strong tendency for societies that experience either an increase in latitude or an increase in rainfall variability to be more likely to exhibit extensive patterns of kin co-residence. The pattern is statistically significant for both latitude (Kolmogorov -Smirnov one-sample test: Z=2.29, p<0.001) and rainfall variability (Z=1.43, p=0.03). In conclusion, then, the available data suggest that the risk-coping strategy of participation in kin support systems may be a common response to environmental uncertainty in traditional societies across Africa.

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Table 1. Correlates of residual female fertility (reproductive success). The influence of ordinal and continuous variables on residual fertility is investigated using Spearman rank-correlation tests (r_s), the influence of categorical variables is investigated using Mann-Whitney tests (W).

Potential correlates of residual female fertility	r_s, W	n
No of maternal sibs living to adulthood[1]	-0.03	287
Husbands' employment at marriage[2]	-0.17*	149
Family (parental) wealth[3]	0.43	269
Marital wealth[3]	-0.16	155
Present wealth[3]	0.15**	295
Small stock[3]	0.13*	295
Is residual fertility higher or lower in women who:		
are fostered	no difference	287
are heads of household	no difference	295
attended school	no difference	289
attended secondary school	no difference	289
entered wage employment	no difference	287
married	no difference	295

*p<0.05, **p<0.01 (two-tailed)

[1] Includes only those siblings who share the same mother (although similar results were obtained with all sibs and half-sibs).

[2] Husband's wage employment at the time of marriage (retirement often occurred at marriage, when husband and wife returned to live in the rural communities of Namaland) was graded on a four point scale: 0 = no wage employment, 1 = part-time wage employment, 2 = low income earner (e.g. farm labourer), 3 = middle income earner (e.g. mechanic), 4 = high income earner (e.g. teacher).

[3] Wealth is notoriously difficult to measure. In this study, a variety of different measures of wealth were generated and independently tested to ascertain their validity. Present wealth is based on the livestock per capita in the household, weighted by the household's major income and expenditure; this accurately predicts several other aspects of household wealth, such as the number of children of school going-age who are not attending school. Since the absolute number of small stock is also correlated with present wealth, this might also be considered an index of wealth. Since data were collected on the livestock owned by both (1) the respondent's family at maidenhood and (2) the respondent and her husband at marriage, this has allowed the calculation of historical family (parental) wealth and marital wealth.

Table 2. Differential support received from siblings, parents, children and foster-children by respondents of reproductive age (15-49 years). Data are mean rank values[1] across respondents.

Relative	Total food received	Total cash received	Total aid received	Number of respondents
siblings	3.46 ± 0.54	2.94 ± 0.50	6.40 ± 1.00	80
parents	0.77 ± 0.21	0.60 ± 0.18	1.36 ± 0.36	47
children	2.04 ± 0.57	1.62 ± 0.55	3.65 ± 1.09	25
foster-children	0.43 ± 0.30	0.71 ± 0.36	1.14 ± 0.59	7

[1]According to the ranking system used during data collection, a score of zero is equivalent to no helping, a score of one is equivalent to a single relative helping but only in times of need, and scores of two and three are equivalent to one relative helping at all times, but uncommonly or commonly respectively. Scores were collected separately for food received and cash received. The points scored in this system are additive across living relatives and, in the case of total aid received, across aid type (i.e. food and cash are combined).

Table 3. Patterns of relatedness between foster children and foster mothers. The coefficient of relatedness is a standard measure of genetic relatedness employed by evolutionary biologists (after Hamilton 1964).

relative type		coefficient of relatedness to foster child[1]	number in sample	proportion of all foster children
biological relatives				
daughter's daughter	dd	0.25	146	0.20
daughter's son	ds	0.25	153	0.21
son's son	ss	0.25	50	0.07
son's daughter	sd	0.25	37	0.05
sister's daughter	zd	0.125-0.25	39	0.05
sister's son	zs	0.125-0.25	30	0.04
sister's daughter's daughter	zdd	0.0625-0.125	18	0.02
sister's daughter's son	zds	0.0625-0.125	14	0.02
other relatives			<12 each	0.17 total
unrelated individuals				
husband's children		0.00	81	0.11
partner's children		0.00	9	0.01
other unrelated children		0.00	43	0.06

[1]Note that the coefficient of relatedness varies for collateral descendants (in this case, sister's descendants) because many families include half-siblings (as a result of the frequent births that occur outside marriage: see above).

Table 4. The pattern of fostering among Nama women by child availability.

relationship of child's parent to respondent	proportion of relative's children fostered:	
	potential foster sons alive % (fostered/available)	potential foster daughters alive % (fostered/available)
sons	0.18 (50/284)	0.14 (37/269)
daughters	0.36 (153/428)	0.35 (146/412)
brothers	0.01 (8/877)	0.01 (9/853)
sisters	0.03 (30/1114)	0.03 (39/1142)

Table 5. The influence of land tenure system on women's residual fertility and other aspects of Nama life histories and socio-economic conditions. Mean values and standard errors shown, or % of cases where data are given in a yes-no format. See Table 1 for further explanation of categories.

Variable	Land tenure system	
	Farmland	Reserve
Residual fertility	-0.18 ± 0.05**	0.03 ± 0.04
No of maternal sibs living to adulthood	6 ± 0	6 ± 0
Husbands' employment at marriage	1.3 ± 0.1**	0.7 ± 0.1
Family (parental) wealth	218 ± 22	246 ± 32
Marital wealth	134 ± 33	60 ± 12
Present wealth	22 ± 3	24 ± 6
Small stock	112 ± 12	121 ± 27
% of women who:		
are fostered	24%	22%
are heads of household	72%	70%
attended school	77%*	88%
attended secondary school	24%	25%
entered wage employment	62%**	47%
married	55%	60%

*$p<0.05$, **$p<0.01$ two-tailed (Mann-Whitney tests or X^2 tests [% frequencies]). Sample sizes are >260 in all cases, except for husband's employment at marriage and marital wealth (n~150 in both cases).

Table 6. Retention indices, *r*, of characters in the SCCS tree. Characters with retention indices >0.70 are highlighted in bold.

Main grouping	character name	number of character states	*r*
Family and kinship			
Mode of marriage	primary	7	0.34
	alternative	6	0.11
Family organization	domestic organization	8	0.37
	marital composition	7	0.34
Marital residence	with kin, first years	5	0.17
	transfer after first years	4	0.49
	with kin, after first years	10	0.56
	with kin, alternate form	4	0.28
	transfer after first years, alternate form	8	0.26
Community organization	all societies	6	0.31
	clan societies	3	0.26
Matrilineal kin groups and exogamy	largest patrilineal kin group	5	0.42
	largest patrilineal exogamous group	3	0
Matrilineal kin groups and exogamy	largest matrilineal kin group	6	0.17
	largest matrilineal exogamous group	3	0
Cognatic kin groups	all societies	6	0.52
	kindreds and ramages	3	0
Cousin marriage	cousin marriages allowed	10	0.48
	subtypes of cousin marriages	8	0.50
	preferred cousin marriages	12	0.33
	preferred subtypes of cousin marriages	6	0.37
Kinship terms for cousins	all societies	8	0.36
Succession to the office of local headman	all societies	3	0.51
	type of hereditary succession	8	0.28
Inheritance of real property	inheritance rules	7	0.64
	inheritance distribution	5	0.61
Inheritance of movable property	inheritance rules	7	0.45
	inheritance distribution	5	0.44
Economy			
Subsistence economy: gathering	all societies	8	0.40
Subsistence economy: hunting	all societies	10	0.47
Subsistence economy: fishing	all societies	10	0.40
Subsistence economy: animal husbandry	all societies	10	0.56
Subsistence economy: agriculture	all societies	10	0.52
Type and intensity of agriculture	cultivation type	6	**0.72**
	crop type	4	0.65
Settlement pattern	all societies	8	0.39
Type of animal husbandry	plow cultivation	3	0.61
	type of animal husbandry	7	**0.74**
	milking of domestic animals	2	**0.70**

Social stratification

Mean size of local communities	all societies	8	0.38
Jurisdictional hierarchy	hierarchy within the local community	3	0.35
	hierarchy above the local community	5	0.40
Class stratification	primary	2	0
	secondary feature	5	0.45
Caste stratification	primary	5	0.13
	secondary feature	4	0.25
Slavery	type of slavery	3	0
	past slavery	4	0.48

Labour patterns

Metal working	sex differences	5	**0.86**
	age or occupational specialisation	2	**0.86**
Weaving	sex differences	7	0.35
	age or occupational specialisation	2	0.61
Leather working	sex differences	7	0.64
	age or occupational specialisation	2	0.68
Pottery	sex differences	9	0.54
	age or occupational specialisation	2	0.62
Boat building	sex differences	6	0.51
	age or occupational specialisation	2	0.60
House construction	sex differences	7	0.26
	age or occupational specialisation	1	0
Gathering	sex differences	8	0.49
	age or occupational specialisation	2	0.61
Hunting	sex differences	3	0.42
	age or occupational specialisation	2	0.42
Fishing	sex differences	8	0.46
	age or occupational specialisation	2	0.59
Animal husbandry	sex differences	8	0.48
	age or occupational specialisation	2	**0.82**
Agriculture	sex differences	7	0.55

House

Ground plan of dwelling	prevailing type	5	0.44
	secondary or alternate type	5	0.35
Floor level	prevailing type	4	0.25
	secondary or alternate type	4	0.43
Wall material	prevailing type	9	0.43
	secondary or alternate type	8	0.52
Shape of roof	prevailing type	9	0.41
	secondary or alternate type	7	0.37
Roofing material	prevailing type	10	0.32
	secondary or alternate type	9	0.29

Various

High gods	all societies	4	0.46
Types of games	all societies	6	0.55
Post-partum sex taboos	all societies	6	0.25
Male genital mutilations	all societies	9	0.25
Segregation of adolescent boys	all societies	5	0.24
Norms of premarital sex behaviour	all societies	6	0.33

Table 7. The distribution of societies (defined following Cavalli-Sforza et al. 1994) in the primary clades on both the cultural tree and the genetic tree. On the cultural tree, two societies appeared on solitary branches among these primary clades: the Yurak Semoy and the Toda: these are not included in the totals below. Similarly, those societies on the cultural tree that could not be equated with genetic groups (e.g. several Asian groups) are not shown. Note that in some cases there are no corresponding cultures to genetic populations in this sample (e.g. Ethiopians).

Society	Distribution of societies among primary clades						
	Cultural tree			Genetic tree			
	1	2	3	1	2	3	4
Mbuti pygmy	1	0	0	1	0	0	0
West African	0	8	0	1	0	0	0
Bantu	0	14	0	1	0	0	0
Nilosaharan	0	7	0	1	0	0	0
San (Bushmen)	1	0	0	1	0	0	0
Ethiopian	0	0	0	1	0	0	0
Berber	0	2	0	0	0	1	0
Southwest Asian	0	3	0	0	0	1	0
Iranian	0	2	0	0	0	1	0
European	0	3	0	0	0	1	0
Sardinian	0	0	0	0	0	1	0
Indian	1	2	0	0	0	1	0
Southeast Indian	0	0	1	0	0	1	0
Lapp	1	0	0	0	0	1	0
Samoyed	0	0	0	0	0	0	1
Mongol	0	1	0	0	0	0	1
Tibetan	0	0	0	0	0	0	1
Korean	0	1	0	0	0	0	1
Japanese	0	1	0	0	0	0	1
Ainu	1	0	0	0	0	0	1
North Turkic	0	2	0	0	0	0	1
Eskimo	2	0	0	0	0	0	1
Chukchi	1	0	0	0	0	0	1
South Amerind	6	7	12	0	0	0	1
Central Amerind	0	6	1	0	0	0	1
North Amerind	21	1	0	0	0	0	1
Northwest Amerind	6	0	0	0	0	0	1
South Chinese	0	1	0	0	1	0	0
Mon Khmer	1	3	0	0	1	0	0
Thai	0	1	0	0	1	0	0
Indonesian	0	6	0	0	1	0	0
Malaysian	0	0	0	0	1	0	0
Filipino	0	0	0	0	1	0	0
Polynesian	0	2	2	0	1	0	0
Micronesian	0	6	0	0	1	0	0
Melanesian	0	6	1	0	1	0	0
New Guinean	0	2	2	0	1	0	0

Australian	2	0	0		0	1	0	0

Table 8. Correlations between an index of environmental variability (latitude: a determinant of seasonality) and the accessibility of kin support in African societies. The accessibility of kin support is graded on a scale of 1-4, describing the degree of co-residence of kin from nuclear families with no co-residence (grade 1) to large extended families in dwellings that embrace 'the families of procreation of at least two siblings or cousins in each of at least two adjacent generations' (grade 4). All data used in this table is taken from the expanded electronic version of the *Ethnographic Atlas* (kin residence patterns are derived from the codes for 'Family Organization'), with data drawn from ethnographies written since 1900 only (although similar results are obtained using the full sample).

Classification[1]	Spearman correlation tests		
	r_s	n	p[2]
Subsistence practice			
pastoralists	0.15	155	0.07
agriculturalists	0.17	430	<0.001
Settlement pattern			
nomadic communities	0.19	153	0.01
permanent communities	0.12	280	0.04
Community size			
small communities	0.09	343	0.09
large communities	0.21	84	0.05
Societal complexity			
simple society structure	0.17	288	0.004
complex society structure	0.13	131	0.14
Environment type			
tropical and sub-tropical	0.30	70	0.01
arid and temperate	0.11	393	0.04

[1]Definition of classes (with reference to *Ethnographic Atlas* codes):
Subsistence practice (Atlas code: subsistence economy): pastoralists (>25% dependence subsistence on animal husbandry), agriculturalists (>25% dependence on agriculture); similar positive correlations were obtained for fishing communities (r_s=0.10, n=32) and hunter-gatherers (r_s =0.13, n=13).
Settlement pattern (Atlas code: settlement pattern): nomadic communities (includes semi-nomadic and semi-sedentary groups), permanent communities (dispersed permanent homesteads to complex settlements such as towns).
Community size (Atlas code: community size): small communities (<100 people), large communities (from 100 to >50,000 people in cities).
Societal complexity (Atlas code: jurisdictional hierarchy, above the community): simple societies (0-1 jurisdictional levels, e.g. chiefdoms), complex societies (2-4 jurisdictional levels, e.g. states).
Environment type (Atlas code: not in Atlas): tropical and sub-tropical, or arid and temperate.
[2]P-values are two-tailed.

Table 9. Contrasts between societies that control for shared cultural ancestry (see also Figure 1). Sister societies were considered to differ in the accessibility of kin support if they did or did not exhibit extensive kin co-residence (i.e. large extended families).

Language family and society comparison[1]	Difference in latitude	Increase in coefficient of variation in rainfall[2]	Does kin support become more accessible?
Afro-Asiatic			
Amhara - Gurage	+5	1.48	yes
Guanche - Tuareg	+5	1.19	yes
Riff - Mzab	+2	1.23	yes
Tera - Gude	+1	1.35	yes
Nilo-Saharan			
Kanembu - Kanuri	+2	1.38	yes
Dinka - Nuer	+1	1.06	yes
Karomojang - Teso	+1	1.00	yes
Madi - Mangbeta	+1	1.46	yes
Niger-Kordofanian			
Soninke - Bozo	+1	1.21	no
Bambara - Mende	+5	2.12	yes
Wolof - Serer	+1	1.17	no
Diola - Temne	+4	1.25	yes
Dogon - Bete	+9	2.98	yes
Baule - Ashanti	+1	1.12	yes
Bini - Isoko	+1	1.07	no
Reshe - Anaguta	+1	0.87	no
Tiv - Bamun	+1	1.10	yes
Venda - Shona	+4	0.28	yes
Tsonga - Ndebele	+4	0.75	yes

[1]Sister societies were identified using the linguistic phylogeny (rather than the cultural phylogeny developed in the previous section) since (1) this tree currently remains the most widely accepted model of historical relationships between closely related societies, and (2) one of the characters used to construct the cultural phylogeny was a character also used here: family organization (see Table 2.1). The four transitions that occurred between high to low accessibility of kin in the absence of changes in latitude are not shown here. All available societies were included in this analysis.

[2]Coefficients of variation in rainfall were based on monthly rainfall values in the same region as the society: data from local weather stations were taken from Meteorological Office (1983) and matched with societies using latitude-longitude coordinates. The figures for changes in rainfall variability listed here are the proportional increases in the coefficients of variation in rainfall from the lower latitude to the higher latitude in each pair.

Figure Legends:

Figure 1. Age-specific rates of fertility (children born alive: filled circles) and fostering (children adopted into the household: open circles). Rates are given as means with standard errors, calculated as the number of birth/fostering events per annum per woman across 14 5-year age classes, beginning with 15-19 years (class 1) and ending at 80-84 years (class 14). Sample sizes are >100 in for all pre-menopausal women. From age class 12 onwards sample sizes fall below 15.

Figure 2. Residual fertility (means, standard errors and sample sizes) for women with (1) above average wealth and above average numbers of maternal siblings (++), (2) above average wealth but below average numbers of maternal siblings (+-), (3) below average wealth but above average numbers of maternal siblings (-+), and (4) below average wealth and below average numbers of maternal siblings (--).

Figure 3. An Adams semi-strict consensus tree of the 186 cultures of the Standard Cross-Cultural Sample (SCCS). Where adjacent societies were members of the same genetic group (as defined by Cavalli-Sforza et al. 1994), these societies have been collapsed into a single branch. Where this has occurred, the branch is labelled with an abbreviation of the genetic group, and the number of societies that are included from the SCCS on that branch is given in parentheses. The remaining societies are shown by name, together with the abbreviation for the genetic group. SCCS societies that could not be matched to genetic groups are not shown. The abbreviations are as follows: Ain (Ainu), Aus (Australia), Ban (Bantu), Ber (Berber), CAm (Central Amerind), Chu (Chukchi), Esk (Eskimo), Eur (European), Ind (Indian), Ino (Indonesian), Ira Iranian), Jap (Japanese), Kor (Korean), Lap (Lapp), Mbu (Mbuti Pygmy), Mel (Melanesian), Mic (Micronesian), Mon (Mongol), M-K (Mon Khmer), NAm (North Amerind), NiS (Nilosaharan), N-W (Northwest Amerind), N-G (New Guinean), N-T (North Turkic), Pol (Polynesian), Sam (Samoy), SAm (South Amerind), San (San Bushmen), SCh (South Chinese), SEI (Southeast Indian), SWA (Southwest Asian), Tha (Thai), WAf (West African).

Figure 4. The relationships between a selection of African societies in a clade from the cultural phylogeny (below) and the relationships between the same Niger-Kordofanian societies on the linguistic phylogeny (above). Note that the cultural tree also contains two Nilo-Saharan speaking groups (shaded grey) and two Afro-Asiatic groups (shaded black). These do not appear on the Niger-Kordofanian tree because they are grouped by linguists into two different language families. The figures in parentheses after the society names describe their geographic locations by latitude and longitude (negative numbers reflects societies south of the equator and west of the meridian line, respectively).

Figure 5. The pattern of extensive kin co-residence (i.e. large extended families: dark shading) and reduced kin co-residence (unshaded) across the Nilo-Saharan societies that were coded for both family organization and latitude in the *Ethnographic Atlas* and which could be placed on the linguistic phylogeny. The figure illustrates that a standard cross-cultural analysis would erroneously count six independent cases of extensive kin co-

residence when there only appear to be five independent instances of the evolution of this behaviour (Lagbara and Madi appear to have inherited this practice from a common ancestor). The number of independent cases of minimal kin co-residence would also be overestimated.

Appendix

The following account is a synthesis of the history of the Nama people that highlights key areas of importance for understanding the context and findings of present study (for further information, see Nurse et al. 1985, Lau 1987, Barnard 1992, Omer-Cooper 1994 and Boonzaier et al. 1996).

The Namas, or Khoikhoi (previously 'hottentots'), are traditionally a pastoralist people that was once widespread throughout southern Africa. In Namibia in the late 1700s, several distinct Nama tribes (collectively called the Gai-Naman) were scattered throughout the country. They possessed vast herds of cattle, worshipped traditional deities, and practiced bride price and polygyny. However, this traditional system came to an end with the arrival of the Oorlam-Namas (or ≠Kham-Naman) in the early 1800s. The Oorlams were bands of predominantly Nama people who had been drawn into early Cape Society: they carried firearms and rode horses, spoke fluent Dutch, and were Christian. They fled the Cape, where their people were oppressed, and travelled northwards across the Orange River into Namibia. The Oorlams came to dominate the socio-political scene in Namibia for the next 50 years, during which time the traditional way of life of the Gai-Naman vanished as they quickly adopted the new cultures of the Oorlams (which they had already had some previous exposure to from local missionaries, traders and explorers).

Germany declared a protectorate in Namibia in 1884: the Namas (now comprising a mixture of Gai-Naman and ≠Kham-Naman) resisted German rule between 1890-1894 and again between 1904-1907. The result of these conflicts, in addition to the earlier hostilities the Nama had experienced with Herero pastoralists (prior to the arrival of German forces), was the exhaustion of Nama society. However, at the time of its victory over the Nama, Germany had fewer than 10 years left in power in Namibia.

Namibia came under South African rule during the First World War. Following its confiscation from the Germans, the League of Nations asked South Africa to administer the territory under a Class C Mandate. However, the systems established in South Africa for the white exploitation of black labour were quickly extended into the country, with an ease facilitated by the earlier subjugation imposed by the German forces. Of particular importance to the indigenous Nama pastoralists was the rapid colonisation of the country by South African farmers. Land that was traditionally used for seasonal grazing became inaccessible as fences appeared and multiplied during the 1930s and 1940s, and the pastoralists became increasingly restricted to the Native Reserves, which were overcrowded and situated in areas of poor farming potential. Inevitably, living under such conditions and without the ability to follow the rains with their livestock to find fresh grazing, the sizes of the Nama herds plummeted and their households became increasingly dependent on finding wage labour outside the Reserves to survive (see Silvester 1998). The Reserves became pools of cheap black labour.

In 1962/3, the Odendaal Plan implemented South Africa's policy of 'separate development' in Namibia, in which a separate 'homeland' was established for each of the main cultural groups in the country. Namaland, the area set aside for the Namas, was an amalgamation of several previous Native Reserves dominated by Nama people (primarily the Berseba and Tses Reserves) plus an area of surrounding white commercial farmland of approximately the same area again (the white farmers were bought-out by the South African government under favourable terms, and subsequently redistributed such that several Nama

families typically occupied a single farm). Since independence in 1990, the 'homelands' of Namibia have officially ceased to exist and Namaland now falls into three new magisterial districts that also administer white farmland; however, the reclassification of administrative borders on paper has had no discernible effect on the livelihoods of the Nama farmers who eke out a living in this region.

Namaland consists of 21,450km^2 of arid rolling plains, rocky hills and steep ravines. The rivers and pans that punctuate this landscape are ephemeral. Rainfall is extremely low and unpredictable, with an average of 100-200mm but an annual coefficient of variation of 40-60%. The human population is sparse (below one person per square kilometer), and the subsistence economy revolves around small stock farming. The majority of people are Namas (86%), although there is also a substantial Coloured community (12%). [The Coloureds, an Afrikaans-speaking people, are a distinct cultural group which has developed from the mixed descendants of Nama-European unions in the early years of the Cape Colony].