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Man the Hunted: Determinants of Household Spacing in Desert and Tropical Foraging Societies

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Controlled comparisons of ethnographic Western Desert Australian Aborigine and !Kung San campsites reveal significant differences in mean distances between households as well as differences in campsite areas based on nearest neighbor analysis. In terms of campsite areas in m^2/person, the Aborigines space themselves over areas many times greater than the !Kung. A review of alternative hypotheses to account for these differences supports a combination of kin-ties and larger campsite areas/person to explain the variance, while the gross overall differences in spacing households are structured primarily by the relative effects of predation pressure, which is inversely proportional to both mean distances between households and campsite areas in m^2/person. Some trial comparisons with other ethnographic cases are offered, along with test implications for archaeology.

INTRODUCTION

The distances at which household units physically space themselves within a larger social grouping are neither random nor invariate from society to society. Simple statistical measures demonstrate that significant differences exist in mean distance between units. These differences reflect the existence of culture-specific norms. For example, analysis of Yellen's (1977) data show that for single-occupation !Kung hunter–gatherer campsites the mean distance between household hearths equals 7.77 m (S = 4.77). By contrast, a series of Western Desert Aborigine campsites mapped by Gould in 1966–1970 yields a comparable measure of 36.7

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m (S = 24.9). While such differences are easy to document, underlying causation is more difficult to establish, and in all such comparisons, larger sample sizes facilitate analysis. However, a growing body of ethnoarchaeological data accumulated over the last two decades now allows anthropologists to move beyond single case studies and approach this, and similar questions in a more controlled, comparative manner.

We define a "household" as a minimal social grouping: individuals who live together and most often form a discrete economic unit. In our sample the household usually coincides with the nuclear family, but this is neither necessarily nor invariably so. Study of household spacing is of interest for two reasons. First, we believe it provides an insight into and simple measure of complex behaviors which are either impossible or extremely difficult to observe directly and thus may provide a valuable ethnographic tool. Second, information on household spacing is preserved in the archeological record, and such a measure can provide new insights into prehistoric behavior.

MAN THE HUNTER—THE EVOLUTION OF A STEREOTYPE

Increasingly controlled and empirical research on ethnographic hunter–gatherer societies since the mid-1960s have presented archaeologists with a paradox that is matched by studies in the arachaeology of early hominids and later hunter–gatherers. Evidence amassed since the seminal *Man the Hunter* Conference of 1966 (Lee and Devore 1968) has demonstrated that ethnographic desert, tropical, and subtropical hunter–gatherers relied more heavily upon plant food collection and the taking of small game for their day-to-day subsistence than on big-game hunting. Efforts by ethnographers studying groups as diverse as the !Kung and G/wi (San-speaking people of the northern and central Kalahari Desert, respectively), the Ngatatjara and Alyawara (Aboriginal groups of the Western and Central Deserts of Australia, respectively), the Anbara of northern Australia, the Hadza of East Africa, the Agta of northern Mindanao in the Philippines, the Ache of eastern Paraguay, the Efe Pygmies of Zaire, and others have produced results that now permit us to reevaluate some of the assumptions that guided these efforts, especially as they apply to the archaeological record.

The paradox is that while the earliest of these studies effectively challenged the idea that hunter–gatherers lived a precarious existence, often on the verge of starvation, and discredited the centrality of big-game hunting as the basis of this mode of adaptation, they also imputed a higher level of stability and internal satisfaction than is warranted by evidence from later work in this field. Sahlin's (1968, 1972) concept of the

"original affluent society" may apply in some cases at the emic level of analysis, but it does not stand up well when comparing hunter-gatherer adaptations against environmental conditions that act to limit resources and to impose stress. Western Desert Aborigines provide evidence of a decision-making hierarchy in their foraging behavior that consistently favored risk-minimizing choices to ensure adequate supplies of water, even when opportunities for favorable hunting were present in less well-watered areas (Gould 1980:69–70). O'Connell's account of optimal foraging among the Alyawara Aborigines must be qualified by the fact that the behavior he recorded took place after the construction of a mechanical well at Macdonald Downs Station had assured the Aborigines there of a dependable water supply (O'Connell and Hawkes 1981). These Aborigines had already developed a relatively central-based foraging strategy based upon this new and dependable European-introduced water source, and the true lesson in his study is that once mobile hunter–gatherers have effectively minimized the effects of a key limiting factor (in this case, water) then they can optimize their foraging behavior. It would not be appropriate to view their "affluence" as something original in their way of life. The !Kung, regarded as the archetype of Sahlin's concept, often expressed concern over stress factors such as predation by large carnivores, as shown by numerous anecdotal references in the published ethnographies. The G/wi, who inhabit a more extreme desert habitat than the !Kung, are noteworthy for their extreme efforts to conserve water during drought-stressed seasons (Silberbauer 1972, 1981).

In short, the literature shows that, despite emphasis on reliable plant foods and small game, life for these traditional, mobile hunter–gatherers still was no picnic. The recognition of the relative unimportance of hunting of large-bodied mammals among contemporary and historic hunter–gatherers following *Man the Hunter* has not been matched by an ethnographic confirmation of the security that was assumed to follow from this. The original stereotype about the precariousness and insecurity of traditional hunter–gatherer existence challenged by *Man the Hunter* has emerged as a real issue that merits closer study and not merely a straw man based on earlier, uninformed speculations about hunter–gatherers. Thus, paradoxically the stereotype of "man the hunter" has evolved simultaneously away from an emphasis on hunting and toward a greater appreciation of the role played by elements of risk imposed by stress factors and the ways in which modern and historic hunter–gatherer societies have adapted to those stresses and minimized these risks. The cumulative effect of these new ethnographies, with their adherence to high standards of controlled, empirical observation, has been to encourage a reexamination of hunter–gatherer behavior, both

past and present, without assuming beforehand that this was a secure or satisfying way of life.

With the above point in mind, it is worthwhile to look at the perspective now afforded by archaeology, especially in light of the effects introduced by taphonomic studies. Here, too, controlled, empirical research has begun to challenge assumptions about hunter–gatherer behavior, especially regarding the security of such a mode of adaptation in the face of heavy predation pressure. C. K. Brain's (1970) "leopard hypothesis" proposed that fossilized Australopithecine remains found at Swartkrans Cave in South Africa were a by-product of predation by Pleistocene leopards and were not due to hominid habitation within the cave. Further studies by Brain (1981) at Swartkrans and Sterkfontein suggested a more complex interpretation based on changing patterns of hominid and other fossil remains representing a shift from Australopithecines as victims of predation to their role as more effective predators themselves. The taphonomic situation at Swartkrans and Sterkfontein is complex, as it is everywhere such approaches have been tried. Recent faunal studies by Potts (1986) at Olduvai Gorge raise similar questions about assumptions concerning the use of this site as a temporary home base by early hominids. Patterns of bone deterioration and deposition at Olduvai more closely resemble the accumulation of hyena dens. The taphonomic approach clearly recognizes these sorts of complexities and offers positive steps to control for the variables involved. This effort has led, especially in Brain's studies, to the parallel but independent recognition by archaeologists of predation pressure as a potential stress factor throughout human hunter–gatherer existence.

Thus both ethnographic and archaeological approaches provide evidence for stress factors and their effects on the adaptive behavior of mobile hunter–gatherers in desert and tropical contexts, with an increasing recognition of predation as one of the most important of these factors. But neither approach by itself has been able to offer potential measures of the effects of these stress factors. By applying ethnoarchaeological approaches, we think it is possible now to posit a potential measure of the relative effects of predation pressure upon mobile hunter–gatherers based upon distances between hearths within campsites. This argument is based primarily upon data collected by the authors of this paper in their studies of the Ngatatjara Aborigines of Western Australia (1966–1970) and !Kung San of the Kalahari Desert of Botswana (1968–1975), but it can be tested by means of comparisons with other desert and tropical hunter–gatherers that have been studied recently or are presently being studied. It also has archaeological test implications which will be discussed after the ethnoarchaeological data has been reviewed.

CONTROLLED COMPARISON OF !KUNG AND NGATATJARA HOUSEHOLDS

Descriptive accounts exist in both areas which suggest important qualitative differences in the spatial arrangement of campsites over the complete spectrum of seasonal and situational variations within these two societies. In the Western Desert of Australia, such accounts indicate dispersed camping arrangements that varied in size from 40+ to as few as three individuals (Thomson 1975:83–97). Sometimes these camps contained brush shelters, while others had only low brush windbreaks or hearths positioned in the lee or shade of a bush or small tree. For the !Kung, we have accounts of more patterned campsites, with people residing in a circular arrangement of brush shelters (Lee 1984:27–32). Sometimes, as with the Aborigines, the !Kung did not use brush shelters, and their campsites also varied considerably in size. Recent studies of the !Kung have also shown a high degree of crowding within such camps (Draper 1973). The patterning of !Kung camps has been variously described as a series of concentric circles (Lee 1984:31) or a ring model (Yellen 1977:125–131) denoting zones associated with different habitational activities and discards. Ethnoarchaeological studies in the Australian Desert, however, show no circular or semicircular arrangements of this kind, nor do they reveal much regularity with regard to the physical shape of the camp (Gould 1980:25–26, 1977:27–42).

Descriptions of !Kung camps as places where, "People prefer to build their huts backed into the bush and facing into the center of the common village space," (Draper 1976:201) and where ". . . people build their shelters actually touching each other; others may build shelters or place their fires ten or twelve feet apart," (Marshall 1976:85) contrast with accounts of Aboriginal campsites as places where distances between camps vary between 10 and 50 yards, usually on open ground affording a good view in all directions (Tonkinson 1978:33–34).

In order to move beyond such descriptive accounts, ethnoarchaeological studies by the authors in both of these regions collected data on open-air campsites in the form of maps, drawn to scale and showing the position of hearths, structures, and other material remains, together with census and other contextual information on these campsites at the times they were mapped. While these camps were occupied for varying lengths of time, each map with its accompanying information about the people present there was done in a single, or at most, 2 consecutive days. The mapping and recording approaches used by the authors, while conducted independently, were identical and produced exactly comparable data. Initial measurements based on this mapping showed that the overall mean

distance between a total of 37 nuclear family hearths in our Western Desert sample was 36.7 m (S = 24 with CV = 67.85) while for the !Kung this mean distance was 7.77 m (S = 4.77, with CV = 61.39) for a total of 78 hearths.

The next step was to establish a controlled basis for measuring the area of each campsite. Any such measure involves an element of arbitrariness, since both !Kung and Aborigine campsites lacked delimited boundaries or other defining features. We were helped, however, by the fact that in both societies there were well established ideas of the domestic hearth as the center of any nuclear family's residence and activities. Marshall's observation that every !Kung household has a fire which it allows to burn all night and regards as ". . . more of an unchanging home than is a house on a plot of ground, from which a family might depart" (Marshall 1976:84) holds equally true for the Western Desert Aborigines and permits us to designate each nuclear family hearth on our maps as a fixed, central point.

After plotting each nuclear family hearth on overlays of each campsite map, we applied a measure widely used in archaeology known as "nearest neighbor analysis." Whallon (1974) offers an explanation of this method and its application to the measurement and analysis of spatial patterning of items over a two-dimensional surface. We discovered that this technique is easier to apply to the horizontal distribution of hearths on an ethnographic campsite than to items exposed on an excavated floor in an archaeological site, since there is no bias imposed by the artifical boundaries of the excavation unit. The distance from each hearth to its next nearest neighbor hearth was measured and the standard deviations of these measurements were calculated. A point of 1.65 SD above the mean nearest neighbor distance for each map established the "cutoff radius" for that campsite. This encompasses 95% of the potentially significant distances between hearths in their spatial distribution on each campsite map. On each map, circles equal to this cutoff radius were drawn around every household hearth, and the total area enclosed by the outermost curve of contacting circles was measured by means of simple plane geometry. Maps of eight Aborigine and 15 !Kung campsites, ranging from the largest to the smallest campsites observed in each case, were measured by means of this technique, and Figs. 1 and 2 show the Aboriginal campsite of Mulyangiriḷ and the !Kung campsite of DBC-18 drawn and measured by this method, respectively. The results of this approach are summarized in Tables 1 and 2.

Owing to the small number of household hearths in the smallest campsites, we found it necessary to depart somewhat from this procedure and treat five of the Western Desert Aborigine campsites and eight of the !Kung campsites as if they were a single large site for purposes of calcu-

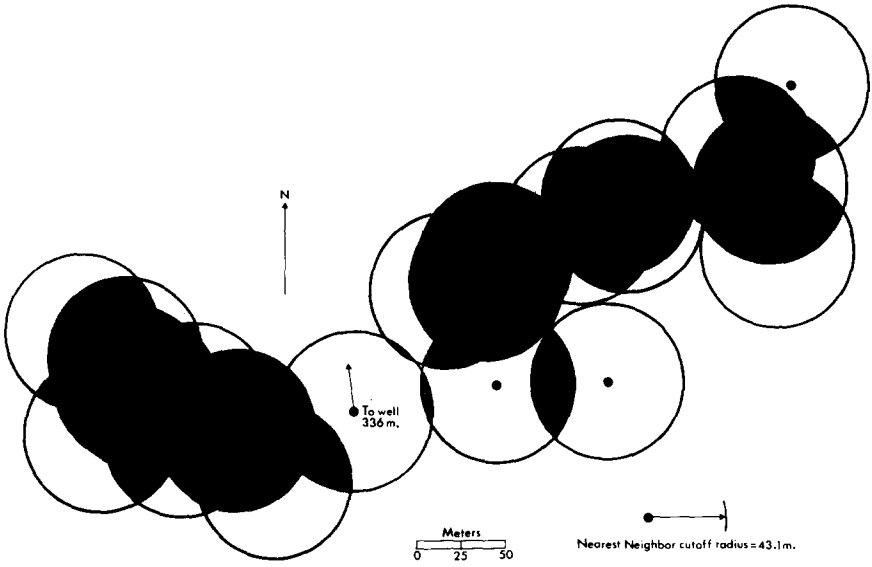

FIG. 1. "Nearest Neighbor" diagram of Mulyangiriḷ Well campsite, Western Desert, Australia.

lating a nearest neighbor cutoff radius. This modification introduces a degree of ambiguity in the results later in the analysis, but it is measurable and does not affect the final results. These are summarized in Table 3. After calculating the total area of each campsite, using the method described above, the area for each campsite was divided by the total number of people residing there on that day. This latter figure included individuals of both sexes and all ages. For the first three !Kung campsites shown in Table 2 (DBC 18–20), these figures represent the largest number of individuals who would have been present there at any one time, and the same is probably true for the first two Ngatatajara campsites shown in Table 1.

The third site shown in Table 1 is unusual. The Aboriginal Reserve at Laverton, Western Australia, contained a group of 37 desert Aborigines who, a few weeks before this map was made, had been contacted by a Woomera Rocket Range patrol in an area approximately 580 km northeast of Laverton. Because they lacked close social ties with the roughly 200 Aborigines already living there, they camped in a separate part of the Reserve. However, the Laverton Reserve was unusually small (approximately 1.4 ha), and the Reserve boundaries were marked by fences and were strongly enforced by surrounding sheep station owners, so these desert people were unable to disperse themselves as much as they would normally have done. These physical constraints are reflected in the rela-

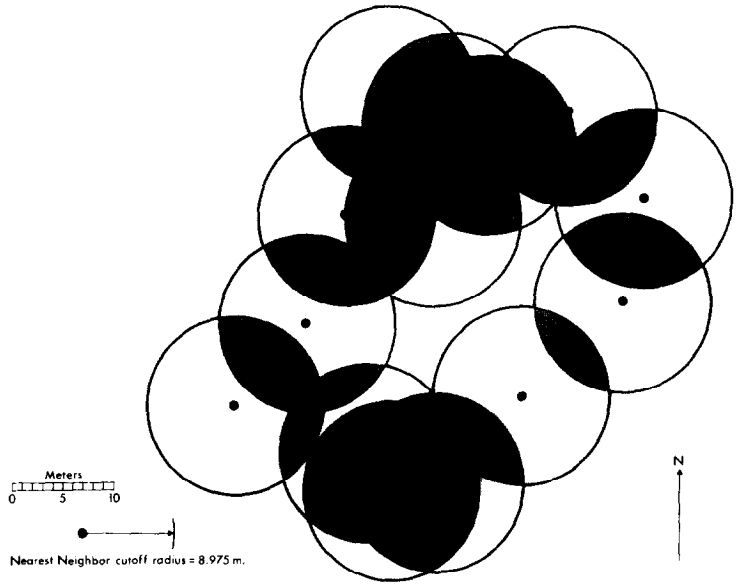

FIG. 2. "Nearest Neighbor" diagram of DBC-18 campsite, Kalahari Desert, Botswana.

tively low total area they occupied and in their relatively low area per person when compared with the other Aboriginal campsites included in this study. For these reasons, the Laverton data were excluded from comparisons between !Kung and Ngatatjara mean hearth distances. All of the other Aboriginal campsites recorded here occurred away from such constraints, although some, like Waṇampi Well and Mulyangiriḷ, had intermittent contact with the Warburton Ranges Mission.

For the !Kung sample, DBC 18–20 were relatively stable campsites recorded at a later date than the others in this study. Each had its own kraal with domesticated cattle and/or goats, indicative of a mixed economy. Although no domesticants were present (other than dogs), somewhat the same conditions of a mixed economy applied to the Aboriginal campsites at Waṇampi Well, Mulyangiriḷ, and Laverton Reserve, where European rations (flour, tea, sugar) were sporadically brought in. Thus neither of these ethnographic cases should be viewed as "pristine" examples of traditional foraging behavior, although hunting and gathering was the dominant mode of economy in all cases.

The most important result shown in Tables 1 and 2 has to do with the difference between area per person at Western Desert Aborigine vs !Kung campsites. In Table 3 these results are summarized both in ungrouped form and with the smaller campsites grouped. In contrast to the simple differences in mean distances between households noted earlier,

TABLE 1
ETHNOGRAPHIC WESTERN DESERT ABORIGINE CAMPSITES (AUSTRALIA)

Campsite (incl. date mapped)	Area (m^2)	No. of persons	Duration of occupation (days)	"Nearest neighbor" cutoff radius	Area (m^2) per person
Waṇampi Well 12/13/66	152,776.07	107	13	85.30	1427.81
Mulyangiriḷ 1/15/70	62,960.32	58	26	43.10	1085.52
Laverton Reserve 4/24/66	20,800.91	37	22 (est.)	37.41	562.19
Tikatika 12/26/66	17,729.14	13	6 (est.)	49.85	1363.80
Titatika 7/22/66	12,890.51	10	5	49.85	1289.05
Pulykara 4/23/70	10,515.62	10	6	49.85	1051.56
Partjaṛ 7/24/66	9,496.70	10	2	49.85	949.67
Tikatika 9/4/66	12,296.69	9	3	49.85	1366.30

the coefficient of variation is much greater for the !Kung data than for the Western Desert Aborigines when one compares areas occupied per person based on "nearest neighbor" analysis.

FACTORS AFFECTING HOUSEHOLD SPACING

Numerous factors can act in concert to influence differences in household spacing measured in this study, and we would group these in four categories. First, one must consider level of technology. The ability to construct multistory structures or geodesic domes, for example, offers a range of opportunities which may affect household spacing. To control for this we limit our analysis to "technologically simple" societies. Second, natural constraints, such as the size of a rock overhang or cave, can also influence spacing since it is reasonable to assume that an advantage such as shelter from rain may lead to the violation of culturally preferred behavior. Restraints imposed by construction can have the same effect. Large structures are easier to construct from cedar poles than mammoth ivory. Third, climate may also be seen as a determining factor since temperature and rainfall influence both the need for and design of structures. One may assume a priori that Western Desert Aborigines space themselves differently than comparable Eskimo family units in

TABLE 2
ETHNOGRAPHIC !KUNG (SAN), KALAHARI DESERT

Campsite (incl. date mapped)	Area (m^2)	No. of persons	Duration of occupation (days)	"Nearest neighbor" (m) cutoff radius	Area (m^2) per person
DBC-20 4/17/76	7397.04	54	60	19.54	136.98
DBC-19 6/8/76	5096.02	45	90 (est.)	19.64	113.24
DBC-18 4/?/76	3495.60	38	420 (est.)	14.82	91.99
//Gakwe≠Dwa 1 5/10/68	896.40	24	12	9.29	37.35
≠Tum ≠Toa 4 7/6/68	585.50	24	3	8.13	24.40
//Gakwe ≠Dwa 2 7/23–7/25/68	383.60	20	7	5.98	19.18
Shum !Kau 3 9/18–9/19/68	444.30	19	6	7.03	23.38
N!abesha 6/3–/68	308.60	17	5	6.54	18.15
≠Tum ≠Toa 5 7/7/8/68	373.50	17	3	6.54	21.97
N/on/oni ≠Toa 2 7/10/68	356.10	17	5	6.54	20.95
≠Tum ≠Toa 3 4/5/68	184.10	12	2	6.54	15.34
Hwanasi 4/?/68	184.70	12	3	6.54	15.39
Shum !Kau 1 5/5/68	216.90	12	2	6.54	18.10
/Tanagaba 2/23/68	175.40	11	2	6.54	15.94
≠Tum ≠Toa 2 2/20/68	191.90	11	9	6.54	17.45

multihousehold winter lodges. For these reasons we have limited our sample to desert, tropical, and subtropical groups. In our cases space is not a constraining factor, climate is controlled, and one may assume that interhousehold distances reflect cultural norms, whether consciously expressed or not.

The final group of factors reflects cultural decisions rather than technological, spatial, or climatic constraints. We isolate for consideration six which we or other scholars believe may be significant:

(1) Brooks et al. (1984) have argued that degree of interhousehold dependence correlates inversely with distance. Groups characterized by

TABLE 3
COMPARISON OF AREAS (IN m^2) OCCUPIED PER PERSON AT WESTERN DESERT ABORIGINE AND !KUNG CAMPSITES

	Ungrouped data	Grouped data	Grouped data with Laverton omitted
Western Desert Aborigines	$n = 8$	$n = 4$	$n = 3$
	$\bar{x} = 1136.99$	$\bar{x} = 1069.90$	$\bar{x} = 1239.14$
	S = 289.62	S = 367.02	S = 173.82
	CV = 25.47	CV = 34.30	CV = 14.03
!Kung	$n = 15$	$n = 8$	
	$\bar{x} = 39.32$	$\bar{x} = 58.05$	
	S = 39.97	S = 48.27	
	CV = 101.65	CV = 83.15	

high levels of sharing—especially of food—will maintain a lower degree of household privacy and this will be reflected by decreased spacing between them. O'Connell (n.d.) compares Australian Alyawara and Paraguay Ache camps and likewise relates differences in spacing to variation in sharing patterns.

(2) The degree of relatedness among members of individual household units may also affect spacing. One may hypothesize that geneological and physical difference are directly correlated with each other and that, for example, in settlements where households are derived from several extended families spacing will be greater than when these units are drawn from a single extended family group.

(3) The estimated length of time a site will be occupied may also play a role. When a group knows that it will remain in one place for a longer time, it may increase the space between units to allow for the addition of late arrivals or for secondary disposal of refuse.

(4) Household spacing may also be affected by the number of individuals in adjacent units. It seems intuitively reasonable that larger households will take up more space than smaller ones and thus distance will increase with unit size.

(5) Schaller and Lowther (1969) have suggested that the body size of mammals being hunted can produce a nucleating effect on hunter–gatherer residence, where the "critical mass" of hunters needed to capture, butcher, and transport large prey may be greater than for smaller animals. This argument admittedly has some difficulties, since hunting of smaller prey, such as rabbits, may require communal efforts, too. But there is no doubt that elephant hunting, for example, would necessitate a relatively large, temporary aggregation of population to make efficient use of the biomass represented by such a resource.

(6) Predation has also been suggested as a factor which may affect

spacing. Casual inspection reveals the striking difference between !Kung and Aborigine camp layouts, and for several years Gould as well as Hawkes and O'Connell have hypothesized the existence of such a relationship (see O'Connell n.d.). Australia today lacks mammalian predators which may threaten humans. In southern Africa such species abound.

In the following sections we examine how household spacing is affected by each of these six factors. In theory the best way to proceed with such an analysis would be to amass a cross-cultural sample large enough to permit the application of multivariate statistical techniques. In practice however, the needed data is lacking and therefore of necessity we have adopted a two-stage approach. A large series of mapped northern Kalahari Desert !Kung campsites permits statistical examination of factors 1 through 4. The !Kung series spans a 39-year period, yet is confined to a single cultural group and geographical location (where the number of predator species has remained unchanged). This permits a controlled comparative study. In the second stage of this analysis, we expanded our comparative sample to include settlements occupied by the Tawana and the Herero, two Bantu speaking groups with an emphasis on herding who live in close proximity to the !Kung (and are thus exposed to the same range of predators), the Ache of Paraguay, the Western Desert Aborigines, and the Alyawara of Australia. Only Australia lacks potential predators.

Because it reflects a social reality and provides a practical archaeological measure, we employ the distance between household hearths as a simple measure of spacing between units. (The "nearest neighbor" analysis described earlier for Ngatatjara–!Kung comparisons was not deemed appropriate for this broader comparison, mainly because published data on the other groups mentioned in this study do not permit this kind of analysis.) Comparative ethnographic data show such hearths provide a major focus for household activities. Although several factors—site reoccupation, special purpose fires, etc.—complicate the application of this fact to practical archaeological use, in many instances one can identify such features archaeologically, and therefore we have focused our analysis on hearth-to-hearth distances rather than other measures which do not allow for such direct archaeological transformation.

EXPANDED COMPARATIVE SCHEDULE

!Kung

The northern Kalahari !Kung have been a center of anthropological interest since pioneering work by the Marshall family in the 1950s (Mar-

shall 1976). In the early 1960s Irven DeVore and Richard Lee began long-term research at Dobe, a waterhole in northwestern Botswana (Lee and DeVore 1976; Lee 1979) and this work continues to the present. Together these projects and their offshoots have produced a large body of published information. Through the late 1960s the Dobe area !Kung relied primarily on hunted and gathered foods and moved seasonally in response to shifting distributions of food and water. Because the average annual rainfall is low (ca. 250 mm) and most precipitation sinks rapidly into the thick mantle of sand, scarcity and uneven distribution of available surface water serves as the major determinant of settlement pattern. Under the pattern which held through the 1960s, during the dry months of the year (ca. August through December) groups clustered in camps near permanent water sources. With the rains, smaller units moved to temporary water points to utilize the relatively underexploited food resources.

Yellen (1977) describes traditional settlement organization. While elderly individuals and groups of adolescent girls or boys may occupy separate huts and hearths, most often the nuclear family forms the basic household unit. These in turn are grouped in extended families, and in some instances several extended families join together in a single settlement. A household normally constructs a single hut, and focuses its activities around this hut and the hearth directly in front of it. !Kung describe the ideal camp as a circle of huts with entrances facing inward, and the actual pattern on the ground usually conformed closely to this. The area which immediately surrounded the hut and hearth was conceived as "private" household space while the empty space in the center of camp and the area outside the hut circle were used for specialized group activities.

Brooks et al. (1984) and Yellen (1977, 1984) describe the changes in social organization, which occurred in the Dobe area in the early 1970s. Wilmsen (1978) has correctly noted that well before the present century northern Kalahari !Kung had been exposed to external influences and therefore cannot be considered "pristine" hunter–gatherers. However, in the Dobe area at least, through the 1960s individuals relied primarily, and at times completely on hunted and gathered resources. Faunal samples excavated from campsites occupied in the early 1940s include less than 2% domestic species. In 1968, 8% of excavated bones represent domesticates. For the Dobe !Kung the early 1970s marked a period of rapid change. In 1969 the first goat kraal was constructed and by 1975 one extended family had a herd of over 50 goats. Fenced fields, the largest over an acre in size, were planted. The amount and variety of material possessions increased enormously and many individuals purchased metal trunks and suitcases to store belongings. Traditional grass huts were replaced by larger more solidly constructed mud walled structures. While

individuals still paid lip service to the sharing ideal described by Marshall (1961), Lee (1979), and others, observation revealed a quite different reality. A number of factors—new possibilities for wage labor, access to a dependable water supply, directed government programs—were responsible for this transformation.

Data for the !Kung analysis derive from two sources and span the period from 1944 through 1982. In 1968 and 1969 Yellen studied a series of small rainy season camps. All camps were established by relatively small groups which subsisted solely by hunting and gathering during the period of occupation. They were used for only brief intervals during the study period. Thus all reflect a similar stage of acculturation, and from this perspective can be treated as a single unit. Detailed information on this series is published in Yellen (1977). For this analysis we eliminate the five camps which were either reoccupied or did not include members of =*toma*'s (an adult male) extended family. The subsample labeled "Rainy season: =*toma* only" includes Yellen's (1977) camp numbers 2, 5, 6, 9, 12, 13, and 15 and were occupied only by members of =*toma*'s extended family. The second subsample, "Rainy season: multigroup" (Camps 10, 11, 14, 16), include =*toma*'s as well as other extended families.

Beginning in 1975, Yellen collected data on a series of dry season camps located near the Dobe waterhole. Distinct from the rainy season camps, these latter are termed the "Dobe Base Camp" (DBC) series. These also are subdivided into "DBC: =*toma* only," a series of 13 camps, and "DBC: multigroup," which includes five cases. Because these camps span a period of 39 years and the latter differ significantly from the earlier ones, they must be chronologically subdivided and cannot be treated as a single sample.

Tawana

The Tawana, speakers of the Bantu language Setswana, inhabit the northwestern portion of Botswana (see Schapera 1953). The first Tawana entered the Dobe area in the late 1800s and became an established presence during the present century. In 1948 the government appointed a Tawana as headman of the region which included Dobe, and a settlement was established at !Xabi, ca. 5 km northeast of Dobe. In 1976 Yellen mapped this camp which consisted of a circular arrangement of mud walled huts many of which were surrounded by solid log fences. Several large kraals for goats and cattle were incorporated into the perimeter of the circle. Primarily pastoral, the Tawana also plant fields and obtain cash through the sale of livestock, and are opportunistic hunters.

Herero

Although sporadic contacts may go further back in time, the disastrous defeat of the Herero nation by the Germans in Southwest Africa (now Namibia) resulted in a major Herero migration into western Botswana. Groups of Herero first settled at waterholes east of Dobe in the 1920s and this presence has expanded and continued to the present time. Ovaherero is also a Bantu language, and to the casual observer in both subsistence and village arrangement, major distinctions between the Herero and Tawana are not apparent (see Vivelo 1977). In 1976 Yellen mapped the Herero village of Mahopa, ca. 10 km northeast of Dobe.

Ngatatjara Aborigines

In the late 1960s when Gould conducted research in the Western Desert of Australia, groups with which he worked were primarily dependent on wild food products for subsistence (Gould 1980). Between 1966 and 1970 Gould mapped eight camps of which one, at Laverton, was artificially constrained, and thus not included in this larger comparative analysis. During this period, most of the groups that subsisted primarily on wild foods moved to or were resettled in government reserves, missions, or near cattle or sheep stations in close proximity to Europeans and became increasingly dependent upon European-introduced rations and technology. Accounts of their foraging economy and changes taking place during the 1960s may be found in Gould (1969a, 1969b), and these can be compared with similar changes occurring among the Mardudjara Aborigines, another closely related Western Desert society, during roughly the same period (Tonkinson 1978).

Alyawara

In pre-European times this Arandic speaking group subsisted entirely by hunting and gathering in the Sandover River area, northeast of Alice Springs, central Australia. With the establishment of sheep and cattle stations in the 1920s, Alyawara were increasingly drawn into a European economy, and most now live in large settlements near areas of employment or on government reserves. While in some communities hunting and gathering may provide up to 25% of the diet, most individuals depend on government welfare (O'Connell n.d.). Settlements mapped by O'Connell between 1973 and 1975 were relatively large and averaged about 90 individuals. Households are marked by a main shelter and hearth.

Ache

The Northern Ache currently number about 350–400 individuals and inhabit lowland subtropical forest in eastern Paraguay. Kaplan et al. (1984) state that until 4 to 10 years ago they subsisted solely by foraging. Now settled around missions, they practice swidden agriculture, and most individuals spend up to half their time foraging away from the missions. While O'Connell (n.d.) reports hearth to hearth distances, we do not have more detailed settlement data.

Efe Pygmies

Brief mention should also be made of recent ethnoarchaeological findings among these Ituri Forest dwellers in Zaire, although these results are somewhat tentative and are still undergoing analysis. Fisher and Strickland (1986) report that Efe settlements are compact, ranging from 40 to 500 m^2, which they note as considerably less than 10,000 to 100,000 m^2 reported by O'Connell for the Alyawara.

REVIEW OF FACTORS INFLUENCING HOUSEHOLD SPACING

1. Relationship between Household Distance and Degree of Sharing

In the early 1970s the !Kung shifted away from their traditional strong emphasis on sharing. At the same time the number of individually owned domestic livestock increased dramatically. Table 4 presents data on 18 DBC camps established between 1944 and 1982. For those occupied in more than 1 year the midpoint of stay was used for chronological assignment. In all but the most recent two sites, distances between nearest hearths were measured. In early sites when households were arranged in a circle, we used the same hearth as both starting and endpoint in our measurements. In later sites, the circle opened to yield a linear arrangement and in this case first and last hearths are taken as measurement endpoints. In the two most recent camps, since fires were placed inside huts it was not possible to measure hearth-to-hearth distances and the distance between hut entrances was substituted in its place. Analysis shows that these two measures closely approximate each other.

A clear pattern emerges from this data. In the early 1970s (ca. 1971–1972) a quantum jump occurs and this coincides with a major shift in lifestyle. The distinction between "Early" and "Late" periods is clear. The mean distance for 1944–1970 sites is 10.41 m (S = 2.15); this increases to 15.27 m (S = 3.66) for their later counterparts. Within each sample no regular time related shifts are evident, and this implies that

TABLE 4
DOBE BASE CAMP (DBC) SERIES

	= *toma* only			= *toma* plus other groups		
(1)	(2)	(3)	(4)	(2)	(3)	(4)
1982	41	16.37[a]				
1981						
1980	36	9.57[a]				
1979						
1978						
1977	25	14.23				
1976						
1975	24	13.50	13			
1974	23	17.96	6			
1973	22	19.96	22			
1972						
1971						
1970				20	13.25	2
1970				19	11.21	3
1969						
1968	17	9.29	6	18	9.30	14
1967	16	9.65	1	15	13.32	14
1966						
1965	14	10.48	18			
1964				12	10.50	17
1963						
1962	8	8.27	1			
—						
—				1. Year, midpoint of		
1953	5	5.78	4	occupation		
—				2. DBC number		
				3. Average hearth to hearth		
—				distance		
1947	33	12.07	6	4. Length of occupation		
1946				(months)		
1945						
1944	32	11.83	3			

[a] Hut-to-hut distance.

two clearly different normative models for household spacing exist. There seems to be no middle ground.

Unlike the Alyawara case reported by O'Connell (n.d.), food sharing occurred regularly and often between households among the Ngatatjara, despite the fact that they lived in settlements that were, if anything, even more dispersed than those of the Alyawara. This sharing behavior was masked to a degree by the fact that on most hunts in which larger bodied mammals were captured (those individuals with body weights in excess

of approximately 6 kg), the carcass was roasted and divided away from the home base, close to where the kill was made. This division, however, ensured that each household represented by a male member of the hunting party received a share of the kill which was then carried back to the home base campsite for further division and consumption (Gould 1967). It is true, however, that food sharing between households declined among the Ngatatjara as dependence on European-introduced rations increased, along with crowding on Aboriginal reserves and settlements in close proximity to Europeans. This crowding can be interpreted as a by-product of resettlement—in some cases, as at Laverton—of forced resettlement within artificially confined boundaries, rather than as a function of the intensity of food sharing between households. In short, the Ngatatjara case offers evidence contrary to the expectation that spacing between households should be inversely proportional to the intensity of food sharing between households. Both the !Kung and Ngatatjara examples also demonstrate the importance of controlling for factors such as crowding due to post-European-contact influences.

2. *Relationship between Kinship and Household Distance*

Both the !Kung rainy season and DBC series provide information on this relationship. Table 5 presents mean hearth distances for the rainy season series. For those camps which include =*toma*'s extended family only, mean hearth-to-hearth distance is 4.68 m (S = 1.36). In multiextended family camps this increases to 6.03 m (S = 1.20). In the DBC "Early" subgroup, the seven sites occupied by only =*toma*'s extended

TABLE 5
!KUNG RAINY SEASON SERIES

	Camp number	Average hearth-to-hearth distance (m)	Length of occupation (days)
=*toma* only	2	4.9	9
	5	3.0	2
	6	3.0	3
	9	5.0	2
	12	5.5	3
	13	5.4	5
	15	6.2	1
=*toma* plus other groups	10	7.6	12
	11	5.8	3
	14	4.7	7
	16	6.0	6

family exhibit a mean hearth-to-hearth distance of 9.62 m (S = 2.17). For the five "Early" DBC sites with more than one extended family represented, this average climbs to 11.52 m (S = 1.75). (No DBC "Late" sites were occupied by multiextended family groups.) Thus both the rainy season and DBC samples support the conclusion that relatedness among household units relates inversely to the distance between them.

We also need to recognize the high degree of variance in household spacing among the Ngatatjara compared to what we find among the !Kung. This variance appears in the measurements involved in the use of nearest neighbor analysis (as expressed by differences in coefficient of variation of areas occupied per person in each case, shown in Table 3). Why should variation in the areas occupied per person among the Ngatatjara be so much greater than among the !Kung?

In the Ngatatjara case, the simple factor of increased overall campsite area relative to population appears to be crucial. As campsites expanded overall, there was a measurable tendency for extended family clusters to appear, in a manner similar to the clustering shown in Fig. 1 for Mulyangiriḷ Well. All of the Ngatatjara campsites present this grouping of related households into extended family clusters. The smallest distances were consistently recorded between hearths of nuclear family households within each extended family cluster. The largest distances consistently occurred between extended family clusters, regardless of the absolute area of the particular campsite. These findings indicate that campsite area *relative to* population size is crucial and must be controlled in an analysis of this kind—hence the use of nearest neighbor analysis in conjunction with census data on the individual campsites in Ngatatjara–!Kung comparisons in this study. These findings suggest that as campsite area expands relative to population, greater variance in the area occupied per person can also be expected. This tendency toward clustering due to kinship-related factors such as extended family affiliation would be measurably less apparent in more compact campsites, as expressed by the figures for the !Kung. Our argument here is that the overall "spreading out" of people on the ground shown by the Ngatatjara data relaxes spatial constraints that otherwise act to reduce this tendency toward visible and measurable kin-group clustering. But this finding in no way accounts for the gross differences between !Kung and Ngatatjara campsite areas relative to population or for the differences in mean hearth-to-hearth distances encountered for these groups.

3. Relationship between Length of Occupation and Household Distance

Simple correlation analysis permits the evaluation of this potential relationship. No significant correlation exists between hearth-to-hearth dis-

tance and length of occupation for the entire rainy season sample. Similar analysis of the entire "DBC Early" series again showed that length of occupation did not correlate with hearth-to-hearth distance. Of the six "DBC Late" camps, three were still inhabited when mapped and thus total length of occupation could not be established. While the remaining three camps provide an inadequate sample for statistical analysis, visual inspection provides no hint of a positive relationship. How long a camp is occupied does not affect household distance.

4. Relationship between Household Size and Household Distance

Yellen's (1977:114–118) analysis of a rainy season sample demonstrated that for households of larger than one person, no significant relationship existed between the number of people in a household and the amount of space it occupied. Tables 4 and 5 present data from the rainy season, DBC Early and DBC Late samples which support this original conclusion. In each sample the hearth-to-hearth distance between two adjacent households was compared with the total membership (adults plus young) of both households. Average distances were then calculated for these composite household groups. For example, as Table 6 indicates, in DBC Early camps, when the total membership of two adjacent households equals five individuals, the average distance between their hearths is 11.05 m. When the number of people increases to 10, the distance is 11.20 m. Thus hearth-to-hearth distance varies independently of household size.

Table 6 reveals another interesting pattern. Comparison of the rainy

TABLE 6
RELATIONSHIP OF HOUSEHOLD SIZE AND HEARTH-TO-HEARTH DISTANCE

	Hearth-to-hearth distance (m)		
Total (adults + young) in adjacent households	Rainy season series	DBC Early series	DBC Late series
3		5.73	8.55
4	5.40	11.91	16.58
5	4.78	11.05	19.85
6	7.00	10.88	10.00
7	7.06	12.25	13.93
8	6.05	9.17	11.90
9	5.60	11.65	19.00
10		11.20	9.75
11	5.38	9.05	
12		9.60	

season and DBC early samples shows that for household aggregations of the same size in all instances hearth-to-hearth distances are significantly greater in the DBC series. For example, two brothers, their wives, and children make up the 11 individual aggregates. When these people lived in DBC Early camps they set their hearths, on the average, 9.05 m apart. Yet these very same individuals when they camped away from Dobe moved closer together to give an average of 5.38 m. As we have shown, this cannot be explained on the basis of kinship, length of occupation, or ideology, and we discuss a possible explanation below, under Factor 6.

5. Relationship between Body Size of Prey and Nucleated Campsites

Schaller and Lowther's suggestion that the taking of large-bodied prey will require more nucleated campsites is supported by recent findings by Kaplan and Hill (1985) that the frequency and amount of food sharing among the Ache vary directly with the size of prey, and inversely with the probability of capture. So this argument can be viewed as a variant of Factor 1, that is, as having to do with intensity of food sharing. When we look at the Ngatatjara evidence, however, we find that the Waṇampi Well campsite presented in Table 1 with the largest area of any Ngatatjara campsite relative to population was also the one where the occupants at that time were most dependent upon hunting macropods, mainly red kangaroo (*Megalaiea rufa*), the largest bodied marsupial mammals living in Australia today, of any campsite in the Aborigine sample. A map and photograph of this campsite appears in Gould (1977:31–32). This campsite was occupied at a time when heavy rains in an area of acacia scrub had led to an unusually dense occupation of kangaroos, and the Ngatatjara, who usually depended on a more diverse range of plant foods and small game switched to a greater dependence on macropod hunting for approximately 2 weeks until hunting success fell off. Throughout this period, food sharing between households at Waṇampi Well was intense. Thus the prediction by Kaplan and Hill (1985) and echoed by O'Connell (n.d.) that:

> ". . . if the frequency of sharing strongly affects interhousehold distance, then it should be possible to predict variation in spacing from a knowledge of diet and local ecology. Hunters taking small prey in relatively consistent amounts, which can be consumed by members of their own household within a day or so, should share little and camp far apart, all else equal"

is not met in the Ngatatjara case.

Perhaps the predictability afforded by European-introduced rations in both the Ache and Alyawara cases had something to do with the relatively low amount of interhousehold food sharing in these instances.

Some European-introduced rations were present at Waṇampi Well, too, but their relative importance in the total diet on this occasion was overwhelmed by the availability of kangaroo meat. Since meat was not available to the Ngatatjara from European sources except in minute amounts in the form of tinned varieties, what was represented at Waṇampi Well in December, 1966, was a clear preference for fresh meat (not smoked or otherwise preserved, but kept, nevertheless, and eaten for up to as much as 6 days) whenever possible. Again, this example points up the need to control for European-introduced components of the diet when introducing arguments about household spacing based upon ecological and dietary factors. What Schaller and Lowther seem to have had in mind was the hunting of very large-bodied mammals such as elephants and giraffes and not the sort of mixed economies with varying degrees of dependence upon European-introduced food items encountered in this study.

6. *Relationship between Predation and Household Distance*

Gould, Hawkes (personal communication), and O'Connell (n.d.) have suggested that fear of predation may affect spacing of individuals within a settlement. Table 7 presents data for three northern Kalahari societies (Yellen), Western Desert Aborigines (Gould), and the Alyawara and Ache (O'Connell n.d.).

Australia lacks mammalian predators large enough to pose a threat to humans. Fossilized remains of a "lionlike" marsupial carnivore, *Thylacoleo carnifex,* have been found in Pleistocene contexts from every state in Australia, but nothing to match this formidable predator has survived into the Holocene. There is no reliable way to estimate how numerous *Thylacoleo* was during the Pleistocene, but Archer (1984) suggests that members of this genus may have threatened some Pleistocene human populations in Australia. In Paraguay the Ache share their range with jaguar (*Felis onca*) and Hawkes (personal communication) states that in-

TABLE 7
MEAN HEARTH-TO-HEARTH DISTANCES (IN m) FOR SIX SOCIETIES

!Kung: Dobe rainy season	5.00
!Kung: Dobe DBC: Early	10.41
!Kung: Dobe DBC: Late	15.27
Tawana	17.66
Herero	20.82
Ache	3–3.5
Western Desert Aborigines	36.70
Alyawara	24–45

formants express fear of this animal. The northern Kalahari contains all of the large southern African predators, the lion (*Panthera leo*), leopard (*Panthera pardus*), spotted hyena (*Crocuta crotuca*), brown hyena (*Hyaena brunnea*), and cheetah (*Acinonyx jubatus*). Human predation is documented for the first three species and it has been claimed that brown hyenas have attacked children (Brain 1981). Dobe informants know of one lion attack and two cases in which a leopard attacked a person. They will not eat lion, leopard, or hyena meat because they say it would be an indirect form of cannibalism: all these animals are known to feed on human flesh. Very rarely do !Kung leave camp after dark, and informants state that one reason they keep dogs is to warn of predators during the night. While no information exists on the density of predator species, all rainy season camps were visited by hyenas within several days of their abandonment. Tawana and Herero likewise express concern about predators. Herero shelter newborn goats at night in a small fortresslike structure with heavy log walls and roof for protection. Many huts have solid fences around them as well as solid wooden doors which they close at night. All this suggests concern with predation.

While household spacing among northern Kalahari groups is variable and clearly is determined by more than one factor, the overall pattern presented in Table 7 support the hypothesis that fear of predation affects household spacing. By northern Kalahari (!Kung, Tawana, Herero) standards, Ache households cluster tightly together. In predator-free Australia, on the other hand, both the Western Desert Aborigines and the Alyawara space households far apart. Thus available data do lend credence to this conclusion.

Discussion

Together, Tables 7 and 8 summarize the effect of five variables on household spacing and what they show is a stepwise progression. Based on the !Kung data, two factors, household size and length of occupation, have no significant effect. While geneological distance does influence spacing, the effect is small: at Dobe under 1.5 m at most. The degree of sharing among households exerts a much more powerful influence on spacing and comparison of Early and Late DBC camps gives an average difference of 4.86 m. This exceeds the effect of geneology by a factor of over three. Finally, the average spacing between Western Desert Aborigine households is 21.43 m greater than the DBC Late average: an increase by more than two. If one accepts that fear of predation is the cause, then the effect of this variable is by far the most important among the alternatives under consideration.

These data suggest archaeological applications. If one limits analysis to

TABLE 8
EFFECT OF FOUR FACTORS ON !KUNG HOUSEHOLD SPACING

Effect on household spacing:	
1. Number household numbers	None
2. Length of occupation	None
3. Geneological distance:	
Rainy season: = *toma* only: 4.69 m	
Multigroup: 5.50 m	Difference = 0.81 m
DBC Early: = *toma* only: 9.62 m	
Multigroup: 11.04 m	Difference = 1.42 m
4. Sharing:	
DBC Early: 10.41 m	Difference − 4.86 m
DBC Late: 15.27 m	Difference

a single geographical region and thus potentially can hold predation constant, it should be possible to examine changes in sharing patterns over time. Conversely, one can look for changes in human response to potential predator pressure and need not be overly concerned about potential confounding factors. In the case of Australia, this argument has clear archaeological test implications. If, indeed, predation pressure and fear of predation can be regarded as primary determinants of household spacing, the horizontal spacing of hearths from contemporaneous levels at open-air archaeological sites of Pleistocene age should be measurably closer and more compact than in similar post-Pleistocene contexts, due to the presence of *Thylacoleo*.

CONCLUSION

Our data suggest that relative predation pressure and fear of predation may have a direct and significant affect on human behavior, and this points to predation as an important selective factor in human evolution. Relative degrees of predation pressure probably operate at a basic level to produce predictable effects throughout cultural systems. The matter of protecting the immature young looms especially large from an evolutionary point of view.

For example, Draper's (1976) accounts of child behavior among the !Kung emphasize how young children tend to remain in close proximity to the campsite and contribute relatively little to the economic life of the community. They rarely hunt or forage, either for themselves or others, but remain dependent upon adult kin for most of their subsistence until ages of around 14 (girls) or 16 (boys). Parents and other adult kin maintain constant awareness of the whereabouts of children and do not allow them to wander far.

Western Desert Aborigine children, by contrast, are highly indepen-

dent and spend much of their time, after weaning, away from their parents and other adult kin in play situations that may involve overnight stays away from and out of sight of the main campsite. Older children regularly take care of younger ones in such situations with, for example, 8-year olds carrying the smallest children who cannot walk well enough to keep up easily. By the ages of 8–10 years old children of both sexes are expert plant and small game collectors. Children of this age range often make cross-country trips in excess of 100 km entirely on their own, foraging along the way and with a sufficient knowledge of water sources and other relevant geography to complete the trip unaided by adults. When with adults, Aborigine children contribute to the diet by catching small game and collecting plants and edible insects, and they are encouraged by adults to do this as soon as they can start to walk.

If one provisionally accepts this argument then the relationship of campsite patterning and child behavior is critical, since under predation-stressed circumstances it is the immature offspring who will most require protection if they are too reach reproductive maturity. In the Kalahari, children who might behave as independently as Aboriginal children would be vulnerable to predation, and the same could be said for children and adults who camp alone or away from the main body of the campsite. In any marginal foraging situation, there are advantages to having children participate independently in the food quest, but for the !Kung the risks of doing this outweigh any potential benefits.

On the one hand measures such as distance between household hearths lack ethnographic appeal because they provide only indirect reflections of socially significant behaviors. Why settle for such a measure when one can observe human actions directly? But some behaviors, such as fear of predation, are impossible to observe, and beliefs, which may be unconscious, can prove extremely difficult to elicit through interview. Thus a one-step removed measure such as we employ may prove of unexpected value. It can be applied easily in many ethnographic settings, and, because it is quantitative, facilitates controlled cross-cultural comparison. Hopefully anthropologists will continue to collect and publish such data.

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