Articles

Life Histories, Blood Revenge, and Warfare in a Tribal Population

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Blood revenge is one of the most commonly cited causes of violence and warfare in tribal societies, yet it is largely ignored in recent anthropological theories of primitive warfare. A theory of tribal violence is presented showing how homicide, revenge, kinship obligations, and warfare are linked and why reproductive variables must be included in explanations of tribal violence and warfare. Studies of the Yanomamö Indians of Amazonas during the past 23 years show that 44 percent of males estimated to be 25 or older have participated in the killing of someone, that approximately 30 percent of adult male dealths are due to violence, and that nearly 70 percent of all adults over an estimated 40 years of age have lost a close genetic relative due to violence. Demographic data indicate that men who have killed have more wives and offspring than men who have not killed.

IN THIS ARTICLE I SHOW HOW SEVERAL FORMS OF VIOLENCE in a tribal society are interrelated and describe my theory of violent conflict among primitive peoples in which homicide, blood revenge, and warfare are manifestations of individual conflicts of interest over material and reproductive resources.

Violence is a potent force in human society and may be the principal driving force behind the evolution of culture (*1*). For two reasons, anthropologists find it difficult to explain many aspects of human violence. First, although ethnographic reports are numerous, data on how much violence occurs and the variables that relate to it are available from only a few primitive societies. Second, many anthropologists tend to treat warfare as a phenomenon that occurs independently of other forms of violence in the same group. However, duels may lead to deaths which, in turn, may lead to community fissioning and then to retaliatory killings by members of the two now-independent communities. As a result many restrict the search for the causes of the war to issues over which whole groups might contest—such as access to rich land, productive hunting regions, and scarce resources—and, hence, view primitive warfare as being reducible solely to contests over scarce or dwindling material resources (*2*). Such views fail to take into account the developmental sequences of conflicts and the multiplicity of causes, especially sexual jealousy, accusations of sorcery, and revenge killings, in each step of conflict escalation.

My theory synthesizes components drawn from two more general bodies of theory. One is the approach of political anthropology in which conflict development is analyzed in terms of the goals for which individuals strive, individual strategies for achieving these goals, and the developmental histories of specific conflicts (*3*). The second draws on several key insights from modern evolutionary thought (*4*). Specifically, (i) the mechanisms that constitute organisms were designed by selection to promote survival and reproduction in the environments of evolutionary adaptedness. This implies that organisms living in such environments can be generally expected to act in ways that promote survival and reproduction or, as many biologists now state it, their inclusive fitnesses (*5*). For humans, these mechanisms include learning and mimicking successful social strategies. (ii) Because no two organisms are genetically identical (save for identical twins and cloning species) and many of life's resources are finite, conflicts of interest between individuals are inevitable because the nature of some of life's resources ensure that individuals can achieve certain goals only at the expense of other individuals (*6*). (iii) Organisms expend two kinds of effort during their lifetimes: somatic effort, relevant to their survival, and reproductive effort in the interests of inclusive fitness. Such life effort often entails competition for both material resources (for example, food, water, and territory) and reproductive resources (for example, mates, alliances with those who can provide mates, and favor of those who can aid one's offspring) (*6, 7*). (iv) It is to be expected that individuals (or groups of closely related individuals) will attempt to appropriate both material and reproductive resources from neighbors whenever the probable costs are less than the benefits. While conflicts thus initiated need not take violent forms, they might be expected to do so when violence on average advances individual interests. I do not assume that humans consciously strive to increase or maximize their inclusive fitness, but I do assume that humans strive for goals that their cultural traditions deem as valued and esteemed. In many societies, achieving cultural success appears to lead to biological (genetic) success (*8*).

In this article I focus on revenge killing, using data collected among the Yanomamö Indians of southern Venezuela and adjacent portions of northern Brazil (*9–11*). Blood revenge is one of the most commonly cited causes of violence and warfare in primitive societies (*12*), and it has persisted in many state-organized societies as well (*13*).

I am using the terms revenge and blood revenge here to mean a retaliatory killing in which the initial victim's close kinsmen conduct a revenge raid on the members of the current community of the initial killer (*14*). Although Yanomamö raiders always hope to dispatch the original killer, almost any member of the attacked community is a suitable target.

Yanomamö Conflicts: Homicide, Revenge, and Warfare

The Yanomamö have no written language, precise number system, formal laws, or institutionalized adjudicators such as chiefs or judges (*15*). Although there are customs and general rules about proper behavior, individuals violate them regularly when it seems in their interests to do so (*16*). When conflicts emerge each individual

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must rely on his own skills and coercive abilities and the support of his close kin. Most fights begin over sexual issues: infidelity and suspicion of infidelity, attempts to seduce another man's wife, sexual jealousy, forcible appropriation of women from visiting groups, failure to give a promised girl in marriage, and (rarely) rape (*9, 10, 17*).

Yanomamö conflicts constitute a graded sequence of increasing seriousness and potential lethality: shouting matches, chest pounding duels, side slapping duels, club fights, fights with axes and machetes, and shooting with bows and arrows with the intent to kill (*10*). In all but the last case, fights are not intended to and generally do not lead to mortalities. Nevertheless, many fights lead to killings both within and between villages. If killing occurs within the village, the village fissions and the principals of the two new groups then begin raiding each other (*17, 18*). The most common explanation given for raids (warfare) is revenge (*no yuwo*) for a previous killing, and the most common explanation for the initial cause of the fighting is "women" (*suwä tä nowä ha*) (*9, 10, 17, 19*).

At first glance, raids motivated by revenge seem counterproductive. Raiders may inflict deaths on their enemies, but by so doing make themselves and kin prime targets for retaliation. But ethnographic evidence suggests that revenge has an underlying rationality: swift retaliation in kind serves as a deterrent over the long run. War motivated by revenge seems to be a tit-for-tat strategy (*20*) in which the participants' score might best be measured in terms of minimizing losses rather than in terms of maximizing gains.

If gain (benefit) is associated with revenge killing in the primitive world, what is gained and precisely who gains? Casting these questions into evolutionary terms, where gain (benefit) is discussed in terms of individual differences in inclusive fitness, might shed new light on the problem. Losing a close genetic relative (for example, a parent, sibling, or child) potentially constitutes a significant loss to one's inclusive fitness. Anything that counterbalances these losses would be advantageous. Yanomamö data suggest two possibilities. First, kinship groups that retaliate swiftly and demonstrate their resolve to avenge deaths acquire reputations for ferocity that deter the violent designs of their neighbors. The Yanomamö explain that a group with a reputation for swift retaliation is attacked less frequently and thus suffers a lower rate of mortality. They also note that other forms of predation, such as the abduction of women, are thwarted by adopting an aggressive stance. Aggressive groups coerce nubile females from less aggressive groups whenever the opportunity arises. Many appear to calculate the costs and benefits of forcibly appropriating or coercing females from groups that are perceived to be weak (*10, 17*). Second, men who demonstrate their willingness to act violently and to exact revenge for the deaths of kin may have higher marital and reproductive success.

The Yanomamö Population

The Yanomamö number some 15,000 individuals and are subdivided into approximately 200 politically independent communities. During the past 23 years I have visited 60 villages on 13 field trips and have spent 50 months living among the Yanomamö. Warfare has recently diminished in most regions due to the increasing influence of missionaries and government agents and is almost nonexistent in some villages. Here I summarize the roles that killing and revenge play in the lives of the members some dozen villages in one area of the tribe who were actively engaged in warfare during the course of my continuing field research (*21*). The current descendants of these communities (and their immediate historical antecedents) were studied more intensely than others between 1964 and 1987 (*9*). The population was distributed among 12 villages and numbered 1394 as of April 1987. Approximately 30% of deaths among adult males in this region of the Yanomamö tribe is due to violence (*9, 22*). This level of warfare mortality among adult males is similar to rates from the few other anthropological studies that report such data. Warfare mortality among adult males is reported as 25% for the Mae Enga, 19.5% for the Huli, and 28.5% for the Dugum Dani, all of Highland New Guinea (*23, 24*).

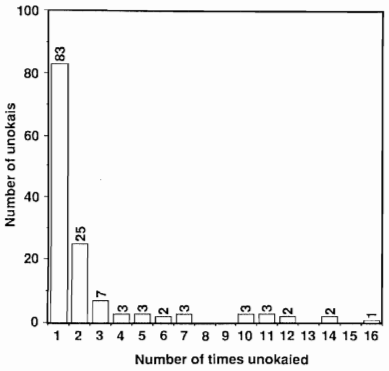

Fig. 1. Number of victims for which living killers *unokaied*. Sixty percent (83 of 137) of Yanomamö *unokais* have participated in only one killing; one man participated in 16 different killings.

Life Histories, Killers, Kinship, and Revenge Motives

In order to understand why avenging the death of a kinsman is such a commonly reported cause of warfare in primitive societies, one needs to document the vital events in the lifetimes of all or most individuals, recording marriages, abductions, genealogical connections, births, deaths, and causes of death (*9*). These data must then be put into the historical context of specific wars whose origins and development are described by multiple informants. Finally, native views, explanations, and attitudes have to be taken into consideration, particularly on topics such as vengeance, legitimacy of violent actions in particular circumstances, and societal rules and values regarding principles of justice.

The Yanomamö are frank about vengeance as a legitimate motive for killing. Their very notion of bereavement implies violence: they describe the feelings of the bereaved as *hushuwo*, a word that can be translated as "anger verging on violence." It is dangerous to provoke a grieving person no matter what the cause of death of the lost kin. It is common to hear statements such as, "If my sick mother dies, I will kill some people."

Vengeance motivation persists for many years. In January 1965, for example, the headman of one of the smaller villages (about 75 people) was killed by raiders in retaliation for an earlier killing. His ashes were carefully stored in several tiny gourds, small quantities being consumed by the women of the village on the eve of each revenge raid against the village that killed him. According to the Yanomamö, women alone drink the ashes of the slain to make raiders *hushuwo* and fill them with resolve (*25*). In 1975, 10 years after his death, several gourds of his ashes remained, and the villagers were still raiding the group that killed him, who by then lived nearly 4 days' walk away.

This case is telling in another way as well. When the headman was killed, his death so demoralized the group that for about a year its members refused to conduct revenge raids, thereby acquiring the reputation of cowardice. They sought refuge and protection among several neighboring groups whose men grew bolder in direct proportion to the visitors' cowardice. These neighbors openly seduced the visitors' women and appropriated a number of them by

force, predicting, correctly, that the visiting men would not retaliate. The group later regained its dignity and independence after embarking on an ambitious schedule of revenge raids (*10*).

Revenge is also sought for the deaths of individuals who are alleged to have died as a consequence of harmful magic practiced by shamans in enemy villages. As is widely found in other primitive societies, an astonishingly large fraction of deaths are considered to have been the result of human malevolence: sorcery in the form of stealing souls, blowing lethal charms, stealing someone's footprint, or directing one's personal spirit associates (*hekura*) to cause a snake to bite someone fatally or a tree to fall on him. Few deaths are considered to be natural. Infant mortality is high and invariably attributed to enemy shamans. Long, bitter wars can be initiated when a visitor from a suspected village is killed by the bereaved of the dead infant (*10*). None of the deaths attributed to magic are considered in this article as violent deaths caused by human malevolence.

Unokais: Those who have killed. When a Yanomamö man kills he must perform a ritual purification called *unokaimou*, one purpose of which is to avert any supernatural harm that might be inflicted on him by the soul of his victim, a belief similar to that found among the headhunting Jivaro of Peru (*26*). Men who have performed the *unokaimou* ceremony are referred to as *unokai*, and it is widely known within the village and in most neighboring villages who the *unokais* are and who their victims were. Recruitment to the *unokai* status is on a self-selective basis, although boys are encouraged to be valiant and are rewarded for showing aggressive tendencies (*10*).

Most victims are males killed during revenge raids against enemy groups, but a number of killings were within the groups (*9, 22, 27*). Most of the latter have to do with sexual jealousy, an extremely common cause of violence among the Yanomamö, other tribal groups, and our own population (*28*).

Raiding parties usually include 10 to 20 men, but not all men go on all raids and some men never go on raids. An enemy village might be as far as 4 or 5 days' march away. Many raiding parties turn back before reaching their destination, either because someone has a dream that portends disaster, or because the enemy group is not where it was believed to be. In all but the most determined raiding parties, a few men drop out for reasons such as being "sick" or "stepping on a thorn." Some of these dropouts privately admitted to me that they were simply frightened. Chronic dropouts acquire a reputation for cowardice (*thê*) and often become the subject of frequent insult and ridicule, and their wives become targets of increased sexual attention from other men.

The number of victims per raid is usually small—one or two individuals—but occasionally a "massacre" takes place resulting in the deaths of ten or more people (*6, 29*). On the eve of a raid the warriors make an effigy (*no owä*) of the person they most want to kill; but in fact, they usually kill the first man they encounter. When a raiding party strikes, usually at dawn, as many raiders as possible (but almost never all members of the raiding party) shoot the victim or victims from ambush with their arrows and hastily retreat, hoping to put as much distance as possible between themselves and the enemy before the victim is discovered. Everyone who has shot an arrow into the victim must undergo the *unokaimou* ceremony on reaching home. Most victims are shot by just one or two raiders, but one victim was shot by 15 members of the raiding party.

The number of (living) *unokais* in the current population is 137, 132 of whom are estimated to be 25 or older, and represent 44% of the men age 25 or older (*15*). A retrospective perusal of the data indicates that this has generally been the case in those villages whose *unokais* have not killed someone during the past 5 years. I have recorded 282 violent deaths during 23 years of studies of villages in the region under consideration (*21*), deaths that occurred sometime during the past 50 to 60 years (*15*). These include victims who were residents of villages in this area or victims from immediately adjacent areas killed by residents or now-deceased former residents of the groups considered here. Of these 282 violent deaths, the number of victims of living *unokais* is 153. These victims were killed during approximately the past 35 years (*9*). All the *unokais* come from the villages under discussion, but not all of the victims do; some are from villages in adjacent areas beyond the focus of my field studies.

Individual capacities of unokais. Most killers have *unokaied* once. Some, however, have a deserved reputation for being *waiteri* (fierce) and have participated in many killings (Fig. 1). One man has *unokaied* 16 times. The village from which he comes is considered to be, by its neighbors, a particularly *waiteri* group: 8 of the 11 men who have *unokaied* ten or more times come from this one village. In this village, 97% of the 164 members are related in at least one way to 75% or more of the other residents of the village (Table 1). The "village" in this case is almost synonymous with "kinship group."

Unit of analysis: Village or kin group? It is customary for anthropologists to use the community as the natural unit of analysis in their studies of primitive warfare because war, by most definitions, is lethal conflict between members of politically distinct groups. The Yanomamö village, however, is a transient community whose membership changes by migration, emigration, and fissioning (*10*). As a result, *unokais* who now live in different villages, and may be mortal enemies, may once have been residents of the same village and collaborators in raids. It cannot be assumed that their violent activities can be understood as actions taken on behalf of a village since any given *unokai* is likely, at some point in time, to be attacking members of a village among whom he once lived. It is more accurate to view Yanomamö revenge raids as actions promoted by prominent men to benefit themselves or close kin and to view the village as a set of kin groups that form around individual leaders, each with selfish interests.

In order to understand why blood revenge is such a powerful motive among the Yanomamö and other tribal groups organized by kinship, one must first understand how complex and pervasive kinship relationships are in such communities and that the major fount of the individual's political status, economic support, marriage

Table 1. Measures of kinship relatedness among members of 12 villages studied.

Village	Population (1987)	Fg(ALL)*	Fg(CON)†	Quartile‡			
				1	2	3	4
5	188	0.057987	0.085104	0.04	0.09	0.05	0.81
6	121	0.063239	0.084429	0.03	0.13	0.07	0.77
7	105	0.089063	0.116243	0.03	0.15	0.00	0.82
50	63	0.084405	0.139225	0.13	0.02	0.11	0.75
51	164	0.103778	0.109175	0.02	0.01	0.01	0.97
52	94	0.080369	0.106137	0.03	0.05	0.02	0.89
53	136	0.063444	0.102216	0.10	0.04	0.01	0.85
54	109	0.078648	0.123159	0.11	0.00	0.10	0.79
84	66	0.117921	0.128590	0.03	0.00	0.00	0.97
90	55	0.111806	0.136574	0.02	0.04	0.25	0.69
92	188	0.095861	0.110016	0.04	0.00	0.03	0.93
93	105	0.080615	0.093202	0.04	0.00	0.09	0.88
Average		0.0860	0.1112	0.05	0.04	0.06	0.84

*Fg(ALL), average of each individual's average relatedness to all members of the village, including unrelated individuals (*34*). †Fg(CON), average of each individual's average relatedness to just genetic kin in the village. ‡Quartiles: 1, fraction of the village members related in at least one way to 25% or fewer of the village members; 2, fraction of the village members related in at least one way to 26 to 50% of the village members; 3, fraction of the village members related in at least one way to 51 to 75% of the village members; 4, fraction of the village members related in at least one way to 75% or more of the village members. The data in Tables 2 and 3 are not additive to arrive at the figures presented in this table for current village sizes.

possibilities, and protection from aggressors derives from kinsmen. One of the most important functions of kin groups is to pool resources and reallocate them to needy members. In the context of threats or coercion by others or of potentially violent encounters, group members cooperate for mutual protection and use their collective skills and abilities to this end, including the capacities of group members to act violently if necessary (*30*).

All Yanomamö villages have several (unnamed) patrilineal descent groups: males and females of all ages who are related to each other through the male line of descent. Members of these groups must find their spouses in some other patrilineal descent group, preferably within the village. Reciprocal marriage exchanges between such groups over several generations mean that the members of any one descent group have close relatives in other descent groups.

Each descent group has one or more *patas* ("big ones") who are the political leaders of that group (*10*). The leader of the largest descent group is invariably the headman of the village, but if the village has two descent groups of approximately equal size it will have two (or more) leaders who, because of past marriages between their groups, are often first (cross) cousins and married to each other's sisters. Political leaders, therefore, usually have, on average, many more kinsmen in the village than do other men of comparable age.

Headmen are usually polygynous, and over a lifetime a successful man may have had up to a dozen or more different wives, but rarely more than six wives simultaneously. One result is that some men have many children. In the sample considered here, one man (now deceased) had 43 children by 11 wives. Needless to say, nuclear and extended families cannot only become very large but their respective members, because of repetitive intermarriage, are related to each other in many ways.

The village, then, is composed of large kin groups: people who are related to members of their own lineal descent group through male links and related to members of other lineal descent groups through consanguineal marriages and matrilateral ties. If someone in the village is killed, the probability is very high that he or she will have many bereaved close kin, including the village leader or leaders who have more kin than others; the leaders are the very individuals who decide whether killings are revenged. All headmen in this study are *unokai*. If, as Clauzewitz suggested, (modern) warfare is the conduct of politics by other means (*31*), in the tribal world warfare is ipso facto the extension of kinship obligations by violence because the political system is organized by kinship.

With the passing of time and generations, adult male members in each village become more remotely related to each other. Their fathers may have been brothers and first cousins, but they themselves are divided into sets of brothers and sets of second parallel cousins or second cross cousins. The sons of these men, in turn, will be even more remotely related, third cousins. Fission produces two new villages in which the coefficients of relatedness among members is higher in the two new groups than what it was when both were members of the same, larger, village (*9, 16, 32*).

Not all individuals are able to remain with the closest of kin at fission, usually because they are married to a person whose kin group elects to leave, and they have to go along or dissolve their marriages. A war between their new group and the old one puts such individuals in an ambiguous position. Such men often refuse to participate in raids against the group whence they fissioned, pointing out that they wish their close kin no harm. No stigma is associated with this, nor is such a man considered a legitimate target of vengeance by members of his current residential group. If one of his close kin in the original group is killed on a revenge raid by members of his current residential group a man may be moved by grief to the point of deserting his wife and rejoining his original group with the intent to retaliate. Or, he might remain in his current group, filled with smouldering resentment and a concealed hatred of those co-residents who participated in the killing of his kinsman. In the next village club fight, he would most likely support those who are contending with his kinsman's killers. This underscores the difficulty of interpreting Yanomamö warfare as a phenomenon that pits all the members of one political community against all the members of a different political community and makes clear why the village is not the most useful unit with which to analyze warfare in many tribes.

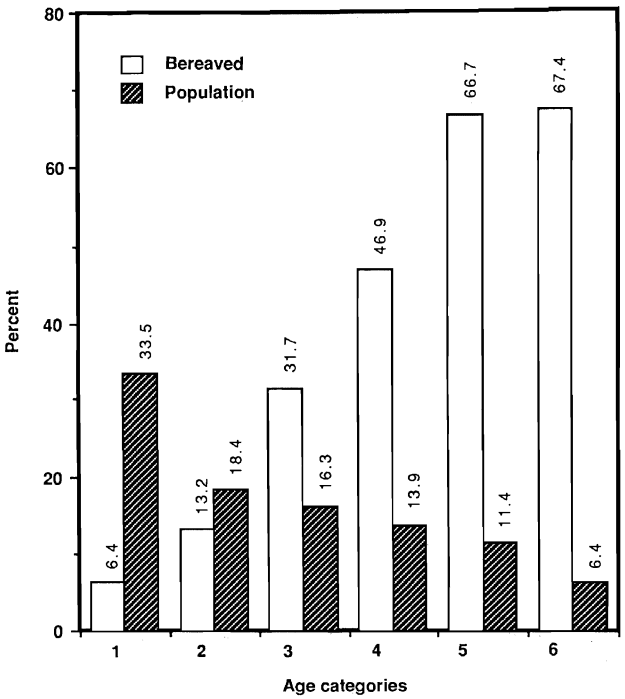

Fig. 2. Age structure and percentage of individuals losing close genetic kin in each 10-year age category. Age categories: 1, birth to 10 years; 2, 11 to 20 years; 3, 21 to 30 years; 4, 31 to 40 years; 5, 41 to 50 years; and 6, 51+ years. Hachured bars represent the percentage of the 1987 living population (males and female) in each age category. Open bars represent the percentage of individuals (male and female) in each age category who had lost a parent, sibling or half-sibling, or child. Approximately 34% of the population falls in age category 1; approximately 6% of these individuals had lost a close kin due to violence. Since individuals in this age category are children, the kinsmen they lost are primarily parents and elder siblings. Two-thirds of the individuals age 40 or older (age categories 5 and 6) have lost one or more close kin due to violence.

Kinship Relatedness and Loss of Kin by Violence

Number of relatives. Few published anthropological accounts give statistics on kinship relatedness among all individuals in tribally organized communities, which may in part explain the anthropological tendency to ignore blood revenge as a cause of warfare in tribal world (*2*). Table 1 provides statistics on relatedness among members of each of the villages. A person is considered to be related to another if at least one genealogical connection between them exists. Most individuals, however, are related to their kin in multiple ways. In most villages well over 80% of the members are related to more than 75% of the village (see fourth quartile).

Table 2. Reproductive success of *unokais* and non-*unokais* as of 1987. In each age category there are individuals who have sired no children. However, 88% of the 137 *unokais* have reproduced compared to 49% of the 243 non-*unokais*. This table is not additive with the data in Table 3 to arrive at the village sizes given in Table 1. Some of the offspring listed here are dead. Living children whose fathers are dead or whose fathers live outside the villages in the study area are not included in this table; some older adult males have adult sons who are listed both as offspring and as either *unokais* or non-*unokais*.

Ages	*Unokais*			Non-*unokais*		
	n	Number of offspring	Average number of offspring	*n*	Number of offspring	Average number of offspring
20–24	5	5	1.00	78	14	0.18
25–30	14	22	1.57	58	50	0.86
31–40	43	122	2.83	61	123	2.02
>41	75	524	6.99	46	193	4.19
Total	137	673	4.91	243	380	1.59

Closeness of kinship relationship. Table 1 presents statistics on closeness of relationship among village members (*33*). These data show that in most villages, members are related to each other more closely than half-cousinship (relatedness to a half cousin is 0.0625), and, to just their actual genetic kin, approximately as first cousins (relatedness to a first cousin is 0.1250) (*34*).

Kinship density and the will for revenge. The quantitative dimensions of kinship relatedness in Yanomamö communities can be referred to as kinship density, which is a combination of the numbers of kin each individual has, how closely related the individual is to these kin, and the obligations and expectations that are associated with particular kinds of kinship relatedness.

A kinship density factor appears to be involved in revenge raids. It is difficult for a small or heterogeneous Yanomamö group to put together a raiding party. The risks are high and men are willing to take them in proportion to the amount of mutual support they receive from comrades and where unwillingness to do so is condemned and ridiculed. Lone raiders do not exist. The higher the kinship density in a local community, the greater is the likelihod that a large number of mutually supportive individuals will take such life-threatening risks and that retaliation will occur if one of the members of the group is killed. Included is the support of the women, who alone consume the ashes of the slain in order to put the raiders in a state of frenzy and strengthen their resolve. The existence of a tradition of revenge killing promotes kinship density by encouraging individuals to remain with close kin when new communities are formed by fissioning. High levels of relatedness also makes it likely that almost every violent death will trigger revenge killing, for most of the members of the victim's community will be close genetic kin.

Measuring levels of societal violence: Numbers and kinds of kinsmen lost by individuals. Anthropology has no generally accepted measure for describing and comparing levels of violence and warfare cross culturally. With few exceptions (*23, 24*), much, if not most, of our knowledge about tribal warfare is based on fragmentary reports by untrained observers or on information collected long after the tribes studied had been decimated by introduced diseases and their political sovereignty taken from them by colonial powers. If the data contain numbers, one never knows the universe from which the sample is taken.

This presents a problem in interpreting Yanomamö violence and placing it into a comparative framework. Are the Yanomamö more or less violent than other tribesmen of the past or present? What should be measured or counted to compare levels of violence in different societies? I suspect that the amount of violence in Yanomamö culture would not be atypical if we had comparative measures of precontact violence in other similar tribes while still independent of colonial nation states (*24*).

One potentially useful measure of the amount or level of violence in tribal societies (or even modern nations) is the fraction of the population that has participated in the deliberate killing of one or more members of his own or some other community. Another useful measure might be the extent to which violence affects the lives of all (or a significant sample) of society's members in terms of the numbers and kinds of close kinsmen each person has lost through violence (*24, 35*). As individuals age, more and more of them lose a close genetic kin due to violence (Fig. 2). Nearly 70% of all individuals (males and females) age 40 or older have lost at least one close genetic kin due to violence, and most (57%) have lost two or more.

Reproductive Success and *Unokais*

The deterrent effect of vengeance killing might not be the only factor driving and maintaining Yanomamö warfare. Men who are killers may gain marital and reproductive benefits.

A preliminary analysis of data on reproductive success among *unokais* and non-*unokais* of the same age categories indicates that the former are more successful (Table 2). The higher reproductive success of *unokais* is mainly due to their greater success in finding mates (Table 3), either by appropriating them forcibly from others, or by customary marriage alliance arrangements in which they seem to be more attractive as mates than non-*unokais* (*36*).

Discussion

A number of problems are presented by these data. First, high reproductive success among *unokais* is probably caused by a number of factors, and it is not clear what portion might be due to their motivation to seek violent retribution when a kinsman is killed. I can only speculate about the mechanisms that link a high reproductive success with *unokai* status, but I can cast doubt on some logical possibilities. For example, it is known that high male reproductive success among the Yanomamö correlates with membership in large descent groups (*32*). If *unokais* come disproportionately from these groups, that might explain the data: both could be caused by a third variable. But *unokais* do not come disproportionately from larger descent groups. The three largest patrilineal descent groups among the Yanomamö considered here include 49.4% of the population,

Table 3. Marital success of *unokais* and non-*unokais* as of 1987. In each age category there are individuals who have no wives in 1987. However, 88% of the 137 *unokais* are married compared to 51% of the 243 non-*unokais*. The data in this table are not additive with the data in Table 2 to arrive at village sizes given in Table 1. Currently unmarried women are not included in this table.

Ages	*Unokais*			Non-*unokais*		
	n	Number of wives	Average number of wives	*n*	Number of wives	Average number of wives
20–24	5	4	0.80	78	10	0.13
25–30	14	13	0.93	58	31	0.53
31–40	43	49	1.14	61	59	0.97
>41	75	157	2.09	46	54	1.17
Total	137	223	1.63	243	154	0.63

but only 48.9% of the *unokais*. The four largest descent groups include 55.9% of the population but only 55.5% of the *unokais*.

Second, it is possible that many men strive to be *unokais* but die trying and that the apparent higher fertility of those who survive may be achieved at an extraordinarily high mortality rate. In other words, men who do not engage in violence might have a lower risk of mortality due to violence and produce more offspring on average than men who tried to be *unokais*. This explanation would be supported by data indicating that a disproportionate fraction of the victims of violence were *unokais*. The data do not appear to lend support to this possibility. Of 15 recent killings, four of the victims were females: there are no female *unokais*. Nine of the males were under 30 years of age, of whom four were under an estimated 25 years of age. Although I do not have the *unokai* histories of these individuals, their ages at death and the political histories of their respective villages at the time they were killed suggest that few, if any of them, were *unokais*. Also, recent wars in two other regions of the study area resulted in the deaths of approximately 15 additional individuals, many of whom were very young men who were unlikely to have been *unokais*.

Third, additional variables not fully investigated might help account for the correlations in Tables 2 and 3. For example, there might be biometric attributes of *unokais* and non-*unokais* not readily apparent to the outside observer, such as differential skills at concealment, agility in moving through dense forest on raids, athletic ability, or other factors. Personal, long-term familiarity with all the adult males in this study does not encourage me to conclude at this point that they could easily be sorted into two distinct groups on the basis of obvious biometric characteristics, nor have detailed anthropometric studies of large numbers of Yanomamö males suggested this as a very likely possibility (*37*).

Fourth, there is the issue of the deterrent effects of swift, lethal, retaliation and whether or not it can be measured. A logical assumption would be that if *unokais* deter the violence of enemies, they would lose fewer close kin than non-*unokais*. In actual fact, they lose about as many close kin due to violence as non-*unokais* do. Two factors complicate the measurement of the deterrent effect. One is that village membership changes chronically and fissioning redistributes individuals in such a way that *unokais* will have some close kin living in distant villages. An *unokai* in one village cannot, by this actions, have much effect on the safety of a close kinsman in another village. Another is the fact that if *unokais* deter the violent designs of others, all members of their kin group benefit, including the non-*unokais* and their dependents.

The last problem suggests that the argument that cultural success leads to biological success (*8*) among the Yanomamö might be the most promising avenue of investigation to account for the high reproductive success of *unokais*. Indeed, the Yanomamö frequently say that some men are "valuable" (*a nowä dodihiwä*) and give, among the several reasons, that they are *unokai*, avenge deaths, or are fierce (*waiteri*) on behalf of kin. In short, military achievements are valued and associated with high esteem, as they are in many other cultures, including our own (*38*). Until recently in human history, successful warriors were traditionally rewarded with public offices and political power which, in turn, was used for reproductive advantage (*39*). Among the Yanomamö, non-*unokais* might be willing to concede more reproductive opportunities to *unokais* in exchange for a life with fewer mortal risks and fewer reproductive advantages (*40*).

Some Yanomamö men are in general more responsible, ambitious, economically industrious, aggressive, concerned about the welfare of their kin, and willing to take risks. Becoming an *unokai* is simply one of a number of male characteristics valued by the Yanomamö and an integral component in a more general complex of goals for which ambitious men strive. All the characteristics just mentioned make some males more attractive as mates in arranged marriages and dispose some of them to take the risks involved in appropriating additional females by force. Both paths lead to higher reproductive success.

Jacoby's (*13*) study of revenge in modern societies makes a compelling case that the desire for *lex talionis* is widespread, even in societies with law and formal judicial systems and that justice everywhere has an undeniable element of retribution. It is difficult for us to imagine the terror that might characterize our own social lives in the absence of laws prohibiting individuals from seeking lethal retribution when a close kinsman dies at the hands of another human, be it premeditated murder or the consequence of an irresponsible accidental act, such as a drunk driver causing the deaths of innocent people. A particularly acute insight into the power of law to thwart killing for revenge was provided to me by a young Yanomamö man in 1987. He had been taught Spanish by missionaries and sent to the territorial capital for training in practical nursing. There he discovered police and laws. He excitedly told me that he had visited the town's largest *pata* (the territorial governor) and urged him to make law and police available to his people so that they would not have to engage any longer in their wars of revenge and have to live in constant fear. Many of his close kinsmen had died violently and had, in turn, exacted lethal revenge; he worried about being a potential target of retaliations and made it known to all that he would have nothing to do with raiding (*41*).

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7. Darwin's second major work, *The Descent of Man, and Selection in Relation to Sex* (Murray, London, 1871) focused on "sexual" selection and those attributes of organisms that appear to have evolved because they conferred an advantage in mate competition. By distinguishing between competition for material resources and reproductive resources I wish to emphasize the importance of sexual competition as a cause of violence. See also B. Campbell, Ed., *Sexual Selection and the Descent of Man, 1871–1971* (Aldine, Chicago, 1972).
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14. Blood revenge in many other societies entails elaborate rules that specify who is obligated to avenge a death and, sometimes, the range of kinsmen (brother, cousin, and so forth) of the killer that is an appropriate target for retaliation. Yanomamö revenge customs are not this specific.
15. The Yanomamö lack a written language and precise notions of time and distance. Therefore, all ages are based on my estimates, which are more accurate for those groups I have been re-censusing since 1964, but less accurate for groups I contacted more recently. However, their language contains words that describe the state of maturity of individuals making it possible to distinguish between broad categories such as infants, juveniles, and adults (reproductively mature individuals and post-reproductive individuals). While I witnessed many violent and near-lethal conflicts, in none of these incidents did the participants die while I was present. I did not accompany raiding parties and did not witness the killings that occurred while I lived there. News of killings travels fast and is widely known. All the data on violent deaths are therefore based on assertions of multiple informants whose accounts were cross-checked. There was remarkable consistency in their reports on violent deaths. The weakest category of data is that dealing with infant and child mortality, due mainly to the Yanomamö taboo on discussing deceased close kin and the horror and anger this provokes when one inquires about it from close relatives. Estimates of fertility should therefore be taken as underestimates due to underreporting. Blood group studies of possible paternity exclusion indicate that informant-provided genealogical data are probably quite accurate [see J. Neel and K. Weiss, *Am. J. Phys. Anthropol.* **42**, 25 (1975)]. For a detailed discussion of my data collecting methods and possible levels of error, see (*9*).
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18. The members of the villages reported here (and their recently deceased kin) have made approximately 200 garden-village sites in the region under consideration during approximately the past 50 years [see N. A. Chagnon, *Proceedings, Eighth International Congress of Anthropological and Ethnological Sciences* (Science Council of Japan, Tokyo, 1970), pp. 249–255 and (*9*) and (*17*) for further discussion of some of these settlement sites]. Nearly half these sites were established during my 23-year study. Approximately 50 fissions took place at these locations, followed in many cases by fusion. About ten within-group killings occurred during the time of my studies, half involving male victims. In all cases involving males, the group fissioned as a consequence of the killing. Fission did not follow the killings of three abducted females who had no co-resident close kin in the group.
19. In 1986, a Ye'kwana Indian, totally unaware of the theoretical debates in anthropology about tribal warfare, described to me a conference in Caracas in which various anthropologists presented theories about customs and phenomena they had studied among Venezuelan native peoples. After one presentation on Yanomamö warfare he said he stood up and told the audience the following: "Even though I am Ye'kwana, I have also lived with the Yanomamö many years. I speak their language fluently and I know their warfare. While the last speaker used many words and elaborate arguments I do not understand, he missed the most fundamental fact about Yanomamö warfare. What he does not seem to understand is that their wars always start over women."
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21. This region has been occupied by the same core Yanomamö populations for at least 70 to 80 years, but population growth and village fissions and fusions have been such that the actual number of discrete villages changes from year to year. The area of focus includes the drainages of the Mavaca and Bocon Rivers, both tributaries of the upper Orinoco River, and immediately adjacent portions of the Siapa River, a large affluent of the Casiquiare River, in southern Venezuela. Fissions, abductions, marriage alliances, and migrations among the villages in this area since the mid-1970s have blurred not only the distinctions between the two clusters of historically distinct villages (*9*), but the identities of specific villages as well.
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24. B. Knauft [*Curr. Anthropol.* **28**, 457 (1987)] has compiled or estimated mortality rates for a number of modern cities, nations, and primitive societies in terms of violent deaths per 100,000 people. Sample rates from his study are: Britain, 1959 data, 0.50; Detroit, Michigan, 1958 data, 58.2; Yanomamö, 1972–74 data, 165.9; Australian aborigines (Murngin), 1906–26 data, 330.0; Hewa of New Guinea, 1971 data, 778.0. The homicide rates for tribesmen are staggeringly high compared to rates for modern cities and nations wherever adequate data has been collected by anthropologists, despite the fact that deaths in tribal societies due to diseases occur at very high rates. However, a major difficulty in characterizing rates of violence in tribal societies with this kind of statistic is the fact that violence waxes and wanes radically over relatively short periods of time in most tribal societies, and grossly different estimates of homicide rates for the same population can be obtained from studies done of the same local group at two different periods of time, or neighboring groups at the same point in time. Knauft's estimate for the Yanomamö is based on an analysis of a relatively small portion of my data for the brief period 1972–74 [T. Melancon, thesis, Pennsylvania State University (1982)]. Radically different estimates could be calculated for the Yanomamö from a different set of villages or different time periods. For example, Lizot's accounts (*11*) of events in one small Yanomamö village (approximately 70 people) between 1968 and 1976 indicates that mortality due to violence was very low to almost nonexistent during that time period. But, in 1982, a very large fraction of the adult males, as well as several women and children of that village, were killed in a war with a neighboring Yanomamö village [see Chagnon in (*6*)].
25. The role of female grief in Yanomamö warfare is an important factor in perpetuating revenge killings. One *unokai* organized and led a raid on a distant village whose members had done him or his kin no personal harm. He killed the headman of that village on this raid. But this *unokai* had married into his current village recently and had lost no genetic kin to raiders of the enemy village. He explained that his wife grieved so intensely for a sister who had been killed by members of the village that he raided that he felt compelled to avenge her death. He said that his wife was very pleased with his actions. Intensity of grief appears to follow patterns predicted from kin selection theory: female kin grieve more intensely than male kin, and genetically close kin more than less closely related kin [see H. Littlefield and J. Rushton, *J. Personal. Soc. Psychol.* **51**, 797 (1986)].
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27. Approximately 6% of the violent deaths are presently classified as "within group," but some may be found to be "between group." These incidents involved violent conflicts between factions that were in the process of fissioning into two new villages and became new villages at approximately the time of these killings.
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34. Values in Table 1 were calculated as follows. Each individual was compared to all members of his or her village to determine the identities of any common ancestors. The genealogies are from three to five generations deep, depending on the ages of the individuals compared. Genealogical connections between pairs of related individuals were established for every identifiable common ancestor and the coefficient of relatedness for each connection was calculated and summed. The quartiles in Table 1 are based on the definition that a person is related to another if at least one genealogical connection between them has been established in the computer search for common ancestors. Closeness of relatedness among individuals was calculated in two ways, with a variant of Wright's formula for coefficient of relatedness (inbreeding coefficients of remote ancestors were not considered). For relatives, Fg[CON], the values of the coefficients of relatedness through all separate loops between Ego and all relatives were added and then divided by the number of relatives to get each Ego's average relatedness to demonstrable relatives. Each Ego's average values were then averaged to give the village average. For all residents, Fg[ALL], the sum of all coefficients of relatedness between Ego and all demonstrable relatives were added and then divided by the total number of residents in the village, including nonrelated residents. These values were then averaged to give the village average.
35. Taken by itself this measure might "inflate" the amount of a society's violence: if all members of a society were related, then a few deaths would result in a statistic showing that a large fraction of people have lost close kin. A standard sociological measure, number of victims per 100,000 population per annum, would be very difficult to estimate in tribal populations where violence waxes and wanes radically over short time spans and where communities are small and scattered. Meaningful

comparable statistics using this measure would require long-term residence by several fieldworkers in many separate villages (*24*).

36. In each of the four age categories, the *unokais* were characterized by both more children and more wives than non-*unokais*. For Table 2, all age categories yielded chi-square values statistically significant at at least the 0.05 level. For Table 3 the chi-square values were not statistically significant for age categories 25 to 30 and 31 to 40 but were at the 0.05 level for the other two age categories. For both Tables 2 and 3, the pooled data (totals) were significant ($P < 0.00001$). In both tables the differences between expected and observed values were in the same direction for all age categories and pooled.
37. R. Spielman, thesis, University of Michigan, Ann Arbor (1971); R. Spielman *et al.*, *Am. J. Phys. Anthropol.* **37**, 345 (1972); R. Spielman, *Am. Nat.* **107**, 694 (1973). During the anthropometric field studies the biomedical personnel, unfamiliar with the life histories of the individuals, informally attempted to guess whether or not particular men being measured were among the *waiteri* (fierce ones), were political leaders, or were otherwise prominent in the group; comparison of their predictions against my life history data on these same individuals showed uniformly poor results.
38. Many U.S. congressmen are and traditionally have been reserve officers in the U.S. Army [E. Hoebel, in *War: The Anthropology of Armed Conflict and Aggression*, M. Fried, R. Murphy, M. Harris, Eds. (Natural History Press, Garden City, NY, 1968), pp. 208–210].
39. L. Betzig, *Despotism and Differential Reproduction: A Darwinian View of History* (Aldine, New York, 1986).
40. C. Levi-Strauss, in an article on "chieftainship" in a South American tribal society, the Nambikwara of Brazil [*Trans. N.Y. Acad. Sci.* **7**, 16 (1944)], argued that tribal communities might profitably be viewed as clusters of people who form around prominent men whose only compensation for the onerous tasks of leadership was the concession the group made to the leaders in the form of multiple wives.
41. Ironically, this man was married polyandrously. His duties as a practical nurse did not allow him time to garden so he had to compromise and share his wife with another man who had a garden.
42. Field research was sponsored by NSF and the Harry Frank Guggenheim Foundation and data analysis by the Harry Frank Guggenheim Foundation. I would like to thank R. Alexander, R. Axelrod, D. Brown, R. Carneiro, R. Hames, M. Daly, T. Harding, M. Harrell, W. Irons, M. Meggitt, S. Plattner, D. Symons, R. Thornhill, and P. Van den Berghe, for critical comments on this manuscript. I thank M. de la Luz Ibarra and E. Kargard for assistance with library research, manuscript preparation, graphics, and computer analyses. I thank A. Spaulding for assistance on the statistical tests.

Quantum Mechanics of a Macroscopic Variable: The Phase Difference of a Josephson Junction

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Experiments to investigate the quantum behavior of a macroscopic degree of freedom, namely the phase difference across a Josephson tunnel junction, are described. The experiments involve measurements of the escape rate of the junction from its zero voltage state. Low temperature measurements of the escape rate for junctions that are either nearly undamped or moderately damped agree very closely with predictions for macroscopic quantum tunneling, with no adjustable parameters. Microwave spectroscopy reveals quantized energy levels in the potential well of the junction in excellent agreement with quantum-mechanical calculations. The system can be regarded as a "macroscopic nucleus with wires."

ARE MACROSCOPIC DEGREES OF FREEDOM GOVERNED BY quantum mechanics? Our everyday experience tells us that a classical description appears to be entirely adequate. The trajectory of the center of mass of a billiard ball is predicted wonderfully well by classical mechanics. Even the Brownian motion of a tiny speck of dust in a drop of water is a purely classical phenomenon. Until recently, quantum mechanics manifested itself at the macroscopic level only through such collective phenomena as superconductivity, flux quantization, or the Josephson effect. However, these "macroscopic" effects actually arise from the coherent superposition of a large number of microscopic variables each governed by quantum mechanics. Thus, for example, the current through a Josephson tunnel junction and the phase difference across it are normally treated as classical variables. As Leggett (*1*) has emphasized, one must distinguish carefully between macroscopic quantum phenomena originating in the superposition of a large number of microscopic variables and those displayed by a single macroscopic degree of freedom. It is the latter that we discuss in this article.

Our usual observations on a billiard ball or Brownian particle reveal classical behavior because Planck's constant $\hbar$ is so tiny. However, at least in principle there is nothing to prevent us from designing an experiment in which these objects are quantum mechanical. To do so we have to satisfy two criteria: (i) the thermal energy must be small compared with the separation of the quantized energy levels, and (ii) the macroscopic degree of freedom must be sufficiently decoupled from all other degrees of freedom if the lifetime of the quantum states is to be longer than the characteristic time scale of the system (*1*). To illustrate the application of these criteria, following Leggett (*1*) we consider a simple harmonic oscillator consisting of an inductor L connected in parallel with a capacitor C. The flux Φ in the inductor and charge q on the capacitor are macroscopic conjugate variables. Observations on the oscillator are made by means of leads that unavoidably couple it to the environment. The dissipation so introduced is represented by a resistor R in parallel with L and C. The natural angular frequency of oscillation is $\omega_0 = (LC)^{-1/2}$, the impedance at the resonance frequency is $Z_0 = (L/C)^{1/2}$, and the quality factor (ratio of stored energy to energy dissipated in one oscillation) is $Q = \omega_0 CR = R/Z_0$. To observe quantum effects we thus require (i) $\hbar\omega_0 >> k_B T$, where

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