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# Life histories, blood revenge, and reproductive success among the Waorani of Ecuador

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**The Waorani may have the highest rate of homicide of any society known to anthropology. We interviewed 121 Waorani elders of both sexes to obtain genealogical information and recollections of raids in which they and their relatives participated. We also obtained complete raiding histories of 95 warriors. An analysis of the raiding histories, marital trajectories, and reproductive histories of these men reveals that more aggressive warriors have lower indices of reproductive success than their milder brethren. This result contrasts the findings of Chagnon [Chagnon N (1988) *Science* 239:985–992] for the Yanomamo. We suggest that the spacing of revenge raids may be involved in the explanation of why the consequences of aggressiveness differ between these 2 warlike lowland South American peoples.**

lowland South America | warfare | Yanomamo

In 1988, Napoleon Chagnon (1) published evidence indicating that, among the famously warlike Yanomamo of Venezuela, living men who were labeled as *unokai* for having undergone a rite of purification after participating in a homicide had significantly more wives and children than their less bellicose brethren. The suggestion that more aggressive males enjoyed an individual fitness advantage over milder men provoked an unusual amount of comment and response, both from scholars with significant field experience among the Yanomamo and other warlike tribal societies (2–10), and from armchair anthropologists and the popular press.

The investigation reported here is not an evaluation of Chagnon's model per se, or an attempt simply to replicate his study within another society. Rather, it is an exploration of what appears to be the most contentious of the issues raised by his article and its critics, namely that the presence or absence of fitness differences among men correlates with differences in aggressiveness. The data used here, collected during the Waorani Life History Project (WLHP), come from the Waorani of Ecuador, a people even more warlike than the Yanomamo.

Although Chagnon (1) was careful to assert that “the argument that cultural success leads to biological success among the Yanomamo might be the most promising avenue of investigation to account for the high reproductive success of *unokais*,” much of the critical response to his article took a more extreme stance. Chagnon's critics argued that he contended that natural and/or sexual selection worked among the Yanomamo to promote alleles for aggressive behavior—that is, that microevolution was selecting for male aggressiveness. The present study of the Waorani addresses the basis for the unusually fierce criticism of his article.

To avoid some of the methodological objections raised to Chagnon's work, we included in our sample of warriors both living and dead men; we ranked their aggression by the number of raids they participated in and not by a local term of contested meaning with which they are labeled. Our analysis is free of the problem caused by the inherent correlation of the warrior's age with both participation in raids and reproductive success.

## Overview

The Waorani (Huaorani, Waodani, Auca) of Ecuador, are known to be even more warlike than the Yanomamo. Chagnon (1) reported that 30% of adult male Yanomamo deaths were caused by warfare; in contrast, women and children had substantially lower warfare death rates. The corresponding rates for the Waorani are all considerably higher.

At the time of first peaceful contact, the Waorani (the singular and the adjectival form is Wao) were the only human inhabitants of a region about the size of New Jersey\* (28), located east of the Andes between the Napo and Curaray rivers. Although occasionally traversing the region or hunting in it, neighboring groups were afraid to settle there, and with good reason. When the Waorani found invaders, they speared them. Their reputation for ferocity was earned by violence against each other as well as outsiders. In a genealogy of 551 individuals going back over 5 generations, Larrick et al. (11) found that 42% of all population losses were caused by Waorani killing other Waorani. These homicides accounted for 54% of male and 39% of female deaths at all ages (12). In addition to this 42%, another 8% of Waorani were killed by neighboring cultural groups (lowland Quichua, Ecuadorian nationals, international oil company employees—all called *kowodi* by the Waorani). The abductions of women and children by other cultural groups (about 9% of individuals lost to the Wao population), and their flight to escape from homicidal pursuers (about 5% of losses), brings to 64% the proportion of all Wao population losses attributable to warfare and the threat of violence (11). This figure refers to the entire population, including women, children, and infants, as well as adult males. Most outmigrants, both captured and voluntary, died of infectious diseases shortly after leaving their territory, so the majority of losses due to flight and abduction should properly be classified as mortality rather than migration.

The general objective of the WLHP is to test various hypotheses dealing with the impacts of this extraordinary rate of lethal violence on individual and inclusive fitness. We focus here on hypotheses concerning the individual fitness consequences of participation in warfare: How a Wao man's participation in raiding correlates with his survivorship, with that of his wives, with the number of wives that he acquired, with the number of ever-born children he produced, and with their survivorship—life history features presumably linked to individual fitness.

Author contributions: S.B. and P.I.E. designed research; S.B., P.I.E., J.Y., J.R., L.J., and M.I. performed research; C.S. and K.L. contributed new reagents/analytic tools; P.I.E., C.S., and K.L. analyzed data; and S.B. wrote the paper.

The authors declare no conflict of interest.

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\*We (Beckerman and Yost, 2007) have previously likened the size of precontact Waorani territory to Massachusetts; New Jersey is closer to the correct size.

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**Ethnographic Background.** The Waorani are interfluvial lowland tropical rainforest horticulturalist/foragers speaking a language unrelated to any other. The best-informed ethnographic summaries are provided by Yost (13) and Wilson and Yost (12); an ethnography by Robarchek and Robarchek (9) is generally reliable, although weakened by sermonizing; a dissertation by Lu (14) focuses on subsistence ecology; a volume by Cabodevilla (15) compiles much historical information, although the text sometimes overreaches the data; a book, an encyclopedia article, and a second book by Rival (16–18) are more imaginative than ethnographic and irretrievably flawed by her erroneous insistence that the Waorani are hunters and gatherers.

The traditional Waorani homeland, south of the Napo River where the Amazon Basin touches the feet of the Andes, is recognized as a biodiversity “hot spot,” abounding in vertebrate species in particular. When the first peaceful contact with a single Wao territorial group was made in October, 1958, the total population of Waorani summed to only ≈500 people, the only inhabitants of an area of ≈20,000 km<sup>2</sup>, living at a population density of around .025 person per km<sup>2</sup>.

In light of the documented abundance of wild resources (19) and the exceptionally low human population, resource limitations cannot be invoked as a constraint on such neotropical manioc horticulturalists as the Waorani and can be eliminated as a cause of warfare in either the ultimate or proximate sense. Indeed, it was the abundance of game that attracted lowland Quichua hunters to this area, where they, like all outsiders, were killed by Waorani if discovered.

Aside from the high homicide rate and its effects, traditional Waorani culture was largely unexceptional for interfluvial Amazonian people (*SI Text A*). Based on the then extant ethnographic literature, when James Yost began his work with the Waorani in 1974 (*SI Text B*) he assumed that the most aggressive warriors would enjoy high prestige. Eight years later, he was still unable to convince himself that his assumption had been correct. He had concluded that the major reputational effect of high participation in raiding was a reluctance of others to live with the fiercest warriors because of the danger of return raids. Such reluctance was probably related to the Waorani tendency to flee rather than to fight when attacked. Even the most ferocious warrior cannot protect his coresidents if he tends to run away when raiders storm his longhouse.

Internal warfare ceased as each longhouse group of Waorani was contacted by missionaries, beginning in 1958. Today, most of the ≈2,000 contemporary Waorani are spread among nearly 40 small villages; the majority of them are in an area of 1,700 km<sup>2</sup>, (density >1 person per km<sup>2</sup>), the core of which is a protectorate ceded to the Waorani by the Ecuadorian government in 1968. The total number of villages changes often, as some are abandoned and others created, reflecting the traditional Waorani semisedentary settlement pattern. At the time of our fieldwork there were 23 villages, but a count in 2006 revealed over 35.

**History.** Because the history of the Waorani is important to our understanding of their warfare practices, and because fanciful statements have been published on this subject, an account of what is known about the past of these people is relevant (*SI Text B*).

In summary, January 1956, 5 American missionaries were killed by the Waorani 5 days after they landed their light plane on a sand beach of the Curaray River. The first sustained peaceful contact with the Waorani was made by missionaries Rachel Saint and Elizabeth Elliot, who entered the westernmost territorial group of Waorani in October 1958. In February 1968, a few members of another territorial group joined the settlement established by Saint and Elliot. By June of 1968, the new territorial group had over 100 members at the settlement; in early August 1969, members of a third territorial group joined the settlement. Peace was maintained until a polio epidemic broke out there in late August, resulting in a couple of killings

and causing a number of people to flee. They returned in early 1970. In early 1972, members of the last major territorial group began to move toward the settlement, accepting the invitation to stop raiding. Over the last decades, the Waorani have expanded from the vicinity of the original missionary settlement to recover as much of their old territory as they can.

**The Current Research.** In the course of the WLHP, we collected detailed genealogical information, reproductive histories, raid histories, and life histories from all available Waorani men and women we identified as being age 50 and over in 2000–2001 ( $n = 121$ : 65 women and 56 men). We also interviewed a large number of their offspring. The research was approved by the Institutional Review Boards of Pennsylvania State University and the University of Connecticut; informed consent was obtained from everyone interviewed.

### Methodology

**Data Collection.** One or more members of the field research team<sup>†</sup> traveled to each of the 23 settlements where eligible Waorani resided and interviewed them in their own communities. During the ≈18 months of fieldwork, we interviewed every Wao old enough to have experienced warfare who could be located and who agreed to answer our questions<sup>‡</sup>. We collected the following data from these informants: genealogy and reproductive history, narrative personal life history, and warfare history (*SI Text C*).

**Data Comparison, Compilation, and Dating.** Before the WLHP began, earlier investigators Catherine Peeke and James Yost had spent years with the Waorani beginning in the 1960s. Their information allowed us to make use of 3 independently gathered datasets (*SI Text D*) in compiling a definitive genealogy, working out birth and death dates for the individuals of interest therein, and assigning dates to raids. This work of compilation, evaluation, and dating took place over 3 years, after the major period of fieldwork.

**Current Databases.** The genealogical database consists of a Microsoft Access file designed by James Boster. Each entry has a unique identification number and a list of all names known for that person. The database is structured so as to associate with each individual his/her sex, parents, spouse(s) and children, as well as year of birth and (if deceased) of death when this information is known. The individual's place of residence is also indicated for persons who are alive as well as a notation as to whether the person is alive or dead<sup>§</sup>. The structure of the database allows each individual warrior to be associated with his children, and their birth and death dates. These details are complete for all of the 95 men in the raiding database, including all their wives and children.

<sup>†</sup>The field research team included the US based authors (Stephen Beckerman, Pamela Erickson, James Yost), as well as James Boster; 3 Ecuadorian field assistants (including Jhanira Regalado and Lilia Jaramillo); and 24 young Waorani men and women (including Moises Iromenga), bilingual in *Wao tedeo* and Spanish, and literate in Spanish, who were employed for longer and shorter periods as field assistants and translators.

<sup>‡</sup>We identified participants based on collaboration with the Waorani indigenous organization, Organización de la Nacionalidad Huaorani de la Amazonia Ecuatoriana (ONHAE), and with Waorani field assistants, on James Yost's 30-year knowledge of the population, and by asking in each settlement for the old people (*pikænanî*) living there. Most interviews took place between June 2000 and August 2001, with follow up interviews in January, July, and August 2002, April 2003, and August 2004. Interview sessions with each participant usually lasted from 1 to 3 hours per session; typically there were several sessions per informant, spread over several days. In 3 cases, Waorani elders were interviewed in Puyo, a small town in Pastaza province, where the ONHAE is headquartered.

<sup>§</sup>In some cases we do not know whether individuals born after pacification who have left the Waorani protectorate are alive, but they are not relevant to the present analysis, which cuts off its dataset at the time of pacification. Some other persons are so peripheral to the warriors and their families that we know very little about them. Whether they are alive or dead is irrelevant to the present analysis.

The raiding database is a file that associates with each of the 95 men for whom we have a usable raiding history a list of all raids he participated in, along with a date and an identification number for each raid. This file also contains the year when pacification took place for each warrior's territorial group. The statistical analysis of these databases was carried out by Corey Sparks in 2006–2007.

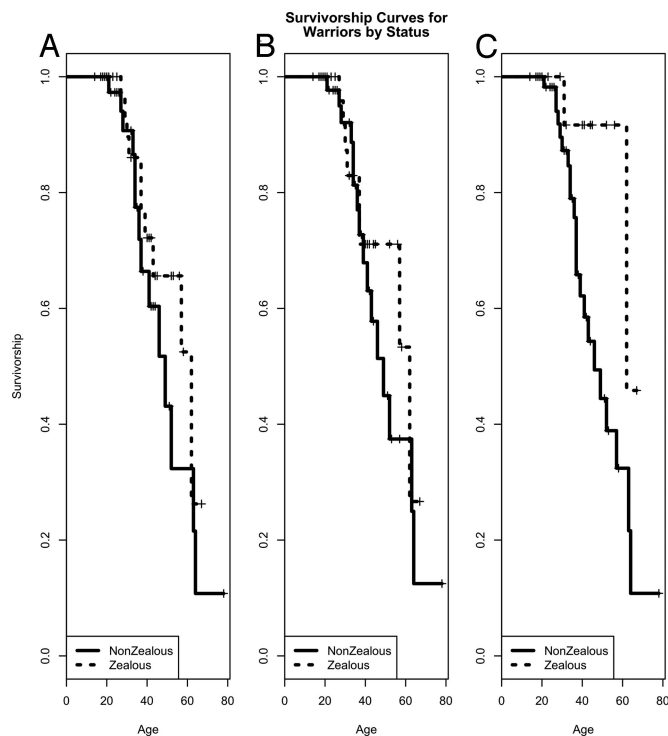
**Hypotheses and Predictions.** The central hypothesis tested in this report is that zealous warriors (we labeled men as zealous warriors if they participated in raiding at an elevated rate) had higher indices of life-history traits relating to individual fitness than did less bellicose men. The life history traits at issue include individual survivorship, survivorship of wives and children, numbers of wives married and numbers of children produced—in short, those attributes that one expects to be associated with men who on average pass on a higher proportion of their alleles to the next generation than others. Predictions that follow from this hypothesis can be tested with our datasets. They are that, compared to men who were not zealous warriors, (i) zealous warriors had higher survivorship than other men; (ii) their wives had higher survivorship than the wives of other men; (iii) they had more wives than other men; (iv) they had more ever-born children than other men; (v) their children had higher survivorship than those of other men; and (vi) they had more children who reached the age of 15 than other men.

The examination of these predictions requires that the data be right-truncated to account for the date of pacification for each warrior who survived until his local group was contacted, because at each date of pacification, the social environment in which survival, marriage, and reproduction took place changed radically (9). The dataset for each warrior who did not die before pacification is truncated at his date of pacification for predictions (i–v), but at his date of pacification – 15 years for prediction (vi).

In analysis, an issue early stressed by Boster emerges—a spurious positive correlation between raw numbers of raids participated in and raw numbers of wives and children acquired by warriors. Because both sets of numbers increase as lifespan increases, driven by their separate associations with the number of years of opportunity to participate in these different activities, a correlation of these raw numbers will inevitably be positive and meaningless. It was this problem that defeated the attempt by Robarchek and Robarchek (9) to perform an analysis similar to that presented here. Lacking data on the life spans of the 48 Waorani warriors whose raiding histories they tabulated, they were only able to make the plausible—and almost certainly correct—argument that men who lived longer participated in more raids, married more wives, and fathered more children.

This difficulty can be overcome, as Boster also pointed out, by examining the cumulative number of raids participated in, and the cumulative numbers of wives and children acquired, as a function of age. Zealous warriors can then be defined as those individuals whose cumulative raid curve exceeds the curve of mean numbers of raids per age for all men. The cumulative curves for the acquisition of wives and children by these more bellicose men can then be compared to the mean cumulative matrimonial and reproductive success curves of men who are not zealous warriors.

Another way of overcoming the inevitable positive association of raw numbers of raids and reproductive success is by expressing raiding, marrying, and reproduction as yearly rates rather than as raw numbers, and testing the significance of the correlations between the first of these rates and the other two. However, the expression of raiding as a rate, when taken as the total number of raids in which a man participated, divided by the total number of years that he was “eligible” (see further below in this section) to raid, raises a secondary difficulty, also emphasized by Boster, namely that the very highest raiding rate is then associated with very young men who went on a single raid and then were pacified, or died, almost immediately. Since a man's first raid is the one when he knows the least about what he is getting into, and the autonomy



**Fig. 1.** Survivorship curves for warriors by status (zealous vs. nonzealous). Test  $\chi^2 = 1$ , 1 df,  $P = 0.31$  (A); Test  $\chi^2 = 0.6$ , 1 df,  $P = 0.45$  (B); and Test  $\chi^2 = 4.3$ , 1 df,  $P = 0.039$  (C).

of his decision to participate or decline is most questionable, there is a problem here. This problem is dealt with in the following analyses by using not the total number of raids a man participated in as the numerator for the lifetime raiding rate, but that total minus one. The denominator for calculating the lifetime raiding rate is the man's years of “eligibility”: his time of exposure to raiding opportunities, taken as the number of years after the man turned 15 until his death or pacification.

**Analysis.** Results of statistical analysis are displayed in Figs. 1–5 and Table 1. Zealous warriors are defined in 3 different ways: (a) individuals whose overall lifetime rate of raiding  $>$  mean for all men; (b) individuals whose overall lifetime rate of raiding  $>$  mean for all men  $+0.5$  standard deviation; and (c) individuals whose overall lifetime rate of raiding  $>$  mean for all men  $+1.0$  standard deviation.

Prediction (i) is for greater survivorship by zealous warriors. Fig. 1A–C present the adult survivorship curves for the zealous and nonzealous warriors corresponding to the definitions given just above. For definitions (a) and (b), there is no statistical difference between the survivorship of zealous and nonzealous warriors ( $\chi^2 = 1$ , 1 df,  $P = 0.31$  and  $\chi^2 = 0.6$ , 1 df,  $P = 0.45$ ). However for definition (c), there is a statistically significant difference ( $\chi^2 = 4.3$ , 1 df,  $P = 0.039$ ), with zealous warriors showing higher survivorship. Still, it should be noted the sample size for the last category is only 14 individuals, so care should be taken in making this interpretation.

Prediction (ii) is for higher survivorship for the wives of zealous warriors. Fig. 2 reveals no difference between the survivorship of wives of zealous warriors and the survivorship of wives of other men for any of the 3 definitions of zealous warriors.

To evaluate the predictions concerning the matrimonial and reproductive success of zealous warriors [predictions (iii–vi)], we performed a series of analyses testing for differences in the cumulative numbers of wives, ever-born children, surviving children, and

**Table 1. Statistical results for life history trait analysis**

Warrior Definition	Variable	Ages of significant differences	Probability level
(a) - Individual mean lifetime rate of raiding > mean for all men			
(a)	Cumulative # of Wives	29–59	<.1
(a)	Cumulative # of children	29–39	<.1
(a)	Cumulative # of children surviving	-	NS
(a)	Total # children surviving to age 15	Total	<.01
(b) - Individual mean lifetime rate of raiding > mean for all men plus 1/2 SD			
(b)	Cumulative # of Wives	29–59	<.1
(b)	Cumulative # of children	29–39	<.1
(b)	Cumulative # of children surviving	-	NS
(b)	Total # children surviving to age 15	Total	<.01
(c) - Individual mean lifetime rate of raiding > mean for all men plus 1 SD			
(c)	Cumulative # of Wives	-	NS
(c)	Cumulative # of children	-	NS
(c)	Cumulative # of children surviving	-	NS
(c)	Total # children surviving to age 15	Total	<.01

total number of children reaching age 15 by the time of pacification. Fig. 3 *A–D* presents the results for the analysis of each of these variables by age and warrior status following definition (*a*) of zealous warrior given above. At each age interval, zealous warriors thus defined acquired fewer wives, produced fewer ever-born children, and had fewer surviving children, although the differences are not statistically significant in some age intervals. Zealous warriors also produced fewer children who survived to age 15.

Figs. 4 *A–D* and 5 *A–D* follow the same formatting but define warrior status as in definitions (*b*) and (*c*) above, respectively. Again, regardless of age category, the more zealous warriors consistently have lower reproductive success. Although the qualitative differences are immediately noticeable throughout Figs. 3–5, the quantitative differences should be viewed with caution. Across the board, for each warrior definition we see significant differences only for some variables and ages; these differences are noted in

Table 1. Once again, we should remain cautious because sample sizes in the definition (*c*) warriors are small; calculations were based on 3 to 7 individuals only, and statistical power is definitely low.

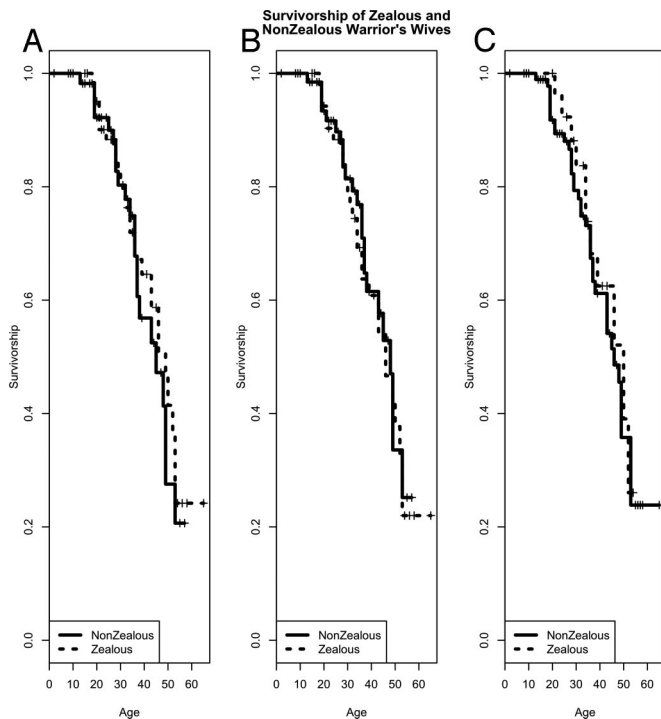
### Discussion

The results we obtained do not agree with those reported by Chagnon (1) for the Yanomamo. Among the Waorani, more aggressive men (i.e., zealous warriors,) no matter how defined, do not acquire more wives than milder men, nor do they have more children, nor do their wives and children survive longer. In fact, the most statistically significant difference revealed by our analysis is in the other direction: Bellicose men have fewer children who survive to reproductive age, a finding that strongly suggests that they have lower individual fitness than less aggressive males.

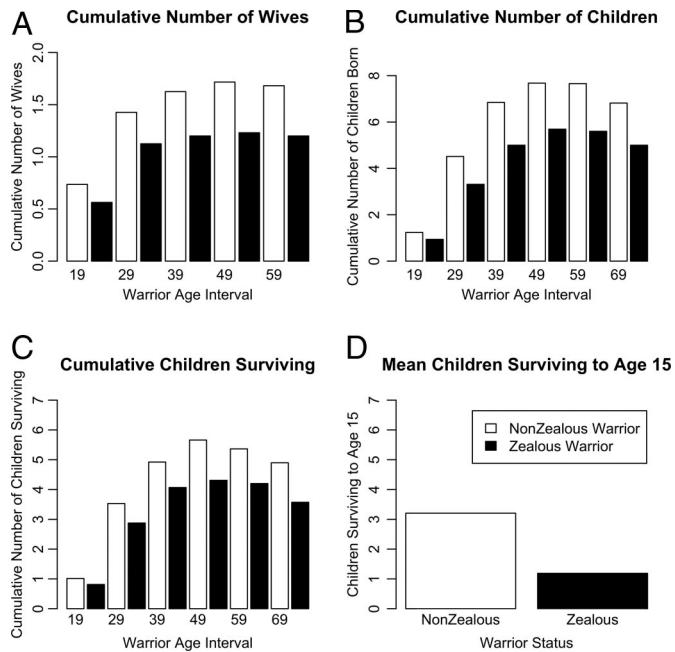
Two questions emerge: Why do our results fail to match Chagnon's findings? And why were Waorani men so bellicose, given that aggressiveness was a questionable strategy at best for men in terms of their survivorship and a losing strategy in terms of their reproduction?

One possible answer to the first question appears in Alès's (20, 21) discussion of Yanomamo warfare. She maintains that Yanomamo male coalitional violence, like that of the Waorani, is ultimately all about revenge. However, she also suggests that the cultural rules guiding Yanomamo violence dictate that an interval of respite follows an exchange of homicides. Tradition dictates that when members of unit *A* kill a member or members of unit *B*, then members of unit *B* should retaliate by killing roughly an equal number of members of unit *A*. Afterward, both sides typically stand down, except for directing sorcery at each other, for about a generation. During this generation of peace, successful warriors on both sides have the opportunity to enjoy the rewards of their martial success: increased access to women, and improved survivorship for their children. A new round of vengeance killing begins between unit *A* and unit *B* only after these reproductive returns from the previous round have been realized (21).

If Alès's assessment is correct, it points to an important difference between the Yanomamo and the Waorani. The Waorani also often take vengeance for a homicide or other injury that occurred in the distant past. When we asked for the motive for a particular raid, a common answer was one or another version of "Their grandfathers had killed our grandfathers." However, we have no evidence that the Waorani have any kind of cultural rule mandating a lapse of time (or restraint in numbers of victims) in revenge exchanges. We found no tradition of standing down, even for a short period, after a rough balance of deaths was achieved. Indeed, a balance, although it might occur by chance, was never sought—the goal was to eliminate the other side. Furthermore, accounts of



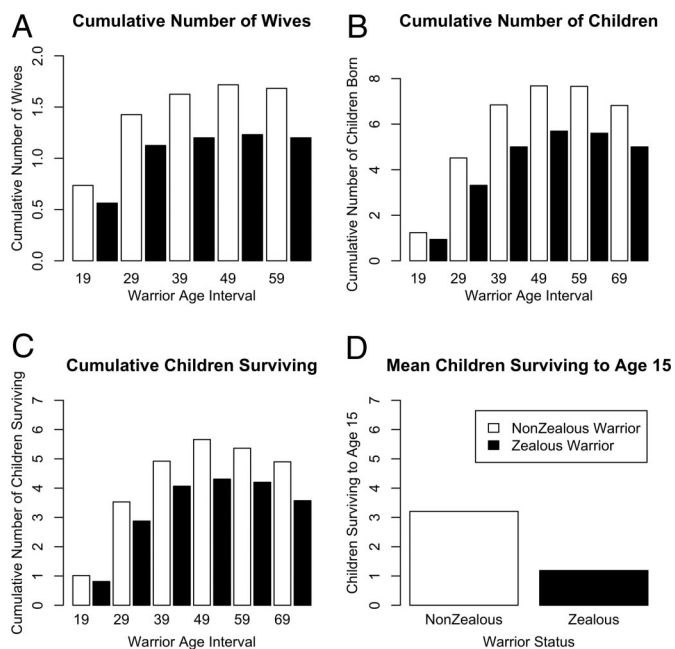
**Fig. 2.** Survivorship of the wives of zealous and nonzealous warriors. Test  $\chi^2 = 0.2$ , 1 df,  $P = 0.621$  (A); Test  $\chi^2 = .1$ , 1 df,  $P = 0.803$  (B); and Test  $\chi^2 = 0.1$ , 1 df,  $P = 0.705$  (C).



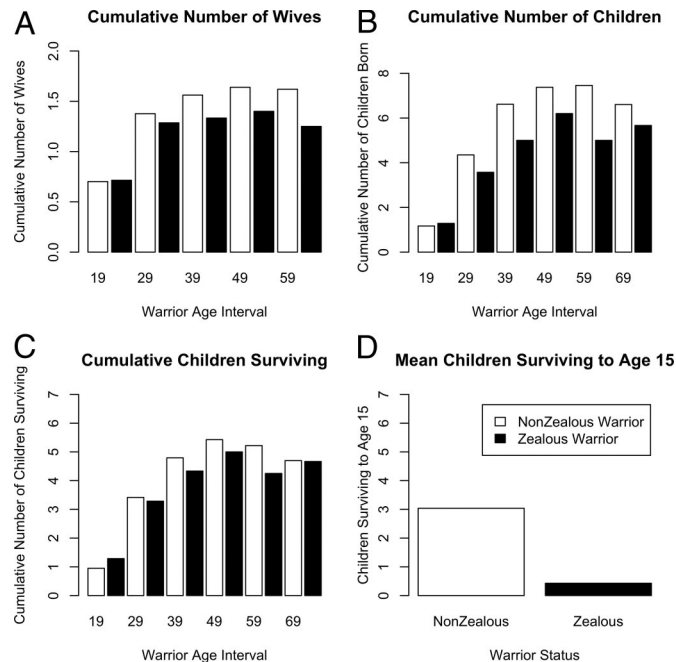
**Fig. 3.** Matrimonial and reproductive success of zealous and nonzealous warriors according to definition (a) of zealous warrior.

particular raids and the events and discussions leading up to them suggest that the standard approach was to act immediately.

If any homicide failed to be avenged promptly (and that failure did sometimes occur), it only meant that the aggrieved party was too young, too frightened, or too weak to respond, or that it believed it was tactically advantageous to wait until the enemies had let down their guard. There was no sense that it was culturally appropriate to introduce a pause in the vengeance cycle as a general rule. If this contrast between Yanomamo and Waorani warfare is valid, it suggests that the pacing of revenge exchanges is important. In order for there to exist even a possibility that an aggressive individual



**Fig. 4.** Matrimonial and reproductive success of zealous and nonzealous warriors according to definition (b) of zealous warrior.



**Fig. 5.** Matrimonial and reproductive success of zealous and nonzealous warriors according to definition (c) of zealous warrior.

enjoys an individual fitness advantage, there must be time for him to use the potential reproductive rewards his bellicosity has earned him. The habitual (although not universal) absence of “down time” among the Waorani (12, 13) may explain the difference between our results and Chagnon’s.

Contrasting cultural patterns may also be implicated in another seminal difference between the 2 societies. Despite their pattern of chronic warfare, the overall Yanomamo population had apparently been growing for at least the past 2 centuries (22, 23), until the malaria epidemics of the 1990s halted this growth. In contrast, the Waorani, as far as we could tell, were well along in the process of killing themselves off at the time of peaceful contact. Another crucial cultural difference may contribute to this demographic contrast. Scholars of the Yanomamo agree that males were killed in much greater numbers in warfare than were females. Using a sample of 610 adult deaths, Chagnon (24) stated that 109 males and 14 females were killed in “raids or duels.” Later, he recorded (25) that in a collection of villages called the Shamatarai population block, in the period to which his population historical data pertained, 52 males were killed in “warfare” (which was distinguished from duels) as well as 5 females (the total number of deaths recorded from all causes was 244). In the Namowei-teri block, 44 males and 9 females were killed in war (total deaths = 315). Apparently the great majority of these remembered deaths were of adults. Reporting actual death records of all ages from these blocks from 1970 to 1974, Melançon (23) recorded 8 males and 1 female killed in warfare, which he distinguished from “infanticide” and “homicide” (total deaths = 118). Early and Peters (26) provided data on deaths at all ages by homicide (as distinct from infanticide) for 4 villages of the Xilixana Yanomami: Out of 237 total deaths, 14 males and 2 females were victims of homicide.

Apparently, male deaths among the Yanomamo from warfare and/or homicide were 5 to 10 times more numerous than female deaths. Among the Waorani, in contrast, male deaths caused by spearing (at all ages) were only 1.4 times more numerous than female deaths from the same cause (12). Waorani willingness to kill women and girls may be responsible for their failure to grow as a population.

With respect to the question of why the Waorani continued to fight even though the men who participated most often in raids gained no fitness advantage, it is possible that the matter of the pacing of the exchange of homicidal revenge raids may be implicated here as well. One of the hypotheses we entertained in designing the WLHP is that Waorani men were caught in a double bind: Pushed to develop, when they were young and in middle life, an early reputation for ferocity to discourage other men from attacking them, they were doomed to create a pool of mortal enemies among the survivors of the people they killed. Comments made to Yost when he first arrived among the Waorani suggested that many men understood their circumstances in those terms. Fig. 1C suggests that this perception may have had some validity for the very fiercest warriors. We should emphasize, however, that the beliefs of teenaged Waorani males about the advantages of gaining a reputation for ferocity may have been no more accurate than the similar beliefs of teenaged gang members in American inner cities.

Life histories collected by Yost and later by the WLHP record 1 incident in which revenge was foregone against a man who was feared because he was a known sorcerer and another in which a revenge raid was planned around avoiding a fearsome warrior (the raiding party killed his wife in his absence). These 2 cases are the only specific instances we know of in which a reputation for being a dangerous man appears to have protected a potential target of revenge. Other accounts of incidents of revenge foregone explain it in terms of disparity in group size (“They were so many and would later come get us”), a wish to avoid a revenge cycle (“His sons would grow up and spear in return”), and a reluctance to confront a vigilant enemy (“If you spear him, he already has his own spear poised and will get one of us. He is on guard”). Our interpretation of these accounts is that an individual reputation for ferocity had only a minor protective effect, if any.

Boster, Yost, and Peeke (27) have argued that most Waorani wanted to escape the endless cycle of reciprocal revenge killings

but were unable to do so because if unit *A* were to refrain from avenging a murder by unit *B*, the refrain would not have been regarded as a peace overture, but simply as a tactical delay. It required the arrival of a new religion, brought by women who had clearly eschewed revenge, to create a situation in which rejecting revenge could be construed as an honest signal of intent not to engage in further vengeance killings.

## Conclusions

Clearly, Waorani men did not gain any individual reproductive advantage by practicing elevated levels of aggression. In fact, they did more poorly in reproductive performance than other men. It is possible, although the statistical power of the inference is low, that the very most aggressive of them did achieve an advantage in survivorship.

Our findings indicate that the Yanomamo situation, in which the more aggressive men had elevated indicators of individual fitness, does not apply to warlike tribal societies in general. The culture-specific particulars of the situation are important. One of the more salient of these cultural specificities is the pacing of homicidal revenge exchanges. More wisdom than is generally recognized may be contained in the folk saying, attributed to many lands and cultures, but perhaps most often to Sicily, “Revenge is a dish best served cold.”

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- Chagnon N (1988) Life histories, blood revenge, and warfare in a tribal population. *Science* 239:985–992.
- Albert B (1989) Yanomami “violence”: Inclusive fitness or ethnographer’s representation? *Curr Anthropol* 30:637–640.
- Albert B (1990) On Yanomami warfare: Rejoinder. *Curr Anthropol* 31:558–563.
- Chagnon N (1989) Response to Ferguson. *Am Ethnol* 16:565–570.
- Chagnon N (1990) On Yanomamo violence: Reply to Albert. *Curr Anthropol* 31:49–53.
- Chagnon N (1995) L’ethnologie du déshonneur: Brief response to Lizot. *Am Ethnol* 22:187–189.
- Moore J (1990) The reproductive success of Cheyenne war chiefs: A contrary case to Chagnon’s Yanomamo. *Curr Anthropol* 31:322–330.
- Lizot J (1994) On warfare: An answer to N. A. Chagnon. *Am Ethnol* 21:845–862.
- Robarchek C, Robarchek C (1998) *Waorani: The Contexts of Violence and War* (Harcourt Brace, Orlando, FL).
- Booth W (1989) Warfare over Yanomamo Indians. *Science* 243:1138–1140.
- Larrick J, Yost J, Kaplan J, King G, Mayhall J (1979) Patterns of health and disease among the Waorani Indians of Eastern Ecuador. *Med Anthropol* 3:147–189.
- Wilson R, Yost J (2002) in *Ethnographic Essays in Cultural Anthropology: A Problem-Based Approach*, eds Morrison RB, Wilson CR (F. E. Peacock Press, Itaska, IL), pp 107–137.
- Yost J (1981) in *Cultural Transformations and Ethnicity in Modern Ecuador*, ed Whitten N (Univ of Illinois Press, Urbana, IL), pp 677–704.
- Lu F (1999) Changes in subsistence patterns and resource use of the Huaorani Indians in the Ecuadorian Amazon. PhD dissertation (Univ of North Carolina, Chapel Hill, North Carolina).
- Cabodevilla MA (1994) *Los Huaorani en la Historia de los Pueblos del Oriente* (Cicame, Coca, Ecuador).
- Rival L (1996) *Hijos del Sol, Padres del Jaguar: Los Huaorani de Ayer y Hoy*. (Abya-Yala, Quito, Ecuador).
- Rival L (1999) in *The Cambridge Encyclopedia of Hunters and Gatherers*, eds Lee R, Daly R (Cambridge Univ Press, Cambridge), pp 101–104.
- Rival L (2002) *Trekking Through History: The Huaorani of Amazonian Ecuador* (Columbia Univ Press, New York).
- Mena P, Stallings J, Regalado J, Cueva R (2000) The sustainability of current hunting practices by the Huaorani. *Hunting for Sustainability in Tropical Forests*, eds Robinson J, Bennett E (Columbia Univ Press, New York), pp 57–78.
- Alès C (2006) *Yanomami, l’ire et le désir* (Éditions, Karthala, Paris).
- Alès C (2008) in *Revenge in the Cultures of Lowland South America*, eds Beckerman S, Valentine P (Univ Press of Florida, Gainesville, FL), pp 60–78.
- Lizot J (1977) Population, resources, and warfare among the Yanomami. *Man* 12:497–517.
- Melançon T (1982) Marriage and reproduction among the Yanomamo Indians of Venezuela. PhD dissertation (Pennsylvania State Univ, University Park, PA).
- Chagnon N (1972) in *The Structure of Human Populations*, eds Harrison G, Boyce A (Clarendon Press, Oxford), pp 252–282.
- Chagnon N (1974) *Studying the Yanomamo* (Holt, Rinehart, and Winston, New York).
- Early J, Peters J (2000) *The Xilixana Yanomami of the Amazon: History, Social Structure, and Population Dynamics* (Univ Press of Florida, Gainesville, FL).
- Boster J, Yost J, Peeke C (2004) Rage, revenge, and religion: Honest signaling of aggression and nonaggression in Waorani coalitional violence. *Ethos* 31:471–494.
- Beckerman S, Yost J (2007) in *Latin American Indigenous Warfare and Ritual Violence*, eds Chacon R, Mendoza R (University of Arizona Press, Tucson, AZ), pp 142–179.