

# Punishment sustains large-scale cooperation in prestate warfare

Sarah Mathew<sup>1</sup> and Robert Boyd

Department of Anthropology, University of California, Los Angeles, CA 90095

Edited by Simon A. Levin, Princeton University, Princeton, NJ, and approved May 16, 2011 (received for review April 12, 2011)

**Understanding cooperation and punishment in small-scale societies is crucial for explaining the origins of human cooperation. We studied warfare among the Turkana, a politically uncentralized, egalitarian, nomadic pastoral society in East Africa. Based on a representative sample of 88 recent raids, we show that the Turkana sustain costly cooperation in combat at a remarkably large scale, at least in part, through punishment of free-riders. Raiding parties comprised several hundred warriors and participants are not kin or day-to-day interactants. Warriors incur substantial risk of death and produce collective benefits. Cowardice and desertions occur, and are punished by community-imposed sanctions, including collective corporal punishment and fines. Furthermore, Turkana norms governing warfare benefit the ethnolinguistic group, a population of a half-million people, at the expense of smaller social groupings. These results challenge current views that punishment is unimportant in small-scale societies and that human cooperation evolved in small groups of kin and familiar individuals. Instead, these results suggest that cooperation at the larger scale of ethnolinguistic units enforced by third-party sanctions could have a deep evolutionary history in the human species.**

public goods | collective action | cultural group selection | parochialism | pastoralists

Over the last 50,000 y, humans have come to dominate the world's biota, in part because we cooperate on larger scales than other mammals. Recent models suggest that informal systems of punishment can maintain cooperation in large groups (1, 2). However, this work leaves two important questions unanswered. First, does punishment actually play an important role in sustaining human cooperation in the absence of formal coercive institutions? In laboratory experiments third parties—individuals who are not the primary party injured by a defection—bear costs to punish defectors (3, 4). However, scholars have questioned whether such punishment exists outside of laboratory settings (5) and, even if punishment does occur, whether it effectively promotes cooperation (6–8). Second, what is the scale of human cooperation? Punishment can sustain cooperation on scales ranging from small kin-based hunter-gatherer bands to large modern states (9). A common view is that the psychology that sustains human cooperation evolved in small foraging bands characterized by modest levels of genetic relatedness and repeated social interactions (10, 11), and this led to a psychology that supports band-level cooperation. According to this view, large-scale cooperation occurs only when this psychology “misfires” in novel modern social environments with coercive institutions. An alternate view is that humans have evolved to cooperate in ethnolinguistic groups (groups with shared cultural norms and language), comprising thousands of unrelated strangers, even without formal coercive institutions (12, 13). According to this view, the scale of human cooperation has been shaped by competition between culturally distinct groups, which led to sanctioning systems that enforce cooperation at the scale of cultural variation. Because much cultural variation is maintained along ethnolinguistic boundaries (14), these models predict cooperation to occur at the scale of ethnolinguistic units. Cooperation on the same scale can also be pro-

moted through genetic evolutionary processes that favor ethnic parochialism (15).

Existing data do not answer these questions. Studies of contemporary hunter-gatherers show that they cooperate extensively in small face-to-face groups (16, 17), and it is evident that politically centralized societies can generate cooperation among thousands of strangers (18). However, numerous societies in human prehistory were larger than those of contemporary hunter-gatherers but still lacked centralized political authority, formal law enforcement, or other coercive institutions. Although ethnographic and oral historical accounts suggest that such societies could mobilize on large scales (19–23), there is little quantitative data on the nature of punishment and the scale of cooperation in these societies (5).

Here we report results from a quantitative study of warfare among nomadic Turkana pastoralists in East Africa that sheds light on these two questions. The Turkana are a large ethnolinguistic group with the social organization of a small-scale society. They are politically uncentralized, egalitarian, and economically undifferentiated. They lack formal or centralized institutions of leadership or coercive authority. They reside in nomadic settlements comprised of households that disperse and aggregate seasonally. The combination of large population size, small-scale social organization, and temporary encampments is not prevalent in contemporary hunter-gatherer populations (22), but did occur in some historically known hunter-gatherers (22, 24, 25). Warfare is a high-stakes form of cooperation. Individual warriors incur the costs of injury or death, but the gains from victory, such as defense, deterrence, or territorial expansion, benefit all. Even when the benefits of victory are not pure public goods (e.g., captured loot), there are still opportunities for shirking during combat that reduce individual risk but also lower the chance of victory. Although archaeological and ethno-historical data showed that war, raiding, and feuding were prevalent in societies without formal political structure (26, 18), few studies address how these societies solved the collective action problem in intergroup conflict.

Based on a representative sample of 88 recent Turkana raids, we find that informal punishment plays an important role in sustaining cooperation in Turkana warfare. Participation in raids has substantial private costs: warriors risk death during combat. The benefits include the jointly acquired loot and nonexcludable benefits, such as deterrence and territorial gain. Cowardice and desertion occur frequently and are punished by the community. Third parties play a critical role in adjudication and meting out punishment, which includes serious sanctions, such as collective corporal punishment and fines. We also find that cooperation occurs at scales much larger than that of foraging bands. Raiding parties are comprised of several hundred unrelated warriors. Participants in

Author contributions: S.M. and R.B. designed research; S.M. performed research; and S.M. and R.B. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

<sup>1</sup>To whom correspondence should be addressed. E-mail: smathew@ucla.edu.

This article contains supporting information online at [www.pnas.org/lookup/suppl/doi:10.1073/pnas.1105604108/-DCSupplemental](http://www.pnas.org/lookup/suppl/doi:10.1073/pnas.1105604108/-DCSupplemental).



Raids also create collective benefits that flow to everyone in the community. Retaliatory raids produce deterrence, a non-excludable good. Such raids are not just a byproduct of a desire for loot; revenge is also an important motive. One participant said that he joined a raid because a neighboring ethnic group had just raided the Turkana. He did not lose any animals, but said that his brother-in-law lost his, and added, "Even if it's not your family, they are Turkanas, like me. So we have to go fight back [against] the enemy." In one raid, the primary goal was revenge, not animals. The raid was initiated quickly after a settlement was attacked so that the enemy would know this attack was retaliation for the recent raid. The warriors set out knowing that they were not likely to acquire animals, and they considered the raid a success even though they returned empty handed.

Large-scale force raids can increase access to grazing areas and crucial dry-season watering holes. The precipitating event for one of the largest raids in the sample was a hunter's discovery that herders from another ethnic group had settled at a watering site that is typically used by the Turkana. The stated goal was to drive them away from Turkana territory. Furthermore, settlements move away from sites of raids, and this can lead to substantial shifts in the territorial ranges of ethnic groups over time.

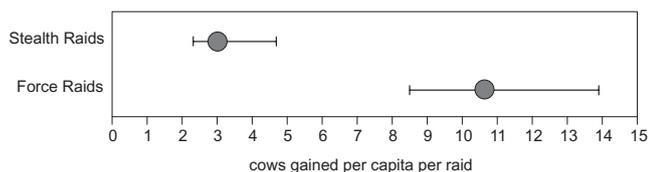
### Cooperation in Warfare Occurs at Large Scales

The Turkana mobilize a large number of warriors for force raids (Fig. 4). On average, 315 men participate in a raid, and the median is 248 men. Furthermore, participants in force raids are not all close associates: they are drawn from an average of five age-groups, four settlements, and three territorial sections (Fig. 5). Territorial sections number about 25,000 people, settlements and age-groups a few hundred. Although there are social ties that bridge these groupings, day-to-day interactions typically occur within them. When asked whether they recognized the men gathered for a raid, participants typically responded that there were some men they knew and some men they did not recognize. A warrior has on average only four of his close kin—father, son, full or half brother, brother-in-law, or full cousin—with him on a force-raid. Stealth raids are much smaller, averaging 12 warriors. A warrior has on average one close kinsmen with him on a stealth raid.

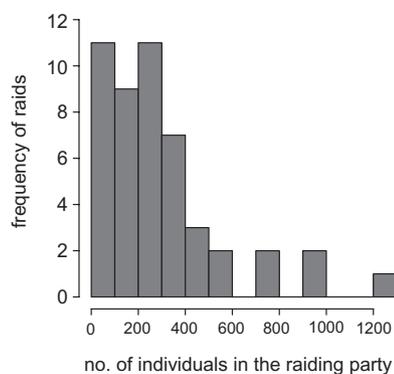
### Free Riding Occurs During Raids

A Turkana man is regularly faced with the option of joining a raid or staying back. Recruitment is informal: a raid is initiated by one or a few men who send word out, encouraging men from other settlements to join, and over the course of a few days warriors from various settlements trickle in to the settlement that has initiated the raid. A man can refuse to join the raiding party, but he needs a good reason, such as the lack of a suitable person to take over herding duties, the need to defend the settlement, being ill, not having a rifle, or having joined recent raids.

The raiding party travels on foot for one or more days to the place where scouts have located an enemy settlement. Along the way, men turn back. They may escape at night unnoticed, or tell



**Fig. 3.** The primary benefit of joining a raid is the livestock acquired. The average per capita gain in a stealth raid is 3 cows and in a force raid is 11 cows. Estimates are based on the share of livestock acquired by the focal warriors in 34 stealth raids and 53 force raids. Error bars represent 68% confidence interval.



**Fig. 4.** The number of warriors in a force raiding party. The average size of a force raiding party is 315 warriors and the median is 248.

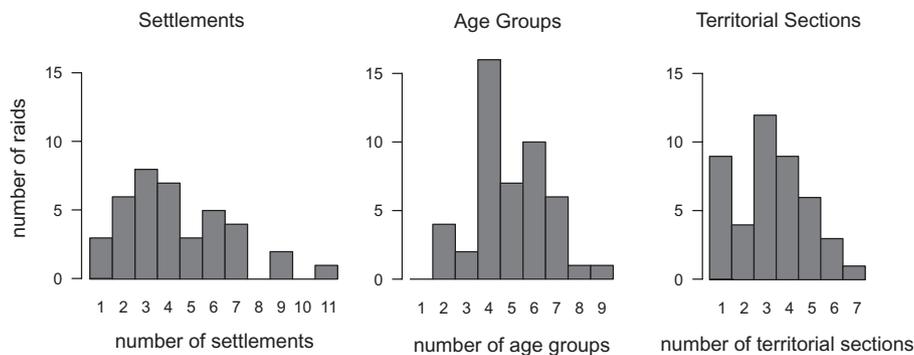
their age-mates that they are ill, worried about their herds back at home, or have a premonition that they will die on this raid. Such desertions occurred in at least 43% of force raids (Fig. 6). This estimate is a lower-bound because it only includes desertions of which the interviewee was aware. Participants said that they would not know of discreet departures by men outside their age-group or settlement.

Warriors have many opportunities to reduce their risk during combat. The fighting begins when the raiding party surrounds the settlement, pasture, or watering point and opens fire. As soon as the offense gains the upper hand, fast young men begin to drive the cattle toward Turkana land, as seasoned warriors engage in a holding action to keep the pursuit at bay, continuing to fight as they retreat. During combat, men constantly urge each other to stand their ground, fire their weapon, and not to run away. In 45% of force raids in which combat occurred, the focal warrior knew of men who lagged behind others during combat, failed to fire their weapons, ran away when the fire-fight began, or retreated too quickly (Fig. 6). Again, this estimate is a lower-bound because warriors report that they mainly know about the behavior of men standing alongside them.

Finally, the jointly acquired loot can be unfairly appropriated. The men driving the cattle homeward are supposed to continue until they are safely within Turkana territory and then wait for the rest of the warriors to rejoin them. Once regrouped, they divide the spoils before they disperse to their respective settlements. Norms specify that members of senior age groups get a larger allocation than members of junior age groups, and that men within an age group get roughly equal shares. However, the loot-sharing system failed in 56% of the force raids, and some participants took whatever livestock they were able to drive off (Fig. 6). Some men position themselves in the rear, a safe distance away from combat, wait for the vanguard to start releasing the livestock, and appropriate the best of the spoils.

### Free Riders Are Sanctioned

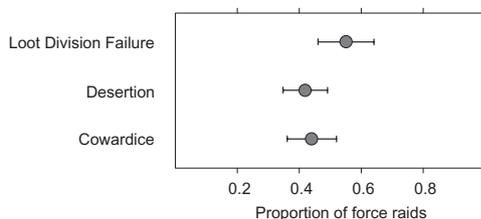
Informally enforced norms allow the Turkana to partially solve the collective action problem in warfare. In 47% of the force raids in which desertions were reported, at least one of the deserters was sanctioned, and in 67% of the force raids in which cowardice was reported, at least one of the cowards was sanctioned (Fig. 7). There are two levels of sanctions. When a warrior's behavior in a raid deviates from that of his comrades, he is subjected to informal verbal sanctions by his age-mates, women, and seniors. If there is consensus in the community that the act merits more serious sanctions, corporal punishment is initiated. Corporal punishment is severe: the coward or deserter is tied to a tree and beaten by his age-mates. One participant had scars on his torso from being whipped by his age group more than a decade earlier.



**Fig. 5.** The number of distinct social units from which participants of a force raiding party are drawn. Settlements, age groups, and territorial sections are social divisions in Turkana society within which day-to-day interactions are most likely to take place. Force raiding parties are comprised of men drawn from an average of four settlements, five age-groups, and three territorial sections.

During this process the violator is told not to repeat this mistake. Corporal punishment often culminates with the violator pleading for forgiveness and sacrificing an animal from his herd. Sanctioners do not confiscate the violator's share of the loot. Instead, the loss of the animal represents a "fine" that is then consumed by his age-mates and other older men. In force raids, there were 20 violations (combining desertion and cowardice) in which at least one of the violators was sanctioned (from Fig. 7). In nine of these cases corporal punishment or fines were imposed. In one case only 3 d had passed since the raid, and there was talk that further sanctions would soon be initiated. Of the nine cases in which serious sanctions were imposed, six involved corporal punishment followed by fines, two involved only corporal punishment, and one involved only a fine. In addition to these nine cases, in 2 of the 20 sanctioned cases the coward's share of the loot was reduced at the time of loot division. In stealth raids, only one of the five sanctioned violations involved a fine, and none involved corporal punishment. In a second case there was talk that further sanctions should be imposed but this had not yet been carried out at the time of the interview (20 d after their return). It is possible that the mechanisms maintaining cooperation in force and stealth raids differ, and collective corporal punishment may be more important in force raids.

The patterns of sanctioning suggest that the system relies on third parties. First, community consensus determines whether someone deserves corporal sanctions. The violator's behavior in the course of the raid is discussed extensively, especially among his local age group. When people from his settlement see the violator, they ask him what happened and why he did what he did. They chastise him for endangering other men and remind him that his fellow warriors died that day in battle. Opinions about whether he should face further punishment often differ. Some



**Fig. 6.** Proportion of force raids in which free riding in the form of cowardice and desertion was noticed and norms regarding loot-sharing were not followed. The estimate for desertion is based on 49 force raids that were initiated, cowardice is based on 40 force raids in which combat occurred, and loot division is based on 32 force raids in which the raiding party was successful. Error bars show one SE.

may feel he should be excused this time as he has not acted like this before. Others will say his behavior was justified because it allowed him to save himself. Some may feel there is no use trying to change him because he is an inveterate coward. Still others will say that unless he is punished he will continue in these wrong ways. Second, once a consensus emerges, members of the violator's age group are responsible for administering punishment, even if they did not participate in the raid and did not experience the consequences of the violation. Third, the collective nature of the corporal sanctions is important. A sufficient number of age-mates must be present, and imposition of sanctions is often delayed because men are dispersed widely and busy with their herding duties. Fourth, both a failure to mete out justified punishment and second-party sanctioning without prior consensus are met with community disapproval. Finally, both deserters and cowards in force raids face similar corporal punishment. If only the victims of a violation initiate sanctions, we should expect that cowards would be punished by the men they endangered, and that deserters should escape sanctions. In raids numbering hundreds of people fighting without a well-defined unit structure, a desertion does not create a primary injured party with a sufficient motivation to impose sanctions.

The fact that direct punishment creates incentives to contribute to the combat efforts does not imply that it is the only factor sustaining the observed large-scale cooperation. We think that positive incentives—rewarding men who are brave in combat—also play a crucial role. However, rewards for bravery in this ethnographic context, are not associated with a single act. Instead, a warrior accumulates these benefits over a long period. Accurately measuring these diffuse benefits and the diffuse costs associated with indirect sanctions is difficult, and distinguishing the effect of behavior during warfare from the effect of other factors that affect a person's value as a social or mating partner is beyond the scope of the present study. However, we can conclude from the rate of direct punishment that, important as indirect sanctions and rewards may be, they cannot be the full story: if they created sufficient incentives, there would be no need for direct punishment.

### Norms Governing Warfare Are Beneficial on Large Scales

A vignette study indicates that Turkana norms governing warfare benefit the ethnolinguistic group, not smaller social groupings in which people are more likely to know each other. Twenty-four subjects, all drawn from the Kwatela territorial section, heard two scenarios. In one scenario, two Kwatela warriors raid animals from the Toposa, another ethnic group, and bring them home to Kwatela land. In the other scenario, two Kwatela warriors raid animals from the Lukumong, another Turkana territorial section, and bring the loot home to Kwatela land. We alternated the order



societies are consistent with this claim. In most mammals, individuals participate in collective violence only in small groups, or with kin. For example, chimpanzee border patrols typically involve 5 to 15 males of the same community (35). In contrast, costly large-scale intercolony combat is common in a range of eusocial insects. The fact that humans are able to solve the collective action problem in large groups may explain why combat involving groups of hundreds of warriors on a side has been documented in hunter-gatherers (22–24, 36, 37) (see *SI Appendix, Section 5* for more examples).

These results imply that large-scale cooperation may have been common for a long period of human evolutionary history. The Turkana cooperate in large-scale combat without political centralization and formal institutions. This fact suggests that early human societies could have done the same. Moreover, warfare is

only one domain of collective action, and is particularly costly to individual participants. Although there could be something unique about warfare that facilitates cooperation, it is plausible that if societies can solve the collective action problem in large-scale warfare, they can also solve myriad lower-stakes collective action problems, and this ability likely played a critical role in the ecological success of our species.

**ACKNOWLEDGMENTS.** We thank Clark Barrett, Monique Borgerhoff-Mulder, Sam Bowles, Sam Boyd, Ernst Fehr, Dan Fessler, Kim Hill, Cristina Moya, Karthik Panchanathan, Joan Silk, Eric Alden Smith, and two anonymous reviewers for useful comments on previous drafts of this article. This research was supported by National Science Foundation Doctoral Dissertation Improvement Grant BCS 0850816, a Leakey Foundation Research grant, an Owen Aldis award, and a Harry Frank Guggenheim Dissertation fellowship; and National Institutes of Health Grant 1RC1TW008631 (to R.B.).

- Boyd R, Gintis H, Bowles S (2010) Coordinated punishment of defectors sustains cooperation and can proliferate when rare. *Science* 328:617–620.
- Hauert C, Traulsen A, Brandt H, Nowak MA, Sigmund K (2007) Via freedom to coercion: The emergence of costly punishment. *Science* 316:1905–1907.
- Henrich J, et al. (2006) Costly punishment across human societies. *Science* 312:1767–1770.
- Bernhard H, Fischbacher U, Fehr E (2006) Parochial altruism in humans. *Nature* 442:912–915.
- Guala F (2011) Reciprocity: Weak or strong? What punishment experiments do (and do not) demonstrate. *Behav Brain Sci*. in press.
- Dreber A, Rand DG, Fudenberg D, Nowak MA (2008) Winners don't punish. *Nature* 452:348–351.
- Ohtsuki H, Iwasa Y, Nowak MA (2009) Indirect reciprocity provides only a narrow margin of efficiency for costly punishment. *Nature* 457(7225):79–82.
- Rand DG, Dreber A, Ellingsen T, Fudenberg D, Nowak MA (2009) Positive interactions promote public cooperation. *Science* 325:1272–1275.
- Boyd R, Richerson PJ (1992) Punishment allows the evolution of cooperation (or anything else) in sizable groups. *Ethol Sociobiol* 13(3):171–195.
- Hagen EH, Hammerstein P (2006) Game theory and human evolution: A critique of some recent interpretations of experimental games. *Theor Popul Biol* 69:339–348.
- Kurzban R, Tooby J, Cosmides L (2001) Can race be erased? Coalitional computation and social categorization. *Proc Natl Acad Sci USA* 98:15387–15392.
- Henrich J (2004) Cultural group selection, coevolutionary processes and large-scale cooperation. *J Econ Behav Organ* 53(1):3–35.
- Boyd R, Richerson PJ (2009) Culture and the evolution of human cooperation. *Philos Trans R Soc Lond B Biol Sci* 364:3281–3288.
- Guglielmino CR, Viganotti C, Hewlett B, Cavalli-Sforza LL (1995) Cultural variation in Africa: Role of mechanisms of transmission and adaptation. *Proc Natl Acad Sci USA* 92:7585–7589.
- Choi JK, Bowles S (2007) The coevolution of parochial altruism and war. *Science* 318:636–640.
- Gurven M (2004) To give and to give not: The behavioral ecology of human food transfers. *Behav Brain Sci* 27:543–583.
- Hill K, Hurtado AM (2009) Cooperative breeding in South American hunter-gatherers. *Proc Biol Sci* 276:3863–3870.
- Gat A (2006) *War in Human Civilization* (Oxford University Press, Oxford).
- Dyson-Hudson N (1966) *Karimojong Politics* (Clarendon Press, Oxford).
- Meggitt MJ (1965) *Desert People: A Study of the Walbiri Aborigines of Central Australia* (University of Chicago Press, Chicago).
- Hamalainen P (2008) *The Comanche Empire (The Lamar Series in Western History)* (Yale University Press, New Haven, CT).
- Lourandos H (1997) *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory* (Cambridge University Press, Cambridge).
- Secoy F (1953) *Changing Military Patterns on the Great Plains* (University of Nebraska Press, Lincoln, NE).
- Kroeber AL (1976) *Handbook of California Indians* (Dover Publications, New York).
- Keen I (2004) *Aboriginal Economy and Society: Australia at the Threshold of Colonization* (Oxford University Press, Oxford).
- Bowles S (2009) Did warfare among ancestral hunter-gatherers affect the evolution of human social behaviors? *Science* 324:1293–1298.
- Little MA, Leslie PW, eds (1999) *Turkana Herders of the Dry Savanna: Ecology and Biobehavioral Response of Nomads to an Uncertain Environment* (Oxford University Press, Oxford).
- McCabe T (2004) *Cattle Bring Us to Our Enemies: Turkana Ecology, Politics, and Raiding in a Disequilibrium System* (University of Michigan Press, Ann Arbor, MI).
- Paul LM, ed (2009) *Ethnologue: Languages of the World* (SIL International, Dallas, TX), 16th ed.
- Gulliver PH (1958) The Turkana age organization. *Am Anthropol* 60:900–922.
- van der Jagt KA (1989) *Symbolic structures in Turkana religion* (Van Gorcum, Assen/Maastricht, The Netherlands).
- Eaton D (2008) The business of peace: Raiding and peace work along the Kenya - Uganda border. *Afr Aff (Lond)* 107(427):89–110.
- Lamphear J (1976) *The Traditional History of the Jie of Uganda* (Clarendon Press, Oxford).
- Evans-Pritchard E (1940) *The Nuer: A Description of the Modes of Livelihood and Political Institutions of a Nilotic People* (Oxford University Press, Oxford).
- Wilson ML, Wrangham RW (2003) Intergroup relations in chimpanzees. *Annu Rev Anthropol* 32:363–392.
- Burch ES (2007) *North American Indigenous Warfare and Ritual Violence*, eds Chacon RJ, Mendoza RG (University of Arizona Press, Tucson, AZ), pp 11–29.
- Maschner HDG, Reedy-Maschner KL (1998) Raid, retreat, defend (repeat): The archaeology and ethnohistory of warfare on the North Pacific Rim. *J Anthropol Archaeol* 17(1):19–51.