

## Warfare and the Evolution of Social Complexity: A Multilevel-Selection Approach

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### *Summary*

Multilevel selection is a powerful theoretical framework for understanding how complex hierarchical systems evolve by iteratively adding control levels. Here I apply this framework to a major transition in human social evolution, from small-scale egalitarian groups to large-scale hierarchical societies such as states and empires. A major mathematical result in multilevel selection, the Price equation, specifies the conditions concerning the structure of cultural variation and selective pressures that promote evolution of larger-scale societies. Specifically, large states should arise in regions where culturally very different people are in contact, and where interpolity competition – warfare – is particularly intense. For the period of human history between the Axial Age and the Industrial Revolution, conditions particularly favorable for the rise of large empires obtained on *steppe frontiers*, regions where nomadic pastoralists and settled agriculturalists lived in close proximity. An empirical investigation of warfare lethality, focusing on the fates of populations of conquered cities, indicates that genocide was an order of magnitude more frequent in steppe-frontier wars than in wars between culturally similar groups. An overall empirical test of the theory's predictions shows that over ninety percent of largest historical empires arose in world regions classified as steppe frontiers.

### **Introduction: the Puzzle of Ultrasociality**

When World War I broke out in August 1914 patriotic crowds in Vienna, Berlin, and London demonstrated in support of their governments' decision to enter the war. More remarkably, young men volunteered in large numbers for military service. In the United Kingdom 300,000 men enlisted in August alone, and more than 2.5 million throughout the war (Ferguson 1999:198). The British government did not need to institute the draft until 1916. Huge numbers of these men were killed (close to a million in Britain alone); others were physically maimed (1.6 million in Britain) or psychologically scarred for life (Urlanis 1971). Such willingness to sacrifice life and limb for the sake of a nation—an imaginary construct with uncertain boundaries encompassing millions of people, most of whom could never even hope to meet each other—presents a huge problem to the standard evolutionary theory. It is a central part of the “puzzle of ultrasociality”—the ability of humans to form cooperating societies consisting of huge numbers of genetically unrelated individuals (Campbell 1983, Richerson and Boyd 1998).

It may seem strange to equate cooperation with warfare, but war involves both the commitment of morally repugnant atrocities and morally uplifting stories of selfless heroism. A fruitful conceptual framework for the study of this human activity, which involves both coercion

and cooperation, is offered by the theory of multilevel selection (Bowles 2006, 2009, Richerson and Boyd 1998, 2005, Sober and Wilson 1991, Wilson and Wilson 2007). Simply put, individuals within a group must cooperate with each other in order to inflict lethal force on other groups. Conflict between groups is only possible from the basis of within-group cooperation.

Multilevel selection theory provides an extremely powerful framework for the study of cooperation in a broad sense. The theory helps us understand how genes cooperate in genomes, organelles (originally, bacteria-like organisms) cooperate in eukaryotic (nucleated) cells, cells cooperate in multicellular organisms, and organisms cooperate in social groups (Wilson and Wilson 2007). In this paper I apply multilevel selection theory to the question of the evolution of complex societies, which are conceptualized as hierarchically organized entities consisting of social groups (groups of groups, groups of groups of groups, and so on).

The paper is organized as follows. I begin by discussing the recent theoretical and empirical results on the role of intergroup conflict in the evolution of small-scale (“simple”) societies. My claim is that the theory of the evolution of cooperation in small-scale, egalitarian societies is rapidly maturing. However, the situation is very different when we consider large-scale societies – hierarchically complex and inegalitarian states and empires. The core of the paper is the development of a theory that addresses this issue. Next, I subject a key assumption of the theory and its overall predictions to empirical tests.

### **Evolution of Sociality in Small-Scale Societies**

Our theories of how small-scale sociality (groups of hundreds, sometimes a few thousands) evolved in humans are rapidly maturing. The relevant conceptual framework is the theory of multilevel selection (Bowles 2006, Boyd and Richerson 1985, Choi and Bowles 2007, Lehmann and Feldman 2008, Richerson and Boyd 1998, 2005, Sober and Wilson 1991, Turchin 2006, Wilson 2002). The basic outlines of the explanation, however, were present already in Charles Darwin’s *The Descent of Man*, as well as in the works of such nineteenth century thinkers as Herbert Spencer or Walter Bagehot (Dawson 2002). “Selfish and contentious people will not cohere, and without coherence, nothing can be effected. A tribe possessing ... a greater number of courageous, sympathetic, and faithful members, who were always ready to warn each other of danger, to aid and defend each other ... would spread and be victorious over other tribes” (Darwin 1871). This mechanism of “group selection” was widely, if uncritically, accepted until the mid-twentieth century. In the 1960s–1970s it was severely criticized (Williams 1966) and replaced by the “individual selectionist” dogma (Dawkins 1976). In the last decade, however, it is becoming accepted that natural selection operates at all levels simultaneously—genes, cells, organisms, groups of relatives, and even groups of unrelated individuals. Multilevel selection provides the conceptual framework for the study of the evolutionary forces acting on different levels of organization.

The power of the multilevel selection framework is most apparent when the theory is applied to traits that have divergent effects at different levels of biological or social organization.

The paradigmatic example is an altruistic (or, more precisely, prosocial<sup>1</sup>) behavior, such as fighting to defend one's tribe against the enemies. This behavior increases the fitness of the group – its probability of surviving, growing, and perhaps “reproducing” by establishing a daughter group in a conquered enemy's territory (Soltis, Boyd, and Richerson 1995). But increased group fitness comes at the expense of lowered fitness of individual altruists. The multilevel selectionist explanation of the evolution of prosocial behaviors was aphoristically summarized by Wilson and Wilson (2007): “Selfishness beats altruism within groups. Altruistic groups beat selfish groups.” Whether an altruistic trait spreads, or dies out, is determined by the balance of these two forces.

A key mathematical result in multilevel-selection theory, the Price equation (Price 1972), provides a precise and quantitative statement of conditions under which a prosocial trait spreads (for an accessible explanation of the derivation and the implications of the Price equation see Gardner 2008). The following discussion applies the Price equation to genetic group selection, but later we will explore its implications for cultural evolution.

Consider a universe inhabited by groups of individuals who come in two discrete types: prosocial versus self-regarding (cooperators versus free-riders). Reproduction is asexual (the behavioral type of the parent is transmitted to its offspring) and the total number of individuals does not change over generations. The overall proportion of cooperators is  $p$ , and the change in this proportion from one generation to the next is  $\Delta p$ . For this case the Price equation takes the following form (Bowles 2006):

$$(1) \quad \Delta p = \beta_G V_G + \beta_I \bar{V}_I$$

where  $V_G$  and  $V_I$  are, respectively, between-group and within-group (among individuals) genetic variances. The bar over  $V_I$  indicates a weighted average over all groups. The coefficient  $\beta_G$  measures the strength of between-group selection (technically, it is the regression coefficient of the effect of between-group variation in proportion of cooperators on the average fitness of members of a group). The coefficient  $\beta_I$ , similarly, measures the strength of within-group selection on cooperators. By definition of a prosocial trait,  $\beta_G > 0$  and  $\beta_I < 0$ . Since variances are always positive (strictly, nonnegative), the first term on the right-hand side of Eq. (1) is positive and the second one is negative. If the second term is greater in absolute value than the first, cooperators will eventually die out. Conversely, if the first term overpowers the second, then cooperators will gradually replace noncooperators. The Price equation specifies the precise conditions under which either of these outcomes takes place. Thus, setting  $\Delta p > 0$  and rearranging Eq. (1) we have the condition for the spread of prosocial trait:

$$(2) \quad \frac{V_G}{\bar{V}_I} > \frac{-\beta_I}{\beta_G}$$

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<sup>1</sup> There are two different senses of the term “altruistic.” In both, an altruistic behavior has a fitness cost for the agent, but fitness benefits may be conferred on another individual, or on all individuals in the altruist's group. In this paper I use the term in the second sense, and thus adjectives “altruistic,” “prosocial,” “cooperative,” and “group-regarding” are often used as synonyms.

(remember that  $\beta_I < 0$ , so the right-hand side is the ratio of *absolute values* of selection coefficients).

This inequality has truly profound implications for our understanding of the evolution of human sociality. The left-hand side says that evolution of prosocial traits is favored when genetic variability within groups is minimized, while between-group variability is maximized. One way to make this ratio larger (which is not limited to humans) is by basing group membership on kinship, which makes groups internally more homogeneous while magnifying differences between groups. This is, of course, the well-accepted mechanism of social evolution by kin selection (Hamilton 1964). In fact, Hamilton's rule can be derived from the Price equation (Gardner 2008) and the kin selection model is merely a special case of the multilevel selection theory (Wilson and Wilson 2007).

More interestingly, humans have additional, and much more important ways of affecting their group composition and, thus, increasing the variance ratio. One is assortative association or capacity to form coalitions. Coalition formation is a most powerful strategy in competitive interactions and the evolutionary forces emerging from coalitionary interactions may have been extremely important for the origin of our "uniquely unique" species (Alexander 1990, Flinn, Geary, and Ward 2005). According to the "social brain" theory, the evolution of human brain size and intelligence during Pleistocene was largely driven by selective forces arising from intense competition between individuals for increased social and reproductive success (Alexander 1990, Byrne and Whiten 1988, Dunbar and Shultz 2007, Gavrilets and Vose 2006). One can view language as a tool that originally emerged for simplifying the formation and improving the efficiency of coalitions and alliances. Thus, humans may be uniquely proficient at detecting and excluding noncooperating free-riders from cooperative groups. In the limit, if all coalitions/cooperating groups succeed in excluding free-riders, there will be only two kinds of groups (those with 100 percent of cooperators and those with none) and the left-hand side of Eq. (2) becomes infinitely large. But any assortative association, even if only partially successful, will increase the ratio of variances and shift the balance of selective forces in favor of prosocial traits.

So far the discussion has focused on genetic group selection. However, another unique feature of humans is our capacity for culture. In a series of influential publications over the last two decades Boyd and Richerson (Boyd and Richerson 1985, 2002, Richerson and Boyd 1998, 2005) have developed "dual inheritance" theory, which treats the evolution (and coevolution) of genes and culture in a theoretically unified way. One important insight from this work is that conformist social learning tends to erase cultural variation within groups and to amplify cultural differences between groups. This process, again, works to increase the left-hand side of Eq. (2) and, therefore, plays an important role in *cultural* group selection.

Turning to the right-hand side, we observe that the evolution of prosocial traits is favored when within-group selective pressure against altruists is minimized, while selective pressures acting on groups are maximized. A key feature distinguishing humans from our nearest biological relatives is egalitarianism and leveling institutions, such as monogamy and food sharing among the nonkin, which help to suppress within-group differences in individual fitness

(Boehm 1997). Humans living in small-scale societies are fiercely egalitarian and use a variety of strategies to prevent “upstarts” from gaining too much power, from gossip to ostracism and homicide (Boehm 2001). Similarly, monogamy (or, more precisely, monogyny) is a powerful leveling mechanism because male reproductive fitness in humans is primarily determined by the number of wives (Betzig 1986),

Another important mechanism for suppressing within-group variation in fitness is moralistic punishment (Fehr and Gächter 2002, Henrich 2008). Unconditional cooperators (altruists) are vulnerable to exploitation by self-regarding free riders. Moralistic punishers (or moralists, for short), unlike altruists, attempt to ensure that others also contribute by punishing free riders. If, despite their efforts, the majority fails to contribute to the common pot, moralists stop contributing themselves (thus, they are *conditional* cooperators). A moralist, thus, is a second-order cooperator because it creates public good (ensuring that all cooperate) while bearing some fitness costs (because punishment is costly). Mathematical models and experiments with real people show that when public good games are played by mixtures of altruistic, selfish, and moralistic strategies the outcome tends to one of two extremes. Either the moralists succeed in forcing free riders to contribute to the common pot, or moralists fail to do so, and then nobody contributes (except for unconditional altruists, if any are present). In other words, either the group achieves a cooperative equilibrium, or succumbs to the “tragedy of the commons.” The implication of this theoretical (and empirically tested) result is that in either case moralists have approximately the same fitness as self-regarding individuals. If a cooperative equilibrium is achieved, costly punishment needs to be applied only rarely, and fitness costs to moralists are low. If a noncooperative equilibrium is attained, then moralists have the same fitness as selfish individuals, because they neither contribute to the common good, nor attempt to punish (contribute to the second-order public good). Thus, the capacity of humans to follow conditional cooperative strategies, such as moralistic punishment, dramatically reduces within-group fitness differential between cooperators and non-cooperators (Richerson and Boyd 2005).

Finally, evolution of prosocial traits is favored when between-group selection pressure is high. Empirical studies suggest that group selection (both cultural and genetic variants) is a powerful force in humans due to the ubiquitous presence of warfare. For example, Soltis et al. (1995), using data collected by early ethnographers in New Guinea, estimated that extinction rates of local groups due to warfare were roughly 10-15 percent per generation. It would take 500-1000 years for a prosocial trait to spread to most local groups by the process of cultural group selection (Richerson and Boyd 2005). More recently, Bowles (2009) employed the Price equation to ask whether the levels of intergroup violence were sufficient for evolution of prosocial behaviors by genetic group selection. He estimated the level of mortality due to warfare in small-scale societies from archaeological evidence (skeletal remains) and ethnographic data. He also estimated the ratio of between-group to within-group variances for hunter-gatherer communities. On the basis of these estimates, Bowles concluded that the intensity of intergroup conflicts was sufficiently high to enable the spread of group-beneficial but individually costly behaviors.

Between-group competition does not need to be limited to lethal conflict and, undoubtedly, there are prosocial traits that spread even though they had no, or only a slight, effect on military effectiveness. However, quantitative empirical estimates (Bowles 2009, Keely

1997, LeBlanc 2003) suggest that warfare was an extremely powerful force in between-group competition. I know of no empirical evidence indicating that other selective forces could even approach the intensity of selection imposed by warfare. Certainly, when we consider the kind of groups that are the main focus of this paper, polities (politically independent communities), the overwhelming danger to their survival comes from other polities (Lenski 1970:91). There are very few examples of polities that disappeared, for example, as a result of succumbing to an environmental challenge. Those examples that we do know, such as the Greenland Norse (Diamond 2004), lived in very marginal environments (and hostilities with the Inuit may have contributed to their extinction). For other kinds of groups, e.g., ethnic diasporas, prosocial traits with no military consequences could be very important, but such issues are beyond the scope of this paper.

Summarizing the recent developments in our understanding of how human sociality evolved, it is important to note that no other theory, apart from multilevel selection, has been able to propose a logically coherent solution to this puzzle. Such mechanisms of social evolution as reciprocity and kin selection, which have driven the research agenda since the 1970s, have proved to be inadequate for explaining human social evolution (Wilson and Wilson 2007). More generally, any theory that is based on the rational choice paradigm, including reciprocity, coercion, and social contract, fails on both logically coherent (it cannot be made to work in mathematical models) and empirical (most people do not behave as rational self-regarding agents) grounds (Richerson and Boyd 1998, Turchin 2006). Selfish people cannot cohere into a functional society (Collins 1992). In contrast, numerous models demonstrate that prosocial traits can evolve in a multilevel selection setting (for recent reviews of this modeling literature, see refs). Furthermore, all models, in which sociality evolves, assume the existence of multiple groups (Wilson and Wilson 2007:334). In other words, our current theoretical understanding is that, in order for a prosocial trait to spread, a model must either explicitly assume a group selectionist mechanism, or implicitly “sneak it in.”

Although great strides have been made in our understanding of how human sociality evolved, the progress is almost entirely limited to social evolution in small-scale societies. This is true not only for theoretical investigations (the great majority of models focuses on social groups of a few tens or at most hundreds of individuals), but also for empirical approaches. Thus Bowles (2006, 2009, Choi and Bowles 2007) focused on hunter-gatherer groups, while Soltis et al. (1995) addressed small-scale horticultural societies. Many of the mechanisms, which uniquely endowed humans to be particularly susceptible to social evolution, are relevant only to small-scale societies, for example egalitarianism.

Complex societies that first appeared c.5000 years ago differ from simple societies in which humans lived during most of their evolutionary history in many ways: sheer scale (from  $10^2$ – $10^3$  people to  $10^7$ – $10^8$  people), hierarchical complexity (from one-two to six and more levels), extreme differences in power and wealth, extensive division of labor, literacy, monumental architecture, presence of cities and states, and so on. Furthermore, although the argument of Boyd and Richerson (Boyd and Richerson 1985, Richerson and Boyd 2005) that social evolution in humans operated on both genes and cultural elements is surely correct, it is equally incontrovertible that the quantitative balance dramatically shifted from predominantly genetic evolution (and gene-culture coevolution) in the Pleistocene to predominantly cultural

evolution in the past 5–10 thousand years. We need a different theory to understand social evolution that lead to the rise and elaboration of complex societies.

### **Warfare and the Evolution of Complex Societies**

#### *Breaking through the barrier of face-to-face sociality*

There are many ways in which social evolution could respond to the selective pressures arising from warfare. Intergroup conflict is a powerful force for increasing social cohesion (for a review, see Turchin 2003: Chapter 3). War pressures also drive innovation, and not only in the means of offence and defense, but also in organizational forms used by society to mobilize the population and productive resources for war. However, the most direct way to win wars is to have more warriors. According to the saying, attributed variously to Turenne or Napoleon (Keyes 2006), “God favors the big battalions.” It stands to reason that intergroup conflict imposed an intense selection for larger society size.

In small-scale societies, integrated by face-to-face interactions, selection for larger group size had an important “side effect”: evolution of huge and energetically demanding brains of humans to store and process social interactions data. The problem is, as the group increases in size, the potential number of relationships that one must keep in mind grows exponentially. Once a human group attains the size of 100–200 individuals (Dunbar 1992, Dunbar and Shultz 2007), even the hypertrophied human brain becomes overwhelmed with the complexity of social computation. Thus, in order for group size to increase beyond the few hundred individuals typical of small-scale human societies, evolution had to break through the barriers imposed by face-to-face sociality.

The breakthrough was, apparently, achieved in two mutually reinforcing ways. First, humans evolved the capacity to demarcate group membership with symbolic markers (Masters 1998, Richerson and Boyd 1998, Shaw and Wong 1989). Markers such as dialect and language, clothing, ornamentation, and religion allowed humans to determine whether someone personally unknown to them was a member of their cooperating group or, vice versa, an alien and an enemy (for a review, see Turchin 2003: Chapter 3).

The second evolutionary innovation was hierarchical organization. A member of a hierarchy needs to have a face-to-face relationship only with  $n + 1$  persons: the maximum number of subordinates (the “span of control”),  $n$ , plus an additional link to its own superior. The growth of hierarchical networks is accomplished not by increasing  $n$ , but by adding extra levels of organization. There is no limit to the overall group size, as long as the sufficient number of organizational levels is added. Centralized hierarchies are also much more effective in war, which is why all armies have chains of command (Andreski 1971). However, the great downside of hierarchical social organization is that those in control have the ability to redistribute resources to their advantage. Hierarchical organization inevitably, despite all efforts to control this tendency, leads to inequality. Thus, there had to be compelling evolutionary reasons for adapting a social practice that corroded the egalitarian values of small-scale societies.

Hierarchical organizations can consist not only of human individuals, but also of other types of “agents,” for example, small-scale communities (internally integrated by face-to-face interactions). In this case, the subordinate agent may be a village (a local community) and the

superior is a chiefly village, where the ruling lineage resides (Carneiro 1998). Adding more levels results in complex chiefdoms, states of various kinds, and empires. A review of such diverse historical states and empires as Ancient Rome and Egypt, Medieval France, and imperial confederations of the Central Asian nomads, suggests that all of these polities arose in such a multilevel fashion (Turchin and Gavrilets 2009). In other words, lower-level units combined into higher-level units that themselves combined into yet higher level units, and so on. Internal organization of states and empires often reflected this process of multilevel integration, similarly to biological organisms retaining vestiges of their evolutionary history.

*Conditions favoring cooperation of lower-level units: cultural variation*

The basic idea that the evolution of complex societies had to involve elaboration of hierarchical structure is of course not new. It is explicit in typologies such as band-tribe-chiefdom-state (Service 1962). Hierarchical complexity (the number of control levels above the local community) is coded in the Standard Cross-Cultural Sample. However, it has not received as much theoretical development as alternative approaches. Models of social evolution (at best) assume two levels: that of the individual and of the group. Group size in such models increases simply by adding more members, not by elaborating internal structure of the group. An influential current in anthropological theory that connects warfare to the evolution of the state (Carneiro 1970, Webster 1975, Wright 1977) also pays less theoretical attention to how hierarchies were elaborated (Robert Carneiro, however, explicitly considers how the first step, transition from independent villages to simple chiefdoms, was made, see Carneiro 1998). Additionally, most theoretical work has been limited to verbal theories. There has been very little explicit modeling done on the dynamics of hierarchy formation (one exception is Axelrod 1997). Currently we (Gavrilets, Anderson, and Turchin 2010, Turchin and Gavrilets 2009) are attempting to address this theoretical lacuna with agent-based models. Here I propose to use a more general approach, based on the Price equation.

In the multilevel selection framework the central question is, what is the balance of forces favoring cooperation of lower-level units and, therefore, their ability to combine into a higher level entity? Here “units” and “entities” are groups (societies) at different levels of hierarchical complexity. In order for a society to grow in size, it has to make repeated transitions from  $i$ -th to  $(i + 1)$ -th level. The success of each transition depends on the balance of forces favoring integration versus those favoring fission. Cultural practices promoting unity at the  $i + 1$  level will spread if

$$(3) \quad \frac{V_{i+1}}{V_i} > \frac{-\beta_i}{\beta_{i+1}}$$

This inequality is simply Eq. (2), in which I substituted  $I$  (“individual) with  $i$  ( $i$ -level group, or community, for short) and  $G$  with  $i + 1$  (a group one level higher, or *metacommunity*). Note that I am here applying the Price equation formalism to cultural evolution and  $V$  refers to variation in cultural traits. As an example of such trait, consider the rules of dynastic succession: division of territory among all sons of the deceased ruler promotes fissioning, while strict primogeniture promotes unity.

Although I now apply the Price equation to different, non-genetic traits, the broad implications of Eq. (3) are unchanged. Evolution of traits promoting integration at the  $i + 1$  (metacommunity) level is favored (1) by increasing cultural variation among metacommunities and decreasing variation among communities (the left-hand side), and (2) by increasing the effect of the trait on the fitness of metacommunities, and reducing the effect at the community level (the right-hand side). The next step is to identify conditions under which the ratio on the left-hand side increases, while the ratio on the right-hand side declines. In my previous work I proposed that such conditions obtain on *metaethnic frontiers* (Turchin 2003, 2006).

Earlier I have touched upon the role of symbolic markers in delineating cooperating communities. An important observation is that symbolically demarcated communities come in a variety of scales, and a typical human lives in a nested hierarchy of such communities. For example, an inhabitant of medieval Dijon in northeastern France was not only a Dijonian, but also a Burgundian, a French, and a Christian. Although in principle any arbitrary marker could be used to demarcate a community, in practice there is a fairly strong correlation between some types of markers and the community's hierarchical level (Turchin 2003). Thus, language is one of the most common markers delineating modern nations and, before the advent of nationalism, their precursors, ethnolinguistic communities or *ethnies* (Smith 1986). Regional communities, or *subethnies*, are usually demarcated by linguistic dialects. On the other hand, supranational communities, or *metaethnies*, are typically unified by religious markers; specifically, by belonging to one of the world religions, so this marker became particularly relevant beginning in the Axial Age (800–200 BCE) (Jaspers 1953). The correlation between these marker types and level of community that they demarcate is not perfect and there are many exceptions. Additionally, there is a host of other cultural markers that people use to distinguish “us” from “them” at different levels. With all these caveats I use dialect, language, and religion as the main markers defining subethnic, ethnic, and metaethnic communities, respectively, because I will need a simple and unambiguous way of dealing with social scale in the empirical test of the theory (next section).

The use of religion as a marker for large-scale cooperating communities may seem puzzling. My focus, however, is not on the supernatural but on the integrative aspect, which, in fact, follows the original meaning of the word (in Latin *religio* meant a bond). The key role that religion plays in promoting cooperation and in integrating societies (especially at the metaethnic level) was obvious to Ibn Khaldun (1958) and Emile Durkheim (1915), and is now increasingly acknowledged by social psychologists. For example, one of the most important functions of organized religion is to codify moral systems – “interlocking sets of values, virtues, norms, practices, identities, institutions, technologies, and evolved psychological mechanisms that work together to suppress or regulate selfishness and make social life possible” (Haidt and Kesebir 2009).

World religions that aimed to integrate diverse ethnic groups first appeared during the Axial Age. They include Zoroastrianism, Hinduism, Buddhism, and later Christianity, Islam, and Tengrism (the religion of Turco-Mongolian nomads), as well as such integrative ideologies without a supernatural content as Confucianism and Stoicism. It is immediately obvious that metaethnic communities, demarcated by these integrative ideologies, include most civilizations, as the term is used by Toynbee (1956) and Huntington (1996). My definition is broader,

however, because it includes such “uncivilized” people as, for example, Turco-Mongolian steppe nomads or Iron Age Celts.

With this background we can now answer the question posed above, under what conditions the ratio of variances on the left hand side of Eq. (3) is maximized. The amount of cultural variation should be greatest in regions where metaethnic communities come in close contact, or *metaethnic frontiers*. Thus, cultural variation among the medieval French (speakers of Langue d’Oïl, including dialects such as the Burgundian and the Picard) was less than that between French and Castilians. But differences between Burgundians and Picards, and even between French and Spanish, were dwarfed by the cultural chasm between the metaethnic community to which they belonged, Latin Christendom, and Dar al Islam (literally, the House of Islam). Different clothing, dietary restrictions, marriage practices, attitudes towards law and authority – the list of cultural differences is too long to enumerate here (more details can be found in Turchin 2003, 2006). Thus, areas, such as the Christian-Islamic frontiers of Iberian Reconquista and in the Holy Land during the Crusades, should be characterized by much greater cultural variation than Burgundy, surrounded by other Christian groups.

Divergent ways of making a living add another source of cultural variation. Agrarian societies are very different from nomadic pastoralist societies (and both differ from hunter-gatherers). Regions in which metaethnic faultlines coincide with steppe frontiers, where nomads and farmers live in close proximity, therefore, should have the highest levels of cultural diversity.

Summing up the preceding discussion, the amount of cultural variation in a region should increase in the following progression, from least to most. (1) A region populated by groups speaking different dialects of the same language and practicing the same religion. (2) A region with groups speaking different (mutually unintelligible) languages, but practicing the same religion. (3) A region populated by groups with different languages and practicing different world religions. (4) A region with groups differing in language and religion, and also including both agrarian and nomadic pastoralist groups. Category (3) is a metaethnic frontier, while (4) is the most intense kind, a steppe frontier.

#### *Conditions favoring cooperation of lower-level units: intensity of warfare*

The observation that cultural variation is highest in regions where groups with very different cultures are in contact is essentially tautological (the main task of the preceding paragraphs has been to operationalize what is meant by “different culture”). The next step is not, and will require to be empirically tested. It is the proposal that warfare intensity is also highest where the antagonists are culturally very different. In other words, the left-hand-side of Eq. (3) is maximized under the same conditions under which the right-hand side is minimized, making for a rather parsimonious theory.

As has been stated above, the purpose of symbolic markers is to distinguish between in-group members, with whom one should cooperate (and, certainly, not kill), and out-group individuals, whom it is permissible, or even mandatory, to kill. A ubiquitous psychological instrument for aiding such decisions is to define out-group individuals as not wholly human, or even to deny outright their claim on humanity. A wholesale killing of non-humans is not an

atrocities, but merely pest extermination. However, because humans live in hierarchically nested groups, there must be degrees of humanity (or “subhumanity”). Thus, French and Castilian knights fought wars in which they killed each other, but they also shared a feeling of belonging to the same class of European nobility unified by common religion. Atrocities did happen (for example, when Henry V ordered the slaughter of the surrendered French knights on the field of Agincourt), but the *modus operandi* was to spare the life of a defeated enemy in the hope of obtaining ransom. Indiscriminate slaughter of defeated enemies, on the other hand, was frequent during the Crusades (Megret 2008). Finally, wars against “heathen savages,” as in the German crusades against the Prussians (Christiansen 1980), were often conducted as campaigns of extermination.

The tendency to treat adversaries as nonhumans, therefore, should increase along the cultural differentiation scale and reach a maximum on steppe frontiers (Category 4). Indeed, there is abundant literature in Chinese, Persian, and Russian demonizing steppe pastoralists (Beckwith 2009). The Chinese, for example, characterized nomads as having “the faces of humans but hearts of wild beasts, creatures for whom armed robbery directed against China was the natural way of life” (Graf 2002:20). Our first examples of ethnic stereotyping, found in Ancient Egyptian and Mesopotamian texts, refer to the cultural divide between farmers and pastoralists (Kruger 2007). For example, the *Marriage of Martu* describes nomads in terms eerily similar to the Chinese quote: “Lo, their hands are destructive, (their) features are (those) [of monkeys]” (Kruger 2007:152).

From the other side of the frontier, steppe nomads regarded farmers as “grass-eating people” not too far removed from livestock (Weatherford 2004:92). The king of the Xianbei, Toba Tao, once compared the Chinese to “a herd of colts and heifers” (Grousset 1970:62). Thus, the tendency on both sides of the steppe frontier was to dehumanize the other.

Tendency to dehumanize the opponent on steppe frontiers was reflected in the frequency of atrocities and whole-sale genocide committed by both sides. For the well documented Chinggis Khan campaign in Central Asia (1219–22), our sources are unanimous that this invasion was a calamity on an enormous scale (Wink 1997:13). The Mongols exterminated whole populations of cities such as Samarkand, Merv, and Nishapur (Hoang 2001). Agrarian states often meted out the same treatment to the nomads. After defeating the Zungharian empire in 1755, the Qing administration followed a policy of deliberate extermination aimed at the whole ethnic group, from the leaders down to simple nomads (Perdue 2005:283-286).

To summarize this part of the argument, there are theoretical reasons to believe that as cultural differences between adversaries increase, so does the probability of ethnocide and genocide (the difference being whether only cultural identity of the vanquished is destroyed or, in addition, a substantial proportion of them are physically eliminated). Empirical evidence, although largely of anecdotal kind, suggests that ethnocide and genocide are particularly frequent on civilizational frontiers (Hall 2000, 2001, Turchin 2003). However, this hypothesis is not universally accepted. Starting with Sigmund Freud, who coined the phrase “the narcissism of minor differences,” some have argued that “the fiercest struggles often take place between individuals, groups, and communities that differ very little” (Blok 1998). Indeed, there are numerous examples of atrocities committed during civil wars, or wars between culturally similar

peoples. Commonly cited examples include the extermination of almost all inhabitants of Magdeburg by the Imperial troops during the Thirty Years War (Wedgwood 1938), the massacre of the population of Bezier during the Albigensian Crusades (Hamilton 1999), and St. Bartholomew massacre in Paris and other French cities during the Wars of Religion (Knecht 2001). Such examples can be multiplied, but the issue cannot be resolved by simply citing anecdotal evidence in support of one, or the other side. What is needed is a systematic and quantitative empirical test, which will be one of the tasks in the next section. As we shall see, it decisively demonstrates that while atrocities (specifically, massacres of populations of conquered cities) happen in all conflicts, they are comparatively infrequent in wars among culturally similar groups, but routine in warfare on steppe frontiers. The “narcissism of minor differences” hypothesis, probably, arose as a result of the human tendency to treat massacres between culturally similar peoples as more reprehensible, with the result that they tend to be better retained by the collective historical memory.

### *The mechanics of uplevel transitions*

At this point it is possible to bring the various strands of discussion together and provide a concise statement of the proposed theory that accounts for the evolution of large-scale societies by the mechanism of cultural multilevel selection.

- Warfare is the chief selective force for increased society size, because larger societies can mobilize more resources and recruit larger armies, which increases their chances of successful defense (or successful predation).
- When the evolution for greater group size ran against the limitations of “social channeling capacity” (how many people an individual can have a personal relation with) humans evolved the capacity to use symbolic markers to determine whether an individual, personally unknown to them, is part, or not, of the cooperating group. Symbolically marked ethnic identities provide diffuse horizontal ties that, although weak individually, are surprisingly powerful *en mass* at integrating large societies.
- Another evolutionary innovation was the use of hierarchical organization that circumvented the limitations of social channeling capacity by requiring that an individual only needed to have a close relationship with a limited number of inferiors and a superior. The growth of hierarchical networks is accomplished by adding extra layers of organization. Hierarchical connections provided strong vertical ties that resulted in centralized societies (and such centralized organizations as armies and bureaucracies) that were very efficient at coordinating cooperation, particularly in military matters. However, hierarchy compromised egalitarianism.
- In order to continue to grow a society has to make a series of transitions from level  $i$  to level  $i + 1$ . Whether lower-level units (communities) evolve cultural mechanisms necessary for integration into a metacommunity depends on the balance of forces mathematically described by the Price equation. Evolution of integration is favored by two conditions: (1) increasing the amount of cultural variation at the metacommunity level relative to that at the community level; and (2) increasing the magnitude of the selective force acting on the cultural trait at the metacommunity level relative to that at the community level.
- These two conditions are correlated: both cultural variation and warfare intensity is elevated in areas where culturally dissimilar groups are in contact and conflict. For the

period of human history between the Axial Age and the Industrial Revolution I operationalize cultural dissimilarity with a scale of four levels: (1) subethnic groups within the same ethnic community, (2) ethnic groups within the same metaethnic community, (3) metaethnic communities: a metaethnic, but not a steppe frontier, and (4) agrarian and nomadic communities on a steppe frontier. Both the amount of cultural variation and the intensity/lethality of conflict increase from (1) to (4).

- The major prediction yielded by the theory is that largest-scale societies (largest world empires) should arise disproportionately frequently on steppe frontiers, followed by nonsteppe metaethnic frontiers, and only rarely, if ever, in regions inhabited by culturally similar groups. In other words, there should be a correlation between the typical scale of societies and the degree of cultural variation in its environment at the point of origin.

To clarify the proposed mechanism, consider first an area populated by culturally similar groups. Most groups are characterized by hierarchical complexity  $i$  (the starting point can be local communities, or simple or complex chiefdoms, etc.; the key question is whether a transition to the next level will be made or not). However, due to some combination of circumstances, perhaps the rise of a charismatic leader, some communities periodically manage to unite a number of others, thus creating metacommunities. Further, suppose there is a cultural trait that promotes integration at the metacommunity level.

However, such a trait will not spread in our hypothetical situation. The problem is that there will be little variation among any metacommunities that arise from the culturally similar background in the prevalence of the trait. There is simply too little variation for evolution to work on. At the same time, there is selection against the trait at the community level, while selective force at the metacommunity level is weak. The latter is because, although warfare may be frequent, the consequences of losing are not particularly drastic. There is little chance of genocide or ethnocide. A loss of political independence often turns out to be temporary, because the conquering polity is likely to fission sooner or later, and there is little threat to community's ethnic identity in the long term. As a result, we expect what some anthropologists have termed "chiefly cycling" (Anderson 1996, Marcus 1998): metacommunities (e.g. complex chiefdoms) periodically arise but sooner or later fission into communities (simple chiefdoms), and there is no social evolution for more hierarchically complex forms of organization.

Now consider the other extreme, a steppe frontier. Here, cultural variation among metacommunities is high. Some of them will be constituted of purely agrarian communities, some of purely nomadic groups, and others of some combination of both (for example, an enterprising band of nomads may cross the frontier and set themselves up as rulers of largely agrarian population). Cultural elements will be shuffled and recombined, giving rise to novel combinations. Recurrently, metacommunities acquire effective combinations of cultural traits and social norms to make them into highly efficient military machines, as well as internal organizations that are good at suppressing fissiparous tendencies. There is plenty of cultural variation for evolution to work on. Furthermore, selective force acting at the metacommunity level is very intense. Consequences of military loss may spell physical extinction of most of the population, when raiding nomads kill some and leave the rest to starve because all their food stores were taken away. It could mean social death, when the surviving population is sold on the

slave markets. Finally, it could mean a loss of ethnic identity, when an agrarian state forces conquered nomads to become peasants.

On a steppe frontier, thus, the balance of forces favors the spread of cultural elements that have an integrative function at the metacommunity level. Whereas in areas of lower cultural diversity one or two uplevel transitions exhaust the amount of variation for evolution to work on, on steppe frontiers it is possible to go many steps while retaining sufficient cultural variability between metacommunities. Particularly conducive to repeated uplevel transitions is the “mirror empires” dynamic. Integration is more lasting when culturally similar units are put together, so the tendency is for an agrarian empire and a nomadic imperial confederation to rise simultaneously on the opposite sides of a steppe frontier, in opposition to each other. Combining ethnically similar units in each empire tends to suppress lower-level and emphasize higher-level cultural variation (thus maximizing the left-hand side of Eq. 3). I describe this process in greater detail elsewhere (Turchin 2009). The scaling-up process operates until each side of the frontier is unified by a huge empire or imperial confederation, as repeatedly happened on the Inner Asian steppe frontier with China.

We should not expect a unidirectional progression from smaller-scale to larger-scale societies, even on steppe frontiers. Evolution is not a directed process, and therefore the rise of huge multilevel empires should occur in fits and starts (and so it did in history). Additionally, there are other, nonevolutionary processes that periodically strengthen disintegrative tendencies (discussed in Turchin 2006: Part II) and cause imperial collapse. Thus, the formation of Chinggis Khan’s empire was not a result of cultural evolution compressed into one generation. Temujin’s rise was made possible by evolution that has been ongoing for at least two millennia before him. Succeeding imperial confederations in the steppe – the Hunnu (Xiongnu), the Turks, and the Mongols – demonstrate increasing military effectiveness and internal cohesion, probably as a result of gradually accumulating a cultural repertoire for large-scale social integration. Temujin was, without doubt, a particularly gifted leader, but he did not invent the recurved bow, the decimal organization system, or the Tengrism, the sky-worshipping universalistic religion of Turco-Mongolian nomads.

As an example of a cultural trait that favors large-scale integration, consider the rise of world religions during the Axial Age. The Axial Age (800–200 BCE) was a remarkable period in human history (Eisenstadt 1982, 1986, Jaspers 1953). In addition to the first appearance of world religions, this period saw the rise of first “megaempires.” During the third and second millennia BCE the maximum territorial size of empires fluctuated between 0.3 and 1 million squared kilometers. In the middle of the first millennium BCE, however, the maximum size jumped by an order of magnitude to the range of 3–10 million square kilometers, and fluctuated at this level during the next two millennia (see Figure 2 in Turchin 2009). The virtually simultaneous evolution of metaethnic integrative ideologies and megaempires was not a coincidence. Zoroastrianism in the Achaemenid empire, Buddhism in the Maurya empire, and Confucianism in the Han empire all contributed to the ability of these states to control and govern ethnically diverse populations. More generally, cross-cultural analyses indicate that there is a strong correlation between societal size and monotheism (Sanderson and Roberts 2008).

Why did Axial Age developments happen in such far-flung localities during the same historical period? A possible explanation lies in a technological development on the Eurasian Great Steppe: the invention of mounted archery in the ninth century BCE, which was made possible by the appearance of a small, but powerful compound bow that could be used from the horseback (Christian 1998:125). Mounted archery became the “weapon of mass destruction” of nomadic pastoralists. It rapidly spread through the Great Steppe and dramatically escalated selective pressures on agrarian states bordering the Steppe. The invasions of Iranic-speaking nomads, Cimmerians and Scyths, in the Middle East began in the late eighth century BCE, and were followed by the rise of the Persian empires (Median in the late seventh century and Achaemenid in 549 BCE). Similarly, the appearance of the Hunnu (Xiongnu) on the Chinese steppe frontier in the mid-fourth century BCE (Di Cosmo 2002) was followed by the Qin (221 BCE) and the more lasting Han (202 BCE) unifications.

#### *Limitations of the proposed model*

The theory that I described in this section predicts that evolution of ultrasociality should be favored when and where cultural variation is high and warfare intense. Of particular importance, however, is not any variation, but cultural variation among higher-level units, or metaethnies. Because this kind of variation should also be associated with higher warfare intensity (this proposition remains to be empirically tested), we arrive at a more parsimonious statement: large-scale societies should preferentially evolve in regions where culturally dissimilar groups are in contact and conflict. Specifically, for the period between the Axial Age and the Industrial Revolution I have focused on one particular kind of such regions: steppe frontiers between settled agriculturalists and nomadic pastoralists. This is where the rise of huge territorial empires (the political form that large-scale pre-industrial societies take) is predicted to be the most frequent occurrence.

Because the theory is stated very parsimoniously, it rides roughshod over much of real-life complexity. There are many factors that affect warfare intensity, and thus the ratio of selection coefficients. Some are correlated with the location on a steppe frontier, such as the effects of landscape ruggedness and the presence of riding animals. Because steppes are flat, they do not provide many defensible locations (such as a mountain fastness) to which a defeated group could withdraw to avoid destruction. Other factors affecting warfare, such as spread of new military technologies, or of world religions, may be uncorrelated with steppe frontier location.

There are also many factors, other than metaethnic diversity, that could work to increase the ratio of variances in the Price equation. In fact, the greatest conceptual failing of the proposed theory is that it leaves the nature of cultural variation seriously undertheorized. Unlike with biological evolution, where we have a reasonably good understanding of how genetic variation is created and transmitted, the same cannot be said about culture. There has been a number of attempts to conceptualize the nature of cultural variation units, including cultural traits (Cavalli-Sforza and Feldman 1981), culturgen (Lumsden and Wilson 1981), memes (Dawkins 1976), and mentemes (Stuart-Fox 2002). None of these proposals has met with universal acceptance.

Furthermore, social evolution involves many different mechanisms, operating on very different time scales. Genetic group selection is the slowest: genes decrease in frequency because

individuals die or fail to reproduce. Cultural group selection operates on the ability of groups to avoid dissolution and to reproduce themselves; it does not require physical elimination of group members who may be culturally assimilated into victorious groups. Cultural group selection should, on average, occur on a faster time scale, than genetic selection, around 500–1000 years according to one estimate (Soltis, Boyd, and Richerson 1995). Selection can also operate not on whole social groups, but on their segments, such as “group projects” (Pomper 2002) or aristocratic lineages with their retinues – “dynasties” of Ibn Khaldun (1958). Shuffling among such groups of political entrepreneurs could lead to very rapid evolution, with significant cultural change occurring within one human generation. Finally, human societies, or their decision making institutions, may “anticipate the eventual results of group selection in many contexts and get there first” (Soltis, Boyd, and Richerson 1995:492). Such “anticipative selection,” when it works, will yield the most rapid rate of social change.

The model advanced in this paper avoids specific assumptions about the nature of cultural variation and the mode of cultural evolution. I acknowledge this as a serious theoretical problem, but I believe that we do not have to wait until the mechanisms of cultural evolution are worked out in detail. The example of Darwin’s theory of evolution, which was an extremely useful vehicle for organizing research even before the nature of genes was understood, is heartening. More importantly, the framework of the Price equation is applicable to any of the scenarios, discussed above, and many more that were not discussed. It does not matter whether the source of variation is genes, memes, or culturgenes; world religions or rules of dynastic inheritance. The units of variation need not even be “replicators” (Richerson and Boyd 2005:83). Price himself once noted that his equation describes the selection of radio stations with the turning of a dial as readily as it describes biological evolution (Gardner 2008).

### **Empirical Tests**

#### *Is warfare lethality particularly intense on steppe frontiers?*

The first theoretical proposition that I test is the postulated connection between cultural variability at the metaethnic level and intensity of warfare. For a particularly stark contrast, I focus on the two extremes of the cultural variation scale, Category 1 versus Category 4. In practice this means that we need to quantify warfare intensity/lethality in internal wars among culturally similar groups, and compare it to wars on steppe frontiers.

Although cultural groups can go extinct not only by genocide, but also as a result of social dissolution and cultural assimilation, providing clear definitions for the latter two processes is not a straightforward task. Accordingly, my focus is on the most extreme forms of extinction, incidents where a large proportion of the population is physically killed by the enemy. Given the nature of the historical record it would be difficult to obtain systematic data on the fates of whole populations following a conquest. There is one situation, however, for which the record is reasonably informative: what happened to populations of conquered cities. This is fortunate, because cities typically served as government seats and were primary repositories of cultural “genotype.” Thus, the fate of cities was of primary importance to the cultural survival in complex societies. Additionally, cities often sheltered rural populations during times of invasion. Thus, the fates of people finding themselves in a city after it lost a siege, or was stormed by enemy troops, provide a reasonable indicator of overall warfare intensity.

I searched the secondary historical literature for detailed descriptions of military campaigns that, ideally, listed all cities that changed hands as a result of military actions. When a city was overrun, I classified the effect on population with a scale between 0 and 10. The “effect on population” includes those killed and those enslaved, if any.

- 0 = nonviolent takeover. The city willingly opens its gates to the enemy; there is no loss of life involved, no looting, and no property destruction.
- 2 = a hostile takeover, but no reports of significant loss of life (after the city fell), no looting, and no property destruction.
- 4 = the city is sacked/plundered. This involves some loss of life and much property destruction, but no segments of population are specifically targeted.
- 6 = a segment of population is specifically targeted for extermination. The targeted individuals could be the garrison, or the elites, or some ethnic or social group. The estimated proportion of population killed is less than 10 percent.
- 8 = the estimated proportion of population killed/enslaved is between 10 and 50 percent. This was also the category for outcomes that the sources described as a “general massacre,” or that the city was “completely destroyed,” “burned to the ground.”
- 10 = the estimated proportion of population killed/enslaved is over 50 percent, as a result, the city is almost, or even completely depopulated. This is the category for claims in historical sources that an entire population was exterminated. It is intentionally broad enough to include any borderline cases, since in practice it is very difficult to kill the entire population down to the last citizen.

The odd numbers were used for cases that fell somewhere between the major categories. Category 2 was a default one when sources simply stated that a city was taken over by one of the belligerents and did not provide any further information.

Because the theory’s domain is pre-industrial societies, I only considered wars that ended before 1700. Given the multitude of wars in the historical record and the focus on pre-industrial societies, the chief limitation was finding campaign descriptions that gave enough detail, that is, listed all cities that changed hands during the hostilities (or, at least, all the major cities). Thus, it is not possible to generate a truly representative sample of internal and steppe-frontier wars. Nevertheless, I made an effort to ensure that all four major frontiers of the Great Eurasian Steppe were represented in the database (the ones with China, Iran, India, and Russia). Additionally, for China and Russia I located multiple instances of internal wars (civil wars or wars of unification) that could be directly compared with multiple instances of steppe-frontier wars in these regions. Finally, to ensure that if there is a selection bias, it goes *against* the pattern predicted by the theory, I consulted various genocide compilations, of which the list of “democides” given in Rummel (1998) appeared to be the most comprehensive. I located all examples of pre-1700 massacres of city populations resulting from internal wars in Rummel’s list and included these internal wars in the database.

The results indicate that although atrocities can happen in internal wars, their occurrence is much less frequent than in wars across steppe frontiers (Table 1). The structure of the database is not very convenient for statistical analysis because different “wars” contained wildly different numbers of “city takeovers” (varying between 2 and 85). In any case, it is not clear whether the appropriate unit of analysis is a war or a takeover, and I analyzed the data both ways. The

pattern, however, is so strong that the method of analysis does not matter. For example, taking a war as the statistical unit, I calculated the mean atrocity index for each campaign (the right-most column in Table 1). There is no overlap between the means for steppe-frontier wars and the means for internal wars, and the overall difference is statistically highly significant ( $t = 15.3$ ,  $P < 10^{-9}$ ). A calculation using individual takeovers as statistical units indicates that the overall probability of genocide (over 10% of population killed, combining categories 8 and 10 together) in steppe-frontier wars was 63%, while in internal wars it was only 1.4%, a difference of two orders of magnitude and statistically highly significant (an independence test for two-way classification (Sokal and Rohlf 1981),  $G_{adj} = 157$ ,  $P \ll 0.0001$ ). In fact, the difference is so huge, there is hardly any need for statistical tests.

*Do large empires preferentially arise on steppe frontiers?*

For an overall test of the theory I turn to the compilation of historical empires/large states, which was begun by Taagepera (1978a, 1978b, 1979, 1997) and extended by others (Chase-Dunn, Hall, and Turchin 2007, Turchin, Adams, and Hall 2006). A qualitative discussion of the spatial pattern of empire distribution can be found in Turchin (2009). Here I use this database to conduct a formal statistical test of the hypothesis that large empires – megaempires – preferentially arise on steppe frontiers. Megaempires are defined as territorial states that controlled at the peak an area greater than 1 million squared kilometers. I excluded the modern sea-based European empires (see the Discussion on these polities).

The basic idea of the test is to divide the world into discrete regions, classify the regions as steppe frontiers or not, and determine the number of megaempires that arose in each region. In order to qualify as a steppe frontier, a region has to satisfy two conditions: (1) it had to have an appropriate environment, and (2) there had to be both agriculturalists and pastoralists present. For the first criterion I use the standard classification scheme employed by ecologists (Ricklefs 2001). These are the *biomes*, or major types of ecological communities. I grouped such biomes as “temperate grassland/desert” and “subtropical desert” into a common category of the “arid zone” (see Table 2). Such biomes as “temperate seasonal forest,” “tropical rain forest,” etc., were grouped together as the “wet zone.” In practice, arid zones are regions in which agriculture is generally impracticable, except along rivers and in oases, while wet zones are generally suitable for agriculture. For example, the “woodland/shrubland” biome, characteristic of the Mediterranean, is not particularly well supplied with rainfall, but is included into the “wet zone.” World regions that were primarily agricultural, but included large stretches of steppe, I classified as “transitional.” Finally, there is some question as to how alpine biomes, characteristic of the Andes and Tibet should be classified, and I created a separate category (“Alpine arid zone”) for them.

The second criterion (presence of agriculture and pastoralism) reflects historical contingency: where cultivars and animals were domesticated, and where they could readily spread (Diamond 1997). Regions where populations did not practice agriculture obviously do not generate the surplus necessary for the existence of the state. Of more interest is the availability of transport animals, primarily horses, since they determine whether genuine nomadic pastoralism is possible. Equally important, horses were a necessary element in the nomadic “weapon of mass destruction,” mounted archery. Introduction of horses into an area usually results in a substantial

intensification of warfare as, for example, happened on the Great Plains of North America after c.1600 (Hall 1989, Hamalainen 2008). Other riding/pack animals, such as camels, and perhaps donkeys, llamas, and yaks, have a lesser, but still significant effect on warfare intensity. A man riding a donkey may not be as terrifying a foe as a horseman, but donkeys, used as pack animals, significantly increase the mobility of a war band and therefore their ability to strike across great distances. Accordingly, the second criterion for steppe frontier was the availability and species of transport animals.

Classifying world regions according to these criteria yields the results shown in Table 2. For an overall test of the steppe frontier hypothesis, we can compare regions that are classified as arid, transitional, or alpine arid zone and have some kind of a riding/pack animal versus the rest. This comparison is statistically highly significant ( $t = 6.9$ ,  $P = 10^{-7}$ ). Results of a more nuanced comparison are presented as a box-plot in Figure 1. Steppe frontier regions (arid or transitional zone with horses or camels) had two or more megaempires, while non-steppe zones had at most one and usually none. The two alpine regions fall in between, with one empire each.

Within these broad categories there are interesting additional differences. For example, arid zones with horses (temperate grasslands/deserts) tend to have a slightly greater frequency of megaempires than arid zones with camels (subtropical deserts).<sup>2</sup> This difference is statistically significant ( $t = 2.47$ ,  $P < 0.05$ ). The difference between arid zones with horses and transitional zones with horses, however, is not statistically significant. Among wet-zone regions there is also evidence that horses tend to increase the frequency of megaempire ( $t = 2.6$ ,  $P < 0.05$ ). This result is consistent with the empirically observed effect of horses on the intensity of warfare. However, other explanations are possible. For example, horses increase the speed of communications across land routes, thus making it easier to hold together far-flung territories under the central control. In any case, this is a secondary factor. The main, and the overwhelming, effect is that of having both settled agriculturalists and nomadic pastoralists interacting at close quarters within a region. Over 90 percent of historical megaempires arose in such steppe-frontier regions (57 or 59 out of 63, depending on how we classify alpine regions).

## Discussion

Human sociality originally evolved in the context of small-scale, noncentralized, egalitarian groups integrated by face-to-face interactions. During the last 10 thousand years human social evolution took a sharp turn towards large-scale, hierarchical and centralized, inegalitarian societies integrated by symbolic markers and chains of command. First chiefdoms appeared ~7.5 kya (thousand years ago) (Carneiro 1998, Flannery 1972) and first states and cities ~5 kya (Childe 1950). Another stage was reached ~2.5 kya with the rise of megaempires, characterized by 6 or more levels of administrative control, and wielding world religions to integrate populations of tens of millions and territories of millions of squared kilometers (Turchin and Gavrillets 2009).

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<sup>2</sup> The primary transport animal in the New Kingdom of Egypt was the donkey.

In this paper I argued that the theory of multilevel selection can help us understand this major transition in human evolutionary history. Human societies did not increase in scale simply by including more and more people. The scaling-up process was accomplished in a special way: increasing hierarchical complexity by adding levels of administrative control. At each step of the process, lower-level units had to cooperate with each other, so that together they could better compete against rival coalitions. However, cooperation is costly, and therefore a transition to the next level is not at all assured. As is described by the Price equation, an integrative tendency is favored when the selective pressure acting at the metacommunity level is stronger than the disadvantages of cooperation for the lower-level communities. Equally important, there must be sufficient cultural variation at the metacommunity level. This subtle, but very important result is not well appreciated by those who were not trained in evolutionary theory. *If variation at the metacommunity level is lacking, cooperation among lower-level communities will not evolve, no matter how strong selective pressures for integration may be.*

To translate this general insight into an empirical research program, I proposed the following scale for the degree of cultural differentiation: (1) between subethnic groups, demarcated by dialectal differences, (2) between ethnic (ethno-linguistic) groups, (3) between metaethnic groups, demarcated by different world religions, and (4) between settled agriculturalists and nomadic pastoralists. The scale is appropriate only for pre-industrial populations. It is crude (only four settings) and is not intended to capture the whole spectrum of cultural variation. On the other hand, it does not require detailed quantitative information, which is unavailable for most historical periods and regions. Thus, it can be used in broad-scale cross-cultural comparisons.

By happy circumstance, the proposed scale captures not only cultural variation, but also much of variation in warfare lethality. The reason is that social groups find it much easier to practice ethnocide and genocide against people who are very dissimilar from them, whose basic humanity could be denied. I test this proposition empirically by scoring the fates of populations of conquered cities on a “genocide scale.” A comparison based on a sample of military campaigns suggests that the probability of genocide (over 10 percent of citizens intentionally exterminated) increases from 1.4 percent in internal wars to 63 percent in wars across a steppe frontier.

Thus, regions in which settled agriculturalists live side by side with nomadic pastoralists are characterized not only by high cultural variation, but also by high warfare intensity. According to the theory, developed in this paper, such steppe frontiers should be the loci where large-scale societies are particularly likely to arise. I operationalize steppe frontiers by their environmental setting (the type of ecological community, or biome) and by the presence of transport animals. A worldwide cross-regional comparison shows that over 90 percent of preindustrial “megaempires” (states that controlled more than 1 million squared kilometers at the peak) arose in arid or transitional regions with horses or other transport animals (e.g., camels). Thus, the chief empirical prediction of the theory is supported. Moreover, the correlation between steppe frontiers and incidence of megaempires is very strong – this is one the most powerful macrohistorical generalizations (Turchin 2010).

*Relationship to previous theoretical proposals*

How complex societies and, in particular, states evolved is a central issue in theoretical social science (for reviews, see Mann 1986, Sanderson 1999). Theories of the state tend to fall into one of two major classes, functionalist versus conflict (Haas 1982, Sanderson 1999, Service 1975). Functionalist theories explain evolution of the state as a solution to organizational and redistributive problems. For example, in the model of Johnson and Earle (2000:31-32), complex societies arise (1) to reduce production risks, (2) to manage resource competition, (3) to allocate resources efficiently and to make capital investments, and (4) to conduct interregional trade. Warfare enters the model as a relatively unimportant factor, under (2) resource competition. In the discussion of the 20 ethnographic cases, which forms the empirical core of the book, the authors emphasize the economic reasons of social integration.

The problem with functionalist explanations in evolution, in general, is that they usually fail to make explicit the mechanism by which a functional trait could evolve. Cooperation is highly functional, yet models have repeatedly shown that it can evolve only under certain, fairly restrictive conditions. There is no question that there are benefits to reducing risk by averaging over widely dispersed producers, or organizing large-scale public works, such as irrigation canals or road networks, but how strong is selection pressure for such traits? Thousands of historical states have been destroyed by warfare, either as a result of external invasion, or due to internal conflict resulting in fission. By contrast, economic factors, even in the case of thalassocratic polities, such as ancient Athens or medieval Venice, where they are expected to be particularly important, do not cause state extinction by themselves. The defeats inflicted on Venice by the Ottoman Turks were at least as important to its decline, as the discovery of alternative trade routes to the Orient. Furthermore, while reduced in power, Venice remained a culturally vibrant city during the eighteenth century; its final extinction as an independent state was effected by Napoleon's army. More quantitatively, Table 1 documents many instances in which whole cities were destroyed by external or internal warfare. Economic failure or environmental disaster may reduce a city's population by half, or even three-quarters, but I know of no examples where an entire city was destroyed as a corporate entity by factors other than war (can anybody think of any such examples?? But documented examples, please – we do not really know why Tikal or Angkor Wat were abandoned).

A major alternative to functionalist accounts are conflict theories such as the conquest theory of the state (Gumplowicz 1963, Oppenheimer 1972) and more recently, the circumscription theory of Robert Carneiro (1970, see also Webster 1975, Wright 1977). Warfare also plays a central role in theories of the state in such diverse disciplines as social biology, economics, and sociology (e.g., Olson 2000, e.g., Richerson and Boyd 1998, Tilly 1990). The historical sociologist Charles Tilly (1975), in particular, offered an aphorism that captures nonlinear causality inherent in the relationship between statehood and warfare: “war made states and states made war.”

Conflict theories, in their extreme form that rely on pure coercion as the force that holds together states, run into insuperable theoretical (as well as empirical) difficulties. Simply put, a society cannot be integrated by force alone. More generally, self-regarding, “rational,” individuals, who respond only to motivations of personal gain and avoidance of punishment, cannot cohere into a functioning society, no matter what punishment schemes or social contracts

are invented (Collins 1992, Durkheim 1915, Richerson and Boyd 1998, for an extended version of this argument see Turchin 2006: Chapter 5). Large-scale coercion has certainly been practiced frequently in history, but it can be achieved only by groups that are internally integrated by cooperation. Thus, extreme versions of both functionalist and conflict explanations cannot be right; both coercion and cooperation are involved in social life and in the making of the functioning state.

Coercion characterizes not only between-group interactions; it is a necessary element of ensuring within-group cooperation. Cooperation is rarely a matter of voluntary action by selfless altruistic agents. Large groups will always contain some individuals whose inclination is to “free ride,” and a cooperative equilibrium is only possible if this tendency is suppressed by moralistic punishers. Thus, cooperation (at a large enough social scale) can only be possible as a mixture of altruism and coercion. Coercion by itself is not enough, but pure, unconditional altruism is also not enough (Turchin 2006: Chapter 5).

The need for both cooperation and coercion in social life was clear to Ibn Khaldun (1958), and most current theories attempt to integrate these two social forces, avoiding the extremes of pure functionalism or coercion. For example, Michael Mann (1986: 146-155) attempted to fold both forces into one concept, “compulsory cooperation.” The evolution of Robert Carneiro’s views is particularly interesting. According to Carneiro (1998: 37), the critical step is how evolution broke through the “severe and impassable barrier” of village autonomy so that multivillage polities – simple chiefdoms – could arise. Originally, he proposed that this step was accomplished by outright conquest (Carneiro 1970). In later articles he shifted from this purely coercive to a more cooperative model: multivillage polities started as alliances of villages with military leaders, who were able to transform their temporary powers over allied villages into enduring political structures, chiefdoms (Carneiro 1998: 36). The question of how to combine the seemingly contradictory forces of cooperation and coercion within one theoretical framework, thus, is already on the agenda of theoretical social science.

The theory of multilevel evolution offers an elegant and parsimonious solution to this theoretical problem. Cooperation and coercion are enjoined in a very special way: cooperation takes place among lower-level units (but is supplemented with punishment of free-riders), while conflict takes place between higher-level collectivities. The theory can be made even more parsimonious by equating “cooperation” with cooperation that increases military effectiveness, directly or indirectly (e.g., by increasing economic efficiency or ideological cohesiveness). The purpose of putting forth such “stripped down” models is often misunderstood. Obviously, a rich mixture of special mechanisms and conditions was involved in any particular transition from a simpler to a more complex society. However, history of science is emphatic: an attempt to build a theory that immediately tries to captures all this rich variety is self-defeating. Theories must be built from bottom up, starting from very simple propositions and then adding more complexity, while testing each step empirically. Only those components should be added that result in a substantial increase of the theory’s explanatory power.

#### *Evolution of social complexity in the modern era*

My focus throughout the paper has been exclusively on preindustrial societies, specifically, on the period of human history bracketed by two great “revolutions,” the Axial Age

and the Industrial Revolution. During this era, roughly 2,000 years long, the nomads enjoyed a preponderance of military power over farmers, which allowed numerically inferior pastoralists to hold their own against agrarian states, and sometimes even dominate them. However, beginning around 1500 CE and greatly accelerating after 1800, humanity was transformed in a multitude of ways (Goldstone 2009). Among other things, this great transformation brought an end to the age of nomad military superiority. The era of the horse and the bow was succeeded by the era of the sailing ship and the cannon. Because multilevel selection is, in principle, a universal theory, its general predictions concerning the effects of variation and selection should hold for any period of human history. The question becomes, what specific forms these general mechanisms took during, for example, the Early Modern period (c.1500–c.1800).

In fact, there are remarkable parallels between Inner Asian nomads and early modern Europeans; so many that one historian has recently referred to the Europeans as the “white Inner Asians” (Lieberman 2010). The horse (or camel) and the sailing ship gave their possessors mobility across huge distances. The reach of the nomads was continental, but Eurasia is a very large continent and the Axial Age developments affected regions thousands of kilometers apart. The reach of early modern Europeans was truly global – any coastal region of the world, as well as some hinterlands (except where the disease environment was unfavorable). Long-distance mobility affects cultural variation in at least two ways. First, it brings very different people in direct contact, such as the Scyths in Egypt, or the Spanish in Peru, creating what I have termed metaethnic frontiers. Second, it increases the temporal rate (and the spatial scale) at which cultural innovations spread through long-distance trading networks. Although Aztecs and Siamese never met face-to-face, the chili pepper, nevertheless, managed to travel from Mexico to Thailand.

In addition to creating interaction zones of high cultural variation, Europeans, like Inner Asian nomads before them, had the ability and willingness to destroy whole societies. Incidence of genocide, ethnocide (with religious conversion as the most common form), and enslavement of large segments of population was common in native-European interaction zones. Furthermore, there was an indirect effect of European presence (Ferguson and Whitehead 1992). Warfare among native groups intensified as a result of conflicts over access to trade for new goods, spread of new weapons, and a demand for slaves. In short, the arrival of Europeans put enormous pressures on native societies. Many of them could not stand up under these pressures and crumbled, or were conquered outright. Others responded to the pressure by evolving into more cohesive and effective polities, capable of resisting European domination.

Interaction zones also gave rise to synthetic societies that combined European and native elements in various proportions. Of particular interest is the metaethnic frontier that arose c.1600 in what is now the eastern United States, because it gave rise to the state that achieved unrivaled power by the end of the twentieth century. The rise of the United States was a result of multiple factors, but here I focus on cooperation and warfare.

The United States is known to be a uniquely cooperative society. This was noted by nineteenth century observers, such as Alexis de Tocqueville (1984) and supported by recent research of Robert Putnam and coworkers on “social capital” (Putnam 2000, Putnam, Leonardi, and Nanetti 1993). Although the capacity of the Americans for voluntary cooperation has

declined somewhat during the last several decades, they continue to be a highly cooperative people (Putnam 2000).

Cooperation is the bright side of the American story, but there is also the dark side. The first war between European settlers and native Americans broke out soon after the settlers arrived on the East Coast in early seventeenth century. During the next three centuries (until 1890) the relations between settlers and natives were characterized by increasing hostility and recurrent warfare. This conflict was characterized by a high level of mutual atrocities – torture, massacres, and genocide. A recent survey found that there were more than 16,000 recorded atrocities committed by all sides between 1622 and 1890 (Osborn 2000).

The theory developed in this paper postulates a causal connection between cooperation and warfare, and the American case appears to be a good illustration of this evolutionary logic. Furthermore, because we have a detailed historical record for Colonial America, it is possible to trace the spread of certain cultural forms of cooperation, such as Americans’ “exceptional ability for voluntary organization” (Tocqueville 1984).

European settlers in North America were divided by a number of ethnic and religious boundaries (Silver 2008). In eighteenth-century Pennsylvania the English found it difficult to cooperate with the Germans and the Irish, and each ethnic group was further divided into feuding sectarian groups. Quakers squabbled with Anglicans, while German Lutherans feuded with Moravians, Mennonites, and so on. As one contemporary observer wrote in the early eighteenth century, “Pennsylvania is a compleat Babel” (Silver 2008). Yet, by the end of the eighteenth century the European settlers forged a common identity (“white people”) in opposition to the natives. As Nancy Shoemaker (2004) showed, these metaethnic labels (the Whites vs. the Reds) were not immediately evoked as soon as settlers and natives came in contact. Rather, during the course of the eighteenth century Europeans and Indians gradually abandoned an initial willingness to recognize in each other a common humanity. Instead, both sides developed new stereotypes of the Other rooted in conviction that they were peoples fundamentally at odds, by custom and even by nature (Shoemaker 2004).

The evolution of civic organizations reflected this expanding definition of common identity. Ethnically and denominationally based clubs appeared in Pennsylvania during the 1740s (Silver 2008). These associations represented what Putnam termed as “bonding,” rather than “bridging,” social capital. For example, St. Andrews Society was narrowly focused on helping the Scots, while Deutsche Gesellschaft did the same for the Germans. However, as settler-native warfare intensified, especially during the second half of the eighteenth century, the focus of civic associations gradually shifted to charity for any victims of Indian attacks, without regard of their ethnicity or religious denomination (Silver 2008). The social scale of cooperation took a step up. Of course, there were definite limits to this new “bridging” social capital: the Indians were most emphatically excluded; in fact, the integration of “white people” developed explicitly in opposition to the Indians. Here we see another instance of the cooperate-to-compete logic in action. Apparently, “an exceptional ability for voluntary organization” and high, verging on genocidal, intensity of conflict are not at all in contradiction with each other.

Our ability to form huge cooperative societies has a dark side. Large-scale sociality and large-scale warfare are intimately connected; they coevolved as a dynamical complex during the last ten thousands years. This does not mean that the humanity is forever doomed to lethal conflict. Warfare is not in our “genes,” and evolutionary history is not destiny. However, current attempts to find other bases for cooperation at the scale of the whole humanity (such as the United Nations) have, so far, proved inadequate to stop the wars. It is imperative that we have a clear understanding of why war occurs in order to be able to evolve beyond it. Multilevel selection, as I hope this paper shows, provides a fruitful theoretical framework for working towards such an understanding.

## References

- Alexander, R. D. 1990. *How Did Humans Evolve? Reflections on the Uniquely Unique Species*, Ann Arbor: Museum of Zoology, University of Michigan.
- Anderson, D. G. 1996. Fluctuations between simple and complex chiefdoms: cycling in the late prehistoric southwest, in *Political structures and change in the prehistoric southeastern United States*, ed J. F. Scarry, pp. 231-252. Gainesville, FL: University Press of Florida.
- Andreski, S. 1971. *Military organization and society*, Berkeley: University of California Press.
- Axelrod, R. 1997. *The complexity of cooperation: agent-based models of competition and collaboration*, Princeton, NJ: Princeton University Press.
- Beckwith, C. I. 2009. *Empires of the Silk Road: A History of Central Eurasia from the Bronze Age to the Present*, Princeton: Princeton University Press.
- Betzig, L. L. 1986. *Despotism and Differential Reproduction: A Darwinian View of History*: Aldine.
- Blok, A. 1998. The Narcissism of Small Differences. *European Journal of Social Theory* 1:33-56.
- Boehm, C. 1997. Impact of human egalitarian syndrom on Darwinian selection mechanics. *American Naturalist* 150:S100-S121.
- . 2001. *Hierarchy in the Forest: The Evolution of Egalitarian Behavior*, Harvard: Harvard University Press.
- Bowles, S. 2006. Group competition, reproductive leveling and the evolution of human altruism. *Science* 314:1569-1572.
- . 2009. Did Warfare Among Ancestral Hunter-Gatherers Affect the Evolution of Human Social Behaviors? *Science* 324:1293-1298.
- Boyd, R., and P. J. Richerson. 1985. *Culture and the Evolutionary Process*, Chicago, IL: University of Chicago Press.
- . 2002. Group beneficial norms spread rapidly in a structural population. *Journal of Theoretical Biology* 215:287-296.
- Byrne, R. W., and A. Whiten. 1988. *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes, and Humans*, Oxford: Clarendon.
- Campbell, D. T. 1983. The two distinct routes beyond kin selection to ultrasociality: Implications for the humanities and social sciences, in *The Nature of Prosocial Development: Theories and Strategies*, ed D. Bridgeman, pp. 11-39. New York: Academic Press.
- Carneiro, R. L. 1970. A theory of the origin of the state. *Science* 169:733-738.
- . 1998. What happened at the flashpoint? Conjectures on chiefdom formation at the very moment of conception, in *Chiefdoms and chieftaincy in the Americas*, ed E. M. Redmond, pp. 18-42. Gainesville: University of Florida Press.
- Cavalli-Sforza, L. L., and M. W. Feldman. 1981. *Cultural Transmission and Evolution: A Quantitative Approach*, Princeton: Princeton University Press.
- Chase-Dunn, C., T. D. Hall, and P. Turchin. 2007. World-systems in the biogeosphere: urbanization, state formation and climate change since the Iron Age, in *The World System and the Earth System*:

- Global socioenvironmental change and sustainability since the Neolithic*, ed A. Hornborg and C. Crumley, pp. 132-148. New York: Columbia University Press.
- Childe, V. G. 1950. The Urban Revolution. *Town Planning Review* 21:3-17.
- Choi, J.-K., and S. Bowles. 2007. The coevolution of parochial altruism and war. *Science* 318:636-640.
- Christian, D. 1998. *A History of Russia, Central Asia, and Mongolia*, Oxford: Blackwell.
- Christiansen, E. 1980. *The Northern Crusades: The Baltic and the Catholic frontier, 1100-1525*: University of Minnesota Press.
- Collins, R. 1992. *Sociological Insight*, New York: Oxford University Press.
- Darwin, C. 1871. *The Descent of Man, and Selection in Relation to Sex*, London: John Murray.
- Dawkins, R. 1976. *The Selfish Gene*, New York: Oxford University Press.
- Dawson, D. 2002. Evolutionary theory and group selection: the question of warfare, in *The Return of Science: Evolution, History, and Theory*, ed P. Pomper and D. G. Shaw, pp. 97-121. Lanham: Rowman and Littlefield.
- Di Cosmo, N. 2002. *Ancient China and Its Enemies: The Rise of Nomadic Power in East Asian History*, Cambridge: Cambridge University Press.
- Diamond, J. 1997. *Guns, Germs, and Steel: The Fates of Human Societies*, New York: W. W. Norton.
- . 2004. *Collapse: How Societies Choose to Fail or Succeed*, New York: Viking.
- Dunbar, R. I. M. 1992. Neocortex size as a constraint on group size in primates. *Journal of Human Evolution* 22:469-493.
- Dunbar, R. I. M., and S. Shultz. 2007. Evolution in the social brain. *Science* 317:1344-1347.
- Durkheim, E. 1915. *The elementary forms of the religious life, a study in religious sociology*, New York: Macmillan.
- Eisenstadt, S. 1982. The Axial Age: The Emergence of Transcendental Visions and the Rise of Clerics. *European Journal of Sociology* 23:294-314.
- Eisenstadt, S. N. 1986. The Axial Age breakthroughs--Their characteristics and origins, in *The Origins and Diversity of Axial Age Civilizations*, ed S. N. Eisenstadt, pp. 1-25. Albany, NY: State University of New York Press.
- Fehr, E., and S. Gächter. 2002. Altruistic punishment in humans. *Nature* 415:137-140.
- Ferguson, B. R., and N. L. Whitehead. Editors. 1992. *War in the tribal zone*. Santa Fe, New Mexico: School of American Research Press.
- Ferguson, N. 1999. *The Pity of War*: Basic Books.
- Flannery, K. F. 1972. The cultural evolution of civilizations. *Annual Review of Ecology and Systematics* 3:399-426.
- Flinn, M. V., D. C. Geary, and C. V. Ward. 2005. Ecological dominance, social competition, and coalitionary arms races: why humans evolved extraordinary intelligence? *Evolution and Human Behavior* 26:10-46.
- Gardner, A. 2008. The Price equation. *Current Biology* 18:R198-R202.
- Gavrilets, S., D. Anderson, and P. Turchin. 2010.
- Gavrilets, S., and A. Vose. 2006. The dynamics of Machiavellian intelligence. *PNAS* 103:16823-16828.
- Goldstone, J. A. 2009. *Why Europe? The Rise of the West in World History: 1500-1850*, Boston: McGraw Hill.
- Graf, D. A. 2002. *Medieval Chinese Warfare, 300-900*, London: Routledge.
- Grousset, R. 1970. *The empire of the steppes: A history of Central Asia*, New Brunswick, NJ: Rutgers University Press.
- Gumplowicz, L. 1963. *Outlines of sociology*, New York: Paine-Whitman.
- Haas, J. 1982. *The Evolution of the Prehistoric State*, New York: Columbia University Press.
- Haidt, J., and S. Kesebir. 2009. Morality, in *Handbook of Social Psychology, 5th Edition*, ed S. T. Fiske and D. Gilbert: in press.
- Hall, T. D. 1989. *Social Change in the Southwest, 1350-1880*, Lawrence, KS: University Press of Kansas.
- . 2000. Frontiers, and ethnogenesis, and world-systems: rethinking the theories, in *A World-Systems Reader*, ed T. D. Hall, pp. 237-270. Lanham, MD: Rowman and Littlefield.

- . 2001. Using comparative frontiers to explore world-systems analysis in international relations. *International Studies Perspectives* 2:252-268.
- Hamalainen, P. 2008. The rise and fall of plains Indian horse cultures. *Journal of American History* 90:833-862.
- Hamilton, B. 1999. The Albigensian Crusade and heresy, in *The New Cambridge Medieval History. Vol. 5: c.1198-c.1300*, ed D. Abulafia, pp. 164-181. Cambridge: Cambridge University Press.
- Hamilton, W. D. 1964. The genetical evolution of social behaviour. *Journal of Theoretical Biology* 7:1-16.
- Henrich, J. 2008. Cooperation, Punishment, and the Evolution of Human Institutions. *Science* 312:60-61.
- Hoang, M. 2001. *Genghis Khan*, London: Saqi Books.
- Huntington, S. P. 1996. *The Clash of Civilizations and the Remaking of World Order*, New York: Simon and Schuster.
- Ibn Khaldun. 1958. *The Muqaddimah: An Introduction to History. Translated from the Arabic by Franz Rosenthal*, New York: Pantheon Books.
- Jaspers, K. 1953. *The Origin and Goal of History*, New York: Routledge & Kegan Paul.
- Johnson, A. W., and T. Earle. 2000. *The evolution of human societies: from foraging group to agrarian state, 2nd edition*, Stanford, CA: Stanford University Press.
- Keely, L. H. 1997. *War Before Civilization: The Myth of the Peaceful Savage*, New York: Oxford University Press.
- Keyes, R. 2006. *The Quote Verifier*, New York: Macmillan.
- Knecht, R. J. 2001. *The rise and fall of renaissance France: 1483-1610. 2nd edition*, Oxford: Blackwell.
- Kruger, P. A. 2007. The Power of Perceptions: the Near East as a Case in Point. *Social Evolution and History* 6:151-175.
- LeBlanc, S. A. 2003. *Constant Battles: Why We Fight*, New York: St. Martin's Griffin.
- Lehmann, L., and M. Feldman. 2008. War and the evolution of belligerence and bravery. *Proceedings of the Royal Society London B* 275:2877-2885.
- Lenski, G. 1970. *Human societies: a Macrolevel Introduction to Sociology*, New York: MacGraw-Hill.
- Lieberman, V. 2010. *Strange Parallels: Southeast Asia in Global Context, c.800-1830. Volume II*, Cambridge: Cambridge University Press.
- Lumsden, C. J., and E. O. Wilson. 1981. *Genes, mind, and culture: The coevolutionary process*, Cambridge, MA: Harvard University Press.
- Mann, M. 1986. *The sources of social power. I. A history of power from the beginning to A.D. 1760*, Cambridge, UK: Cambridge University Press.
- Marcus, J. 1998. The peaks and valleys of ancient states: an extension of the dynamic model, in *Archaic states*, ed G. M. Feinman and J. Marcus, pp. 59-94. Santa Fe, NM: School of American Research Press.
- Masters, R. D. 1998. On the evolution of political communities: the paradox of Eastern and Western Europe in the 1980s, in *Ethnic Conflict and Indoctrination*, ed I. Eibl-Eibesfeldt and F. K. Salter. Oxford: Berghahn Books.
- Megret, F. 2008. A Cautionary Tale from the Crusades? War and Prisoners in Conditions of Normative Incommensurability, in *Prisoners in War*, ed S. Scheipers. New York: Oxford University Press.
- Olson, M. 2000. *Power and Prosperity: Outgrowing Communist and Capitalist Dictatorships*, NY: Basic Books.
- Oppenheimer, F. 1972. *The State; Its History and Development Viewed Sociologically*, New York: Arno Press.
- Osborn, W. M. 2000. *The Wild Frontier: Atrocities During the American-Indian War from Jamestown Colony to Wounded Knee*, New York: Random House.
- Perdue, P. C. 2005. *China Marches West: The Qing Conquest of Central Eurasia*, Harvard: Belknap Press.

- Pomper, P. 2002. Darwinizing History: The Evolution of Power in Russia, in *The Return of Science: Evolution, History, and Theory*, ed P. Pomper and D. G. Shaw, pp. 145-188. Lanham: Rowman and Littlefield.
- Price, G. R. 1972. Extension of covariance selection mathematics. *Annals of Human Genetics* 35:485-490.
- Putnam, R. D. 2000. *Bowling Alone: The Collapse and Revival of American Community*, New York: Simon and Schuster.
- Putnam, R. D., R. Leonardi, and R. Y. Nanetti. 1993. *Making Democracy Work: Civic Traditions in Modern Italy*, Princeton, NJ: Princeton University Press.
- Richerson, P. J., and R. Boyd. 1998. The evolution of human ultrasociality, in *Ethnic Conflict and Indoctrination*, ed I. Eibl-Eibesfeldt and F. K. Salter, pp. 71-95. Oxford: Berghahn Books.
- . 2005. *Not by Genes Alone: How Culture Transformed Human Evolution*, Chicago: University of Chicago Press.
- Ricklefs, R. E. 2001. *The Economy of Nature, 5th edition*, New York: W. H. Freeman.
- Rummel, R. J. 1998. *Statistics of Democide: Gemocide and Mass Murder since 1990*, Münster: LIT.
- Sanderson, S. K. 1999. *Social Transformations: a General Theory for Historical Development*, Lanham, MD: Rowman and Littlefield.
- Sanderson, S. K., and W. W. Roberts. 2008. The Evolutionary Forms of the Religious Life: A Cross-Cultural, Quantitative Analysis. *American Anthropologist* 110:454-466.
- Service, E. R. 1962. *Primitive Social Organization: an Evolutionary Perspective*, New York: Random House.
- . 1975. *Origins of the State and Civilization: The Process of Cultural Evolution*, New York: Norton.
- Shaw, R. P., and Y. Wong. 1989. *Genetic Seeds of Warfare*, Boston: Unwin and Hyman.
- Shoemaker, N. 2004. *A Strange Likeness: Becoming Red and White in Eighteenth-Century America*, New York: Oxford University Press.
- Silver, P. 2008. *Our Savage Neighbors: How Indian War Transformed Early America*, New York: W. W. Norton.
- Smith, A. D. 1986. *The Ethnic Origins of Nations*, Oxford, UK: Blackwell.
- Sober, E., and D. S. Wilson. 1991. *Unto Others: the evolution and psychology of unselfish behavior*, Cambridge, MA: Harvard University Press.
- Sokal, R. R., and F. J. Rohlf. 1981. *Biometry: The Principles and Practice of Statistics in Biological Research. 2nd edition*, New York: W. H. Freeman and Company.
- Soltis, J., R. Boyd, and P. J. Richerson. 1995. Can group-functional behaviors evolve by cultural group selection? An empirical test. *Current Anthropology* 36:473-494.
- Stuart-Fox, M. 2002. Evolutionary theory of history, in *The Return of Science: Evolution, History, and Theory*, ed P. Pomper and D. G. Shaw, pp. 123-144. Lanham: Rowman and Littlefield.
- Taagepera, R. 1978a. Size and duration of empires: systematics of size. *Social Science Research* 7:108-127.
- . 1978b. Size and duration of empires; growth-decline curves, 3000 to 600 BC. *Social Science Research* 7:180-196.
- . 1979. Size and duration of empires: growth-decline curves, 600 B.C. to 600 A.D. *Social Science History* 3:115-138.
- . 1997. Expansion and contraction patterns of large polities: context for Russia. *International Studies Quarterly* 41:475-504.
- Tilly, C. 1975. Reflection on the history of European state-making, in *The formation of national states in Western Europe*, ed C. Tilly, pp. 3-83. Princeton, NJ: Princeton University Press.
- . 1990. *Coercion, capital, and European states, AD 990-1990*, Cambridge, MA: Blackwell.
- Tocqueville, A. d. 1984. *Democracy in America*, Garden City, NJ: Anchor Books.
- Toynbee, A. J. 1956. *A study of history*, London: Oxford University Press.
- Turchin, P. 2003. *Historical dynamics: why states rise and fall*, Princeton, NJ: Princeton University Press.
- . 2006. *War and Peace and War: The Life Cycles of Imperial Nations*, NY: Pi Press.

- . 2009. A Theory for Formation of Large Empires. *Journal of Global History* 4:191-207.
- . 2010. Toward Cliodynamics – an Analytical, Predictive Science of History, ed D. Krakauer.
- Turchin, P., J. M. Adams, and T. D. Hall. 2006. East-West Orientation of Historical Empires and Modern States. *Journal of World-Systems Research* 12:219-229.
- Turchin, P., and S. Gavrillets. 2009. Evolution of Complex Hierarchical Societies. *Social History and Evolution* in review.
- Uralnis, B. 1971. *Wars and Population*, Moscow: Progress Publishers.
- Weatherford, J. 2004. *Genghis Khan and the Making of the Modern World*, New York: Random House.
- Webster, D. 1975. Warfare and the Evolution of the State: A Reconsideration. *American Antiquity* 40:464-470.
- Wedgwood, C. V. 1938. *The Thirty Years War*, London: Jonathan Cape.
- Williams, G. C. 1966. *Adaptation and Natural Selection*, Princeton, N.J.: Princeton University Press.
- Wilson, D. S. 2002. *Darwin's Cathedral: Evolution, Religion, and The Nature of Society*, Chicago: University of Chicago Press.
- Wilson, D. S., and E. O. Wilson. 2007. Rethinking the theoretical foundations of sociobiology. *Quarterly Review of Biology* 82:327-348.
- Wink, A. 1997. *Al Hind: The Making of the Indo-Islamic World. Vol. II: The Slave Kings and the Islamic Conquest*, Leiden: Brill.
- Wright, H. T. 1977. Recent Research on the Origin of the State. *Annual Review of Anthropology* 6:379-397.

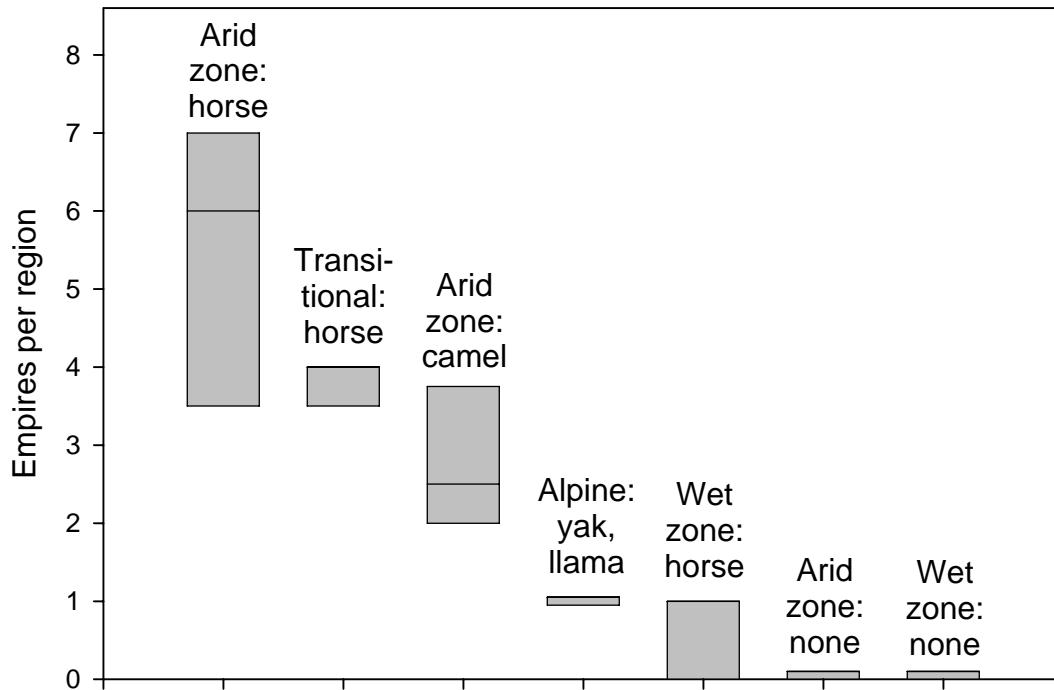
**Table 1.** Incidence of atrocities and genocide in internal and steppe-frontier wars. Codes 0, 2, ... 10 refer to the atrocity index, defined above, ranging from 0 = nonviolent takeover to 10 = over 50% of population deliberately exterminated. For the purpose of calculating the percentages (but not the averages) borderline cases (odd numbers, see above) were “rounded up” (e.g., 3s were put together with 4s). The detailed data on which these results are based is given in *Supplementary Information*.

<b>Military campaigns</b>	<i>n</i>	<b>Percentage of cases</b>						<b>Avg.</b>
		<b>0</b>	<b>2</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>10</b>	
<i>Steppe-frontier wars</i>								
Nomadic invasions: Han-Sui interregnum, 220-589	12	0	25	8	25	33	8	<b>5.8</b>
Nomadic invasions during An Lushan rebellion, 762-3	2	0	0	0	50	50	0	<b>7.0</b>
Mongol conquest of the Jin empire, 1212-34	10	0	20	10	40	10	20	<b>5.9</b>
Mongol invasion of Central Asia and Iran, 1219-21	21	0	19	0	5	5	71	<b>8.1</b>
Mongol conquest of Russia, 1237-40	28	0	0	4	7	64	25	<b>8.2</b>
Muscovite conquest of Kazan and Astrakhan, 1552-56	3	0	33	0	0	33	33	<b>6.7</b>
Ghaznavid invasions of Northern India, 1001-25	12	0	8	0	58	8	25	<b>6.2</b>
Timur’s invasion of Northern India, 1398-99	10	0	10	10	20	30	30	<b>7.2</b>
<i>Internal wars</i>								
Civil wars during the Jin Collapse, 300-328	8	25	50	13	13	0	0	<b>2.1</b>
Rebellions of the later Tang, 751-881	10	0	100	0	0	0	0	<b>2.0</b>
Sui unification wars, 580-89	4	0	100	0	0	0	0	<b>2.0</b>
Yuan/Ming transition wars, 1355-72	85	18	82	0	0	0	0	<b>1.6</b>
Chinese civil war of 1398-1402	9	0	100	0	0	0	0	<b>2.0</b>
Albigenian crusades, 1209-44	17	59	12	6	12	6	6	<b>2.2</b>
Wars of the Roses, 1455-85	11	55	18	27	0	0	0	<b>1.5</b>
Thirty Years War before the entry of France, 1618-35	51	6	82	10	0	0	2	<b>2.2</b>
Russian unification wars under Ivan III, 1462-1505	19	21	74	0	5	0	0	<b>1.8</b>

**Table 2.** The influence of the arid zone and horse on frequency of megaempires. Regions without agriculture are included at the end for completeness, but were not used in statistical analyses.

<b>Region</b>	<b>Environment</b>	<b>Transport animal</b>	<b>Megaempires</b>	
Iran	Arid zone	horse	8	Median, Achaemenid, Parthian, Sassanid, Samanid, Buyid, Seljuk, Il-Khanid
Afghanistan and Pakistan	Arid zone	horse	6	Kushan, Hephthalite, Ghaznavid, Delhi Sultanate, Mughal
Mongolia (eastern Eurasian Steppe)	Arid zone	horse	6	Hunnu, Juan-Juan, Gok-Turk, Uigur, Hsi-Hsia, Mongol
Turkestan (central Eurasian Steppe)	Arid zone	horse	4	Khorezm, Kara-Khitai, Chagatai, Timurid
Pontic-Caspian (western Eurasian Steppe)	Arid zone	horse	3	Huns (Atilla's), Khazar, Golden Horde

North Africa	Arid zone	camel, horse	4	Egypt (New Kingdom), Fatimid, Almohad, Mameluk
Mesopotamia, Syria, and Levant	Arid zone	camel, horse	3	Assyria, Seleucid, Ayyubids
Sahel	Arid zone	camel, horse	2	Almoravid, Mali
Eastern Africa and Arabia	Arid zone	camel, horse	2	Axum, Caliphate
North China	Transitional	horse	4	Shang, Qin/Han, Sui/Tang, Sung
Manchuria	Transitional	horse	4	Liang, Liao (Kitan), Jin (Jurchen), Qing (Manchu)
Balkans and Anatolia	Transitional	horse	4	Macedonian, East Roman (Dominate), Byzantine, Ottoman
Eastern Europe	Transitional	horse	3	Kievan Rus, Lithuania-Poland, Russia
Northern and Western India	Transitional	horse	4	Mauryan, Gupta, Harsha (Kanyakubia), Maratha
Tibet	Alpine arid zone	yak, horse	1	Tufan
Andes	Alpine arid zone	llama	1	Inca
Western Europe	Wet zone	horse	1	Carolingian
Mediterranean	Wet zone	horse	1	Roman
Eastern China	Wet zone	horse	1	Ming
Indochina	Wet zone	horse	1	Khmer
Central, southern, and eastern India	Wet zone	horse	0	
Korea and Japan	Wet zone	horse	0	
Southern China	Wet zone	horse	0	
Equatorial Africa	Wet zone	none	0	
Southern Africa	Arid zone	none	0	
Southwestern U.S.	Arid zone	none	0	
Mesoamerica	Transitional	none	0	
Island SE Asia	Wet zone	none	0	
Oceania	Wet zone	none	0	
Missippian (Eastern U.S.)	Wet zone	none	0	
Amazonia	Wet zone	none	0	
Siberia	No agriculture	–	–	
Nonagricultural South America	No agriculture	–	–	
Nonagricultural North America	No agriculture	–	–	
Australia	No agriculture	–	–	



**Figure 1.** A box plot showing the effect of environment and presence of transport animals on the number of large empires in a region.