

Stones, Bones, and States: A New Approach to the Neolithic Revolution

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The invention of agriculture, the wide spread shift to a sedentary lifestyle, and the growth of large population centers began around 10,000 years ago in what we now call the Neolithic revolution. This profound change in human activity marks the beginning of modern human society and has long been of interest to economists, anthropologists, and social scientists in general. Was it caused by a shift in relative prices due to climate, population pressure, or changes in the animal environment? Did it result from technological innovation in human knowledge about the physical world? Was institutional change a catalyst?

Early research was highly speculative, with abundant explanations built on little data. New evidence from archeology and anthropology has eliminated some hypotheses and raised possibilities for answering more specific questions. This paper contributes to both the Neolithic empirical evidence and the theoretical questions about the Neolithic revolution. We propose a theoretical answer to how larger social groups were organized. A sedentary life-style was necessary for settled agriculture, and the shift to larger population units occurred contemporaneously with, and may have even preceded, the spread of new agricultural techniques. We then focus on the paradoxes inherent in the question: why did people move into towns and cities?

Urban living came at a substantial cost. Accumulating evidence from skeletons, which we discuss below, shows that Neolithic cities and towns were unhealthy. Their residents were smaller in stature than hunter-gatherers and their bones had relatively more lesions indicating dental decay, infections and other signs of physiological stress. Since early city dwellers had the option of living as healthier hunter-gatherers, why did they choose to live in cities? What benefit of larger social organizations offset this cost?

The most obvious reason is defense against violent attack. It is easy to see why community defense may have played a critical role in establishing settled agriculture. Comparative advantage and learning by doing should have given hunters a military edge when it came to fighting. Potential farmers unable to protect their crops had no incentive to become farmers. Since the weight of sheer numbers would convey a substantial military advantage, social organizations that could put larger numbers of people in the field, with a

modicum of coordination, would enjoy a significant advantage. Again, the question boils down to the new ability of some human societies to sustain large population groups.

The simultaneous emergence of new institutional forms to organize larger social units and new agriculture techniques suggests that either institutional or technical innovation may have been the driving force in the revolution. New archeological evidence suggests that sedentism preceded domestication of plants, implying that institutional change probably preceded technical change (Gebauer and Price 1992). Regardless of whether institutional change was the driving force in the Neolithic revolution or a response to changing opportunities, the new Neolithic institutions must have created new ways of structuring human interaction. We offer a new approach to Neolithic institutional change consistent with conundrum posed by the archeological record: why were people willing to live in cities where their health was lower than in the surrounding hunting and gathering societies?

After briefly reviewing the existing economic and anthropological hypotheses about the Neolithic revolution, we present a theory of the state consistent with the conundrums in the archeological record and capable of explaining the emergence of large social units several millennia ago. The heart of the theory is what North, Wallis, and Weingast call the “natural state” (North, Wallis et al. 2006). In a natural state, the political system manipulates economic privilege to create rents that can be used to create social order and reduce violence. We then set forth the methodology and the skeletal evidence showing that urban life was relatively unhealthy but also considerably less violent. Consistent with their ideas, we argue that institutional change in the form of well-organized elite coalition with relatively well-defined elite property rights reduced violence to the point that early cities became attractive places to live despite their adverse effect on health.

Any method of reducing violence requires inducing militarily powerful individuals to stop fighting. The natural way of doing this is to weld a number of powerful individuals into mutual, credible agreements with each other to stop fighting. In order for these agreements to be credible, however, the military elites must lose something significant if they choose to fight each other. Credible agreements require that each military elite must perceive that it is in his own interest and in the interests of the other military elites not to fight. The solution is for the military elites to agree to enforce each other’s exclusive property rights in the land, labor, capital, and valuable economic functions that they control. Because each elite member of the

dominant coalition has exclusive rights to the surplus produced by his assets, and because that surplus declines if violence breaks out, it is possible to create a coalition of elites that simultaneously creates and enforces elite privileges (including property rights) and reduces the level of violence in society.

Viewing a nascent state as a coalition of powerful individuals who credibly commit to end violence against each other is preferable to a model in which a monopoly of coercive power gives rise to the state. Gaining a preponderance of military power requires the organization of significant numbers of individuals. Rather than finessing how this organization originates and maintains itself, our approach begins by identifying the organizational mechanism at work. Moreover, a state that rules by coercing subjects and rivals is continually waging, or threatening to wage, war against its own subjects and its rivals. Belief systems in which the legitimacy of the state is tied to the provision of order can never emerge in such a system, since the explicit agreement between the powerful is cooperate or else. Instead, Elman Service argues that successful social organizations “wage peace” (Service 1975). That is, the social system secures peace and cultivates beliefs about the legitimacy of the system, which are consistent with the fact that powerful individuals have positive incentives to maintain the peace, rather than living in a social order where a balance of terror is all that insures order.

Our review of the evidence as well as new data we bring to the table show that violence was the common lot of hunter-gatherer societies. Property rights are only enforced by the force of arms. As a result, the emergence of a natural state does not reduce the rights of non-elites and transfer them to elites. Instead, elites create newly defined and enforced rights for themselves. In turn, a natural state allowed non-elites to obtain protection at the cost of reduced health. The attraction of an agrarian society was not a higher physical standard of living, it was a safer life and thus, presumably, greater utility.

Unlike the earlier economic explanations of the Neolithic revolution, our approach generates two predictions about early human societies that produce readily-implemented tests. First, the archeological record should show that residents of population centers suffered less from violence. The fourth section of the paper describes how violent trauma can be inferred from skeletal remains, and then we apply the methodology on a sample of several thousand of skeletons from the Western Hemisphere. The fifth section presents results clearly showing that early urban dwellers experienced significantly lower levels of violent trauma over their

lifetimes in comparison to hunter gatherers.

Second, the theory of the natural state predicts that early states all should share a common organization form in which elites dominate economic, political, and social privileges. The sixth section of the paper compares the theoretical predictions to the anthropological evidence of the formation of early states. Again, the evidence provides a consistent picture of the structure of early states that fits neatly with the predictions of the natural state theory.

II. Existing Explanations

Almost all of explanations of the transition to settled agriculture, by economists or anthropologists, focus on the changing relative returns of hunting and farming. When the returns to hunting fall and/or the returns to farming rise (or combined changes in both raise returns to farming relative to hunting), individuals are induced to shift their labor from hunting and gathering to farming. In some of the early theories the shift in relative returns was caused by an exogenous change, but in most theories the change is endogenous to the behavior of humans themselves.

V. Gordon Childe and others postulated that exogenous climate change at the end of the Pleistocene Era may have induced shift into agriculture as competition for food resources in a drying environment caused technological change in food production (Childe 1951; Childe 1954). Childe's hypothesis that the geographic origins of plant domestication would be found near water did not hold up well to archeological investigation. Another type of exogenous change was technological, that humans suddenly came upon the knowledge that plants could be cultivated and domesticated. The geography of domestication should thus follow the existence of wild progenitors of domesticated species (Sauer 1952; Braidwood 1960). This type of geographical explanation rarely plays an explicit role in economic explanations, but it is often plays a central role in anthropological theories and in actual archeological tests of competing theories (Isaac 1970).

Endogenous explanations could include positive or negative effects of human behavior on the environment. Smith (1975) suggests that the widespread extinction of large animals at the end of the Pleistocene reduced the returns to hunting and induced a shift into agriculture. More generally, growing human population endogenously changes the returns to hunting and farming as pressure on land and animal

resources lowers the marginal productivity of hunting, growing human populations lower the marginal value of labor making labor-intensive agriculture efficient (even in the absence of declining productivity in hunting), and the interaction of the two effects produces a strong set of incentives to shift to farming (Locay 1989).

In other approaches the endogenous human effects are positive. Ester Boserup and Julian Simon argue that rising population pressure provides the impetus for technological innovation (Boserup 1965; Simon 1977; Boserup 1981; Simon 1981). Michael Kremer develops a general theory of technological change in which the size of the population is a critical determinant of the rate of technological change, since the probability of innovation occurring to a single individual is presumed to be independent of the size of the populations (Kremer 1993).

North and Thomas focus on institutional development (North and Thomas 1977). They begin with a simple relative returns model in which growing population drives down returns to hunting and causes a shift into agriculture, which is presumed to have constant returns. But then they note that while individual property rights are difficult, if not impossible, to create and enforce in a hunting and gathering society, communal rights to resources become more valuable as population rises. Following Harold Demsetz's classic argument that property right creation is a function of the value of the resource (property) at issue, they argue that increasing population pressure led to the creation of better communal property rights in land (Demsetz 1967). The ability to exclude others from using land significantly raised the returns to agriculture. Property rights also directly increased the returns to innovation in agriculture, leading to an increase in the rate of innovation. Matthew Baker provides a similar analysis, in much greater formal detail, of how communal property rights to land may have evolved in a hunter-gatherer society (Baker 2003). By extension of the North and Thomas argument, the creation of communal rights in a hunting society may have eventually made agricultural innovation more likely.

Even a casual perusal of the anthropological and archeological literature on the domestication of plants and the emergence of farming suggests that the economists have had little, if not zero, impact outside of economics and economic history. The reasons are obvious. Economists have contributed nothing to the empirical evidence available to discriminate between competing hypotheses. The ideas that economists put

forward are useful, but the working principles in almost all economic theories are based on simple relative price arguments that anthropologists already fully grasp.

The economic theories share a common element: things have to get worse before they get better, if indeed they ever do get better. The impetus to technical innovation (in theories with endogenous technological change) or the shift to agriculture (in theories with exogenous or fixed returns in hunting and farming, but endogenous population growth) is a decline in the productivity of hunting or a decline in the marginal product of labor generally. In the property rights story, increasing population raises the value of land and lowers the value of labor, and induces the creation of rights to the more valuable resource. While it seems too obvious to mention, any relative price argument for the timing of the Neolithic revolution suffers from the virtual certainty that the same relative prices existed at some point earlier in human history and did not induce a revolution.¹

Perhaps a stronger reason for lack of attention to economic theories is that the physical evidence uncovered by intensive field work led in a different direction than a crisis/innovation model. Carl Sauer noted that adoption of new agricultural techniques was unlikely to occur in populations that were critically resource constrained (Sauer 1952). “People threatened by famine cannot afford the leisurely experimentation that would lead to more abundant food in the future.”² Nonetheless, anthropology and archeology generated an abundance of population pressure theories as well, notably those by Lewis Binford, Kent Flannery, and Mark Cohen (Binford 1970; Flannery 1973; Cohen 1977; Binford 1983). As evidence continued to accumulate about the geographical origins of domestication and the timing of those developments the stylized facts had to be altered.

“Agriculture firsts appears in areas with an abundance of resources – the land of plenty – rather than a scarcity.” (Gebauer and Price 1992). Although field investigation continues to generate new evidence, the emerging picture is that social groups in resource rich environments that had already become sedentary were

¹That is, over the previous 100,000 years relatively scarce resources and abundant population must have occurred in countless local environments, even if global population and resource constraints were not the same as they were 10,000 years ago.

²The quote comes from Isaac’s paraphrase of Sauer’s argument (Isaac 1970), p. 10.

the first to develop agriculture. Plant domestication emerged from abundance, not scarcity. Baker's theoretical result that property rights are more likely to emerge in hunter-gatherer societies with abundant and predictable resources is to the point here (Baker 2003). In predictably resource rich environments, some groups began changing their social structures and institutions in a way that made larger social groupings possible. It was in these locations and societies that the first agricultural innovations were concentrated.

Anthropologists began developing theories in which an abundance of resources allowed the formation of more sophisticated social structures capable of manipulating an economic surplus for social advantage (Brunton 1975; Bender 1978; Hayden 1990; Hayden 1992). The new social institutions made agriculture possible. Neolithic institutions must have simultaneously solved the problem of managing larger social institutions and (perhaps simply as a result of the ability to coordinate larger numbers of people) the problem of defending sedentary cultivated fields against animal and human predation. Now we have reached the point where the conundrum laid out in the introduction comes into play. How were these societies organized, how did they overcome free rider and credible commitment problems within larger organizations, and how were large numbers of individuals induced to give up hunting and gathering for an agrarian life that promised them less in terms of health and nutrition?

III. Violence, hierarchy, and the natural state

Hunter-gatherer societies are typically made up of small units, bands of roughly 25 people, loosely organized into larger social structures or tribes with extensive kinship relations. Bands are typically egalitarian and leaders do not enjoy privileged access to the most or the best resources.³ Reciprocity and gift giving are pervasive, both within bands and to a lesser extent within and between tribes. Violence within and between bands and within and between tribes is a serious problem and a regular part of life. Small social units, regularized mutual exchange and obligations, and a high level of violence appear to be consistent with an inherent genetic predisposition to social behavior in humans combined with a limit on the number of other

³ Barbara Bender and Robert Kelly (Bender 1978; Kelly 1995), [citing Levi-Strauss 1955, p. 403, Spencer, 1959, and Damas 1968.]. Christopher Boehm has an extensive discussion of egalitarian society (Boehm 1999).

people that a single individual can come to know and trust through personal interaction. Trust evolves out of personal contact. Distrust between individuals who do not know one another is the rule. Since the number of individuals one person can know well enough to trust is limited, so is the size of the basic social unit. As the size of a social unit expands, the interaction between members necessarily becomes less regular, knowledge of other individuals is less extensive, and the larger social unit becomes progressively less capable of undertaking coordinated action as a group.

The high level of violence within and between bands and tribes makes mutual trust an extremely valuable asset for two (or more) individuals to possess. The anthropological literature on violence has progressively eroded the idea that human prehistory was ever peaceful over long stretches of time or peoples (Keeley 1996; LeBlanc 2003). We provide empirical evidence for the high level of violence in hunter-gatherer societies in the next two sections. For now, we take a high level of violence as a maintained assumption. The challenge is to explain how a stable larger social organization can emerge in a world with pervasive violence. Perhaps it helps to put the question in a slightly different way: how can some individuals living in a violent world manage to construct personal relationships that extend farther over space, time, and populations to order social relations in a way that makes a larger social organization possible?

Trust requires credible commitments. Both parties in a relationship must believe that it is in the other party's best interest to abide by the terms of the relationship. In small social units credible commitments emerge naturally from widely shared experiences, common knowledge about beliefs and preferences, and the credible ability to punish those who defect from agreed arrangements, if necessary by denying defectors access to the community for some time in the future. Extending trust across communities requires something more explicit than shared experience, and we see evidence of such arrangements within tribes. For example, exogamy is a necessary requirement for small social groups to avoid the adverse genetic consequences of inbreeding. The need to marry outside the group can be converted into a credible commitment device between groups by developing formal institutions for placing wives, husbands, or spouses with other groups within the tribe. The personal relationship between parents, children, and siblings provides the basis for a credible commitment mechanism.

The presence of a variety of such credible commitment devices in hunter-gatherer societies is well

documented in the anthropological record, but the devices are not sufficient to support a larger, sustainable, well organized social unit.⁴ One problem is certainly violence. As Keeley documents, intra- and inter-tribal violence between units with shared family members is so common that societies often produce rules about fighting where brothers or cousins are exempted from the normal rules of engagement. Sharing spouses and other hunter-gatherer institutions are not enough to control violence. Our conceptual model focuses on violence and, as a result, begins by paying particular attention to military specialists: the most violent and powerful members of a society. The emphasis on the military, however, is merely expository. As we explain later, the “natural state,” the system of organizing society capable of controlling violence is an amalgam of military, political, economic, and religious institutions. Indeed, the social organization would not work if it did not include all the major elements of a social system.

Let’s begin with a stylized problem. Imagine a population made up of many small groups and no well organized states or military forces. In hunter-gatherer societies most males fight, but some are better fighters than others. Some individuals specialize in violence and all individuals have to stand ready to defend their rights by force of arms. Imagine two specialists in violence, living in close geographic proximity. The specialists provide protection to their band, but the biggest threat they face is each other. The two bands cannot credibly commit not to fight, although the bands can employ devices like spouse sharing. If the specialists try to reach an agreement not to fight, the first specialist to put down his arms risks being attacked and killed by the other. Thus, it is an equilibrium outcome for both specialists to continue fighting. The solution? If the two specialists recognize each other’s rights to land, labor, and resources their control, then there is a possible solution. Everyone is more productive in the absence of warfare. If the specialists can credibly believe that they can each extract economic surplus from their assets, and here it is critical that they recognize each other’s rights to exploit the land, labor, and capital on the violent, then it is credible that each specialist will earn more rents from his assets if there is peace. The knowledge that both specialists can expect lower rents if violence breaks out can enable the specialists to credibly commit not to fight each other.

⁴Bender provides several examples, including the wife sharing arrangement, and then cites Levy-Strauss and Sahlins “alliance” theories (Bender 1978).

Within a hunting band, egalitarian social norms constrain even the best hunters from not taking more than their share. The leader “controls the circulation of valuables, has much to distribute and considerable power, yet, bound by the ethos of reciprocity, he continually gives away all that he gains, cannot refuse a request for help, and is often poorer in material possessions than his followers.”⁵ Controlling violence, however, requires that violence between bands and tribes be limited, and that necessarily requires agreements between individuals across bands and tribes. In order for the inter-band and inter-tribe commitments to not fight to be credible, however, the individuals making the promises must be capable of preventing their fellow band members from violating the agreement and both parties to the agreement must see that it is in the other’s interest not to fight.

The transition to a sedentary life, which is directly associated with agriculture (and perhaps a precondition for it), is also associated with the emergence of social hierarchy. “Suffice it to show that on the one hand, sedentism, through concentrating labour in a more circumscribed area, tends to encourage increased productivity, and on the other through feeding back into the system and promoting hierarchization, encourages increased production.” (Bender 1978), p. 213. Bender’s stress on the development of social systems as a cause of plant domestication rather than a techno-environmental explanation, goes immediately to the point we emphasize. Creating a credible commitment not to fight across social units required the development of relations within social units that enabled some individuals to make commitments across units. In general, this is the development of elites, of a social hierarchy. Note critically, however, that a central function of the elite is to form durable alliances with elites in other social units. The cross-unit agreements ultimately lead to the consolidation of multiple bands into a larger social unit. Bender relies in part in Levi-Strauss’s notion of alliances, precisely the inter-group dynamic that we adopt.⁶

Now back to the specialist in violence. Part of the agreement between the two specialists is to enforce each others property rights to the land, labor, and capital they each control. This creates a social mechanism

⁵Boehm (1999) and Bender (1978), p. 212 citing the people noted in footnote 1.

⁶Later in the paper we will consider Norman Yoffee’s finding that early states are patch works of different groups across a geographic area tied by elite interactions (Yoffee 2005).

capable of sustaining elites, something the small hunter-gatherer band does not do.⁷ Because the elites possess a preponderance of violence within their joint communities and are capable of reaching credible commitments with each other, elites can create and enforce their own property rights to what were previously community assets. Since land and people are much more productive if they are protected from the threat and actuality of violence and the increased output from providing peace goes to the elites, the elites can credibly commit not to fight.

The exposition to this point has focused on military specialists to the exclusion of political, religious, and economic elites for the simple, powerful reason that more complex societies cannot develop if the problem of controlling violence is not solved. This does not mean that a coalition of military elites can, by themselves, provide order and structure a larger society. The logic of the natural state suggests exactly the opposite. Military elites will not be able to structure a more complex social order unless economic, religious, and political elites simultaneously develop that make it possible to extract surplus from non-elites. The mechanism of rent creation that undergirds the fundamental commitment not to fight depends on the existence of at least rudimentary social institutions capable of organizing and mobilizing resources and trade. To simplify, we discuss the development of trade as the function of economic elites and the development of production and distribution networks a function of political-religious elites.

As military specialists attempt to construct durable agreements across the border of groups, they will utilize all of the existing methods of securing credible agreements, like spouse exchange, available in their cultures. External exchange of valuable or rare objects and resources, trade, is one of those mechanisms. Concurrently, since the value of the land and labor can be enhanced by specialization and division labor, facilitated by trade (external or internal to the group), there is a strong incentive to identify a small group of traders to carry out both internal and external trade. These traders are economic elites. By granting economic elites privileged control over trade, the traders also earn economic rents. Those rents serve to bind the

⁷Everyone has to sleep sometime. The individual leader of a band who tyrannizes his fellow band members is likely to die in bed. As Boehm emphasizes, in many small societies the community will press the family of the leader to execute the tyrannicide in order to prevent subsequent blood feuds.

interests of economic elites to the continued existence of their internal regime as well as the larger organization formed by the external relationships of the military specialists.⁸

Similarly, organization of production through the allocation of land and labor and control of the distribution of output (which is connected to trade) is typically under the control of what we call political-religious elites. While it may seem odd to lump the two together and even odder to give them control over the economic functions of production and distribution, it is simply a fact that much of the production, distribution, and redistribution of resources and commodities in pre-industrial economies, including Europe through the middle ages, was undertaken through a system controlled by political and/or religious authorities and not by markets. While few people were truly self-sufficient, many small communities produced primarily for their own consumption and were bound by customary relationships between individuals mediated by community custom enabled and enforced by political or religious sanctions. Ownership and control of land, water, and valuable capital assets like land and buildings were more often than not vested in public (communal) rather than purely private entities (individuals). Control over those resources were vested in political-religious elites. Access to these resources was available through in-kind distribution and redistribution in the political-religious system. In all likelihood, direct physical control over output was a more important way to mobilize surplus than internal trade.

The ability to extract resources from these societies, either explicitly in the form of taxes or implicitly through rights over use, depended on the sophistication of the institutions governing production and distribution. Without the ability to extract higher output from the land and labor that elites controlled, there was no incentive for military elites to refrain from violence. Again, as with trade, the existence of an appropriable surplus was a precondition for credible commitments between military specialists. Once those arrangements were in place there was a strong feedback effect, as the privileges of political-religious elites were strengthened as a way to increase output. As before, the political-religious elites received rents because

⁸It should be clear why the notion of fixed boundaries between groups, and the whole notion of internal and external relations between groups, is problematic in a natural state. As natural states develop, they internalize functions and activities. What was external trade becomes internal trade; what was defense against invasion becomes policing.

of their special privileges, enabling those elites to credibly commit to support the existing regime.

Given the sparse record of evidence, it seems fruitless to speculate whether military, economic, or political-religious elites emerged first. With the evidence in hand we cannot test such a hypothesis and it is extremely likely that the order of emergence differed across societies and that in many societies any high-status individual might carry out two or more elite functions. Three implications do flow from the conceptual framework, however. 1) Military, economic, and political-religious elites should emerge more or less simultaneously in sedentary societies as the scale of those societies grows. 2) Internal and external trade in these societies should be under elite control. 3) Hierarchical structures of resource control and use should develop, typically not through private property rights but through communal control of resources where decisions about use, distribution, and redistribution of resources is concentrated in a narrow political-religious elite.

These speculations should give way to evidence. In the next three sections we document that the implications of the natural state theory for violence in hunting-gathering society compared to sedentary societies and structure of early state organizations is consistent with the available data.

VI. Measuring Violence from Skeletons

Our conceptual framework suggests that settled societies should exhibit measurably lower levels of humanly induced violence than their hunter-gatherer contemporaries. Evidence to test this hypothesis is available in the archeological record, but interpretation requires that we understand the methods by which interpersonal violence can be inferred from skeletons.

Types of skeletal injuries. Skeletal trauma may be classified into three types: antemortem, perimortem and postmortem (Walker 2001). Antemortem fractures are easily visible because healing produces a well-defined callus of new bone that usually persists throughout life. Well-aligned fractures in children may remodel and obscure an injury but in the absence of modern medical technology such as pins, screws and casts that hold bones in place, the chances of good alignment were poor. Thus in archaeological populations, most significant skeletal injuries that did not accompany death left permanent, visible evidence

of repair on the bone.

If a broken bone lacks visible signs of healing it must have occurred near the time of death or was the result of postmortem destruction in situ or damage during excavation. Using bone color and the pattern of breakage, a trained physical anthropologist can distinguish between these causes. Living bone breaks like glass or hard sheets of plastic, leaving oblique angles and sharp edges, but soon after death bones typically lose collagen and become brittle. Dry bones break like a piece of chalk, at right angles. Marked color differences between the surface and the interior of the bone suggest breakage after death.

For obvious reasons, healed trauma is included and dry bone breaks are excluded from study. One could argue either way on perimortem breaks, but inclusion is sensible because they could have caused death; the downside is that some breaks might result from rough handling (or worse) after death and before burial. At the risk of some overstatement of violence among the living, perimortem trauma is included in the analysis.

It is likely, however that skeletal injuries understate violence on balance. Broken bones are just the tip of the iceberg because many wounds affect only soft tissues. Only one assault injury in seven can be classified as muscular/skeletal in the United States (Rand 1997). Philip Walker estimates that the frontal view of the skeleton represent about 60 per cent of the target area for a projectile (Walker 2001). Of course, the area affected depends upon the size and number of the projectile(s), and weapons technology in general. Hand-to-hand combat with clubs creates many skeletal injuries, especially to the head.

The first step in interpreting skeletal injuries is to determine the proximate cause, which can be learned by combining mechanical properties of bone with known characteristics of injuries caused by blunt instruments, projectiles, and the like (Spitz 1980). Narrowing the range of plausible mechanical causes prepares the next, more difficult step of determining social, cultural and economic factors behind injuries, which is the objective of this paper.

Accidents versus violence. How can one tell whether a damaged bone is merely the result of an accident as opposed to intentional violence? Clues are available from several sources, including the location of the bone, the type of damage, presence or absence of multiple trauma and weapons technology in use. A

projectile point embedded in the back, as found in 9,000 year old Kennewick man (Washington) and 5,300 year old Otzi the ice man (northern Italy), leaves little doubt about the cause. Although there could be explanations other than violence, such as funerary rituals, cut marks on bones usually signify deliberate trauma. In a famous example of misinterpretation, however, Raymond Dart (Dart 1953) constructed a dismal picture of rampant violence in the human past by mistaking carnivore tooth marks for blade cuts (Cartmill 1993). Modern osteologists know that careful study in well preserved remains can distinguish the two causes.

People instinctively protect their head during a fall. A common site of accidental injury is the lower arm, wrist and hand, which is extended to lessen the blow when hitting the ground. Uneven terrain, characteristic of high elevations, complicates mobility and increases these types of injuries (Larsen 1997). Bones of the ankles and legs also suffer many accidents and are more often broken at high elevations. Not all lower arm fractures result from accidents, however. A type of break called a “parry fracture” occurs to the middle of the ulna when an assault victim raises his arm to deflect a blow to the head, but this type of break can also happen if the arm is twisted during a fall. This qualification aside, arm, wrist, hand and leg fractures are a reasonably good indicator of accidental trauma.

While deliberate aggression can affect any part of the body, the head is a common location of interpersonal violence (Larsen 1997). Holes left by bullets and by weapons such as pikes, swords and knives are reasonably clear evidence of intent, as are depression fractures to the cranium, left by clubs or other blunt instruments. Broken noses and jaws also reflect interpersonal conflict. One could imagine a few head injuries occurring by accident, but it is safe to argue that the vast majority result from violent intent.

Modern Evidence Provides Clues of Ancient Patterns. Modern studies have identified numerous factors associated with violence, including demographic characteristics of individuals, geographic location, ethnic status, type and availability of weapons, poverty, and diet or substances consumed. Although the literature considers many other covariates, the discussion here is tailored to those available for analysis of the skeletal data. Some of the factors we discuss here cannot be controlled for in the historical data, but we want to consider the possibility that the missing data may explain the pattern of results we find.

Age and sex are clearly associated with modern patterns of trauma. Men are considerably more likely

than women to experience injuries of all types (Baker 1992). Rand indicates that males are responsible for 84 per cent of assaults treated in emergency rooms (Rand 1997). The median age of perpetrators in American homicides was 20 years (87 per cent were males) and that of victims was 25 years, of whom 78 per cent were male (Fox 1987). A relatively large share of women (57 per cent) compared with men (17 per cent) are victims of violence by family members or intimate partners (Rand 1997). Fox reports that homicides have approximately the same pattern (Fox 1987).

Sex differences also apply to the bones affected. In England, 83 per cent of assault victims had facial injury (Shepherd, Shapland et al. 1990), and a significantly higher proportion of women (56%) compared with men (26%) had these fractures (Shepherd, Gayford et al. 1988). Whether people are genetically programmed to assault the face is an open question, but contrary evidence comes from a positive correlation between the rise of modern boxing and an increase in the proportion of homicides caused by hitting and kicking (Walker 1997).

The NRC study of the United States (Reiss and Roth 1993) confirms the age and sex pattern of violence found in England. Nearly 90 per cent of those arrested for violent crimes in the United States are men (p. 72), and the lifetime risk of homicide is about three to four times greater for men than women (p. 69). The risk of victimization by violent crime peaks at age 16 to 19 for both men and women and declines substantially with age. Somewhat higher rates of victimization apply to minorities, with rates per 1,000 being 39.7 for blacks, 37.3 for Hispanics and 28.2 for whites (p. 69). In 1990 one half of all homicide victims were black and their rate of victimization was six times higher than for whites (p. 70). The connection with ethnicity may operate through other variables such as income, education and place of residence. Violent crime rates increase monotonically by community size, with the cities over 1,000,000 population having rates roughly five times higher than communities of 10,000 or less in size, a differences that has widened since the early 1970s.

The classic study by Shaw and McKay (Shaw 1942) on the ecology of crime reported that rates increased with poverty, ethnic heterogeneity and residential mobility. Two of these factors, poverty and high mobility, were present when the twentieth century peak in homicide rates was reached in the early 1930s

(Reiss and Roth 1993). But is it absolute or relative poverty that matters? Several studies point to the importance of community inequality (Reiss and Roth 1994). Other studies have focused on the role of alcohol (Miczek, DeBold et al. 1993; Reiss and Roth 1993), weapons (Reiss and Roth 1993; Ord and Benian 1995), and sugar consumption (Kanarek 1993). We cannot control for any of these factors directly in our empirical tests, but we can consider whether they bias our results.

In recent years numerous studies have appeared on battered children (Helfer, Kempe et al. 1997; Donnelly and Oates 2000). It is difficult to determine whether the concern stems from a genuine increase in the incidence of the phenomena or simply greater social awareness. By the mid-nineteenth century social commentators of the city, such as Charles Dickens, had the topic of violence and neglect of women and children on their radar screens (Dickens 1965; Dickens 1966). During the Victorian era children's rights advanced with the passage of laws mandating education and limiting work. In 1875 the New York Society for the Prevention of Cruelty to Children was incorporated. Some studies, however, suggest that child abuse has existed throughout recorded history (Bakan 1971). Study of skeletons may help to inform the debate.

Patterns of violence in ancient societies, distilled from several anthropological studies, indicate some parallels with modern evidence. Angel found a higher rate of traumatic injuries (especially to the head and neck) among males relative to females in the eastern Mediterranean (Angel 1974). Robb reports that with the rise of agriculture cranial trauma increased for males relative to females and by the Iron Age all types of trauma were higher among men (Robb 1997). He suggests that gender roles evolved to expect violent behavior for men, but it is difficult to test this hypothesis.

In sum, if modern patterns of violence extended to the distant past, what relationships might be found in the skeletal data with respect to covariates that are available here for study? Certainly there would be more trauma among men than women, and the pattern is so widespread in the recent past that its absence would cast doubt on the veracity of the skeletal data. Estimated rates that are roughly equal for men and women might then indicate deaths of men in battles at unexcavated locations, which would tell in the sex ratio of deaths in the database. In the modern world, violence is heavily concentrated against older teenagers and individuals in their twenties, and data since the mid-nineteenth century points to some abuse, and therefore trauma among

children. Today violence is highly correlated (positively) with community size, may rise with the power of weapons and probably increases with consumption of alcohol, although social responses vary widely.

Poverty is a risk factor for violence in the modern world but it seems implausible to argue for a biological imperative, or a level of material poverty below which people automatically descend into violence. If absolute lack of material goods caused aggression, however, the distant past should have been quite violent relative to the present given the enormous increase in living standards over time. On the other hand, income or material goods might have been potent only in a relative sense, in which case inequality was the driving force. Perhaps envy was the primary motive for crime and aggression, and those locations known for inequality in material goods or power (e.g. cities), should have been sites of violence. Plausibly a sudden decline in living standards, or thwarting of expectations, caused by phenomena such as natural disasters or sudden climate change, could trigger violence.

V. New Skeletal Evidence and Empirical Results

A decade ago Richard Steckel and Jerome Rose invited a large group of physical anthropologists, economic historians, demographers and medical historians to document and analyze the history of health in the Western Hemisphere using data from archaeological skeletons (Steckel and Rose 2002). Anthropologists who contributed data on several skeletal indicators of health for individuals who had lived at sites scattered from South America to southern Canada. The combined dataset includes 12,520 skeletons from 65 localities representing populations who lived from 4,500 B.C. to the early 20th century. As explained below, some sites were deleted from the statistical analysis and some skeletons lacked estimates of age or did not have the requisite bones for study of trauma.

Table 1 lists information on the geographic, ethnic, and temporal distribution of the skeletons. Nearly 80 per cent were Native Americans, with the remainder almost evenly split between Euro-Americans and Afro-Americans. About two-thirds of the Native Americans resided in North America as opposed to Middle America (11.9 per cent) or South America (22.2 per cent). Slightly more than one-half (52.6 per cent) lived in the Western Hemisphere prior to the arrival of Columbus and nearly 14 per cent lived more than 2,000 years

ago.

Sample Issues. Although archaeologists have purposely excavated some famous sites (e.g. Herculaneum and Pompeii) most skeletons available for study originate with building projects. Occasionally entire cemeteries are excavated, but in general one can seldom argue that skeletons proportionally represent an entire society. Many collections in Europe, for example, are disproportionately from modern cities and towns, where more construction has occurred relative to rural areas. Conditions that make for large urban areas today, such as low-cost transport, may have been relevant in the past. Thus, in assessing health from skeletons it is important to consider settlement size.

More to the point of this paper, one may ask whether modern excavations might be connected with violence in the past. Speculation is difficult on the possible connection for the pre-Columbian period, simply because little is known about the geographic sites of violence. Sex ratios of the dead provide important clues. If current building projects target growing urban areas and if geographic conditions persisted in giving rise to large settlements, then a geographic bias could exist if past violence was greater in urban as opposed to rural areas. Thus, the statistical analysis controls for rural-urban location.

Potentially worrisome is that some violence occurred on battlefields, which may be remote from urban areas and less likely to have been excavated. Most famous battlefield sites such as Gettysburg are specifically protected by law. Others, such as the Taunton site from the War of the Roses, were deliberately excavated and reveal a gruesome pattern of frequent, multiple trauma that is characteristic of many battlefield burials (Fiorato, Boylston et al. 2000). A great deal is already known about battlefield violence since the Medieval era, but without excavation of these sites the evidence will be found in the skeletal record only to the extent that the wounded survived to be buried in other locations.

There are good reasons to separate the study of military from non-military violence. Not only are the people who perished in military battles usually buried in separate locations but the forces giving rise to conflict are often quite different. Men volunteered or were conscripted into armies that fought on behalf of governments or political movements. In contrast, interpersonal violence usually occurs on a much smaller scale in the area where the people live, and the victims frequently know one another. Their disputes are

tempered by social norms, sometimes stimulated by alcohol and often accompanied other crime, anger, personal hatred or a desire to get even. The vast majority of the sites in the Western Hemisphere database are non-military and the few sites associated with battles are removed from the study.⁹ Even then it is impossible to distinguish purely military from other wounds, but the remaining evidence most likely reflects domestic and interpersonal violence.

Empirical Results: We measure violence as a dummy variable indicating whether a skeleton had trauma to the head or a weapon wound, such as an arrow point or cut mark. The explanatory variables are age at death, sex, elevation, settlement size, time period and ethnicity. To provide a backdrop for study of violence, accidental trauma is examined separately, as are children under age 15, who usually lack dimorphic traits for reliable sex determination.

Tables 2 – 4 present logit regression estimates for Native Americans. The first of these tables shows that accidents were higher among males, whose occupations contributed to the problem, and at high elevations, where terrain was a factor. There was also an age-dependent relationship that was the net result of two processes. Since the signs of skeletal trauma persisted throughout life, the frequency accumulated with age. On the other hand, death eliminated a few individuals prone to accidents early in their careers, leaving the more agile (and less injury ridden) to survive to older ages. The selective editing of people by age was probably more potent with regard to violence.

Individuals who died at ages 45+ were about 7 percentage points more likely to have an accidental injury as someone who died at age 15-24. The dy/dx values should not be interpreted as prevalence rates because the denominator is the number who died, not the number who were alive at a particular age. The difference in the numbers between adjacent ages is suggestive and might be usefully compared with the number at risk (which declines with age as a result of deaths) implied by a plausible model life table, but any such calculations await careful evaluation of model specification. Size of settlement and time period were not systematically related to accidental trauma.

⁹ Also deleted are individuals of unknown sex, ambiguous ancestry, or age undetermined.

The results for violence contrast sharply with those for accidental trauma, containing both expected outcomes and surprises. In the first category are higher rates for men relative to women and the large jump in trauma in the post-Columbian period.¹⁰ Although we cannot identify the ethnic source of the injuries, European-Americans clearly initiated some acts of violence. But contact was very destabilizing and plausibly set in motion a chain of events whereby native-on-native violence increased from new weapons, disease, new labor regimes, alcohol and competition for resources.

There was no statistically significant difference in coefficients between ages 15-19 and 20-24 (based on a regression, not shown). If we accept the results at face value, as opposed to imagining they follow from some unknown process of selection, one must ask why. An additional regression (not shown) for the age group 0 to 29, which includes five-year age categories as regressors, indicates a very low coefficient for those under age 10 (only 0.9% of deaths at this age showed violence); a jump to 4.7% in the ratio of violence among those who died at age 10-14; essentially no change to age 20-24; and then a doubling of the ratio to a plateau at higher ages. These ratios suggest high incidence rates at ages 10-14 and 25-29. Other regressions (not shown) indicate this double-plateau pattern is confined to the pre-Columbian period; after Europeans arrived, the probability that a person's skeleton had evidence of violent injury was low and flat throughout childhood years and did not increase dramatically until the early twenties. One might ponder whether changing tactics of conflict or a change in weapons technology influenced the changing age structure of violence.

The fundamental empirical result is very clear: relative lack of violence in villages and cities compared to hunter-gatherer bands. The evidence suggests the existence of a remarkable degree of social or cultural control over violence in villages and cities that somehow eluded small bands of hunter-gatherers. Sex ratios of deaths suggests the pattern was not the bi-product of missing violent deaths of men who were buried at unexcavated locations; the proportion male among deaths was very nearly the same across all settlement categories (about 47.5 per cent). Moreover, Table 4 shows that violence among children, whose sex ratio was

¹⁰ In a separate examination of types of violent trauma, there was no systematic sex difference in injuries to the face. Consistent with modern evidence, women were more likely to suffer facial trauma relative to other types of

probably unaffected by selective migration because they were unlikely to have left home before age 15, was also low in urban areas. The absence of sugar and alcohol in the pre-Columbian world cannot be the explanation because hunter-gatherers also lacked these products. Common citizens may have been mesmerized into peaceful subservience by rituals that displayed the apparent control (or at least understanding) of the politically powerful over celestial events. Possibly, inhabitants of urban areas were so poorly nourished that they lacked the energy for violence, and ritualized violence may have diffused interpersonal aggression.

The probability of a violent skeletal injury was nearly 6 percentage points higher among those who lived at high elevations, a result that could have occurred for several reasons. In the Western Hemisphere, upland areas tended to have lower food productivity and often fewer food types. In contrast, coastal areas often had abundant sources of marine foods, which provided a critical food (protein) plus many foods found in upland areas. The struggle for food in upland areas may also have led to violence. The food problem was likely compounded by isolation in valley settlements, a living arrangement that probably enhanced suspicion of outsiders. The common presumption that an encounter with a stranger would be aggressive may have led to pre-emptive violence as a form of self-defense. Finally, the terrain of high elevations contributed to accidental injuries, a few of which occurred to the head.

European and African-American patterns of injury provide a backdrop against which to evaluate results for Native Americans. The pattern of accidental trauma, shown in Table 5, is similar to that for European and African-Americans, given in Table 2. For all ethnic groups, accidents were higher among males and strongly related to age at death. In contrast with natives, however, elevation was less of a factor in accidents; the coefficient on high elevation is positive but not statistically significant. There was no systematic difference between blacks and whites in accidental trauma.

Two similarities across ethnic groups in violent trauma, apparent by comparing results in Table 6 with those in Table 3, are higher rates for men and for localities at high elevations. European and African Americans also had an age dependent process, but the probability unexpectedly declined somewhat at the intentional violence. Otherwise the results for types of violent trauma mirrored those for the summary measure.

oldest age group. Plausibly the popular weapons were so powerful (i.e. guns) that individuals prone to violence were killed at younger ages rather than surviving to die at older ages with lesser violent injuries.

All blacks and whites in the non-native sample lived in villages or cities, limiting the geographic separation available in the data. Even though the cities of the nineteenth century were small by standards of the late twentieth century, the absence of a size-of-place gradient is surprising relative to modern evidence. As discussed below, the explanation cannot be found in a relative absence of men among the dead in cities. Consistent with modern data, however, blacks had significantly higher rates of violent skeletal injuries than whites. Given the social and legal setting in the South of the late nineteenth century, it is likely whites were the source of some, if not much violence against blacks.

Table 7 distills information on relative levels of violence. The table presents probabilities for men aged 25-34 calculated from parameter estimates in Tables 3 and 6. The range of expected probabilities of the skeleton having a violent injury at the time of death is considerable. Surprisingly, both the lowest and highest rates occurred in urban areas, natives who lived in pre-Columbian cities versus blacks who lived in nineteenth century cities.¹¹ If pre-Columbians were violent, it was concentrated among the hunter-gatherers, whose level was nearly twice that of European Americans. And the rate for the latter may be biased upward by an excess of men who lived in the cities. As expected, trauma was reasonably high among village tribes in the early post-Columbian period, and the somewhat low proportion of males among the dead suggests the level may be underestimated by burial of men in other locations. The skeletal evidence is clear: the shift from hunting-gathering societies to sedentary urban societies was accompanied by a marked reduction in the level of human induced violence. Despite the poor health and lower physical standard of living of most residents of villages and cities, the urban areas were significantly safer places to live. We turn next to the evidence that the social institutions and organizations capable of reducing the level of violence in early societies is consistent with the logic of the natural state.

¹¹ The calculations allocated 50 per cent of individuals to each of the early and late pre-Columbian periods.

VI. Early States

The evidence presented on the structure of early states is not as dramatic or precise as the skeletal results on violent trauma. Not only were there thousands of early states, we know little or nothing about many of them, and what we do know is not easily ordered into an empirical test. Nonetheless, it is possible to compare the structure of states and societies predicted by the natural state framework with what we do know of early states and see whether the predictions are consistent. These are not powerful or discriminating tests, but they do enable us to triangulate the theoretical predictions about social change and the formation of larger social units by using a dimension of the historical record that is independent of archeological record on violent trauma and physical living standards in urban areas.

We use two types of historical evidence. The first historical approach is to take a sample of societies that are beginning to develop larger social units. Claessen and Skalnik assembled anthropological histories of 21 societies with “early states,” stretching chronologically from ancient Egypt to the history of Kachari in northeast India since 1800 (Claessen and Skalnik 1978). They classified and analyzed many dimensions of political, economic, social, and religious development in the societies. Their results are striking. Of the 21 countries, 17 engaged in long distance trade, 2 did not (Hawaii and Tahiti, for obvious geographic reasons), and in 2 others there was no evidence. In all 17 societies with long distance trade the government either controlled the trade or trade was conducted directly by government agents (4 cases). “*Trade and markets form a source of income for the ruling hierarchy of the early state* (significant at the 99% level.)” (Claessen and Skalnik 1978), p. 541-3. There are no cases of early states in their sample with trade where that trade is not controlled by the government.

Claessen and Skalnik are revealing on the structure of military and political-religious elites as well. All 21 societies exhibited social stratification. All 21 have a leadership made up of a sovereign king and his kin as well as an aristocracy (p. 547). In 14 societies priests are a separate social class (in two cases there is no information) and in only eight cases is there an explicit military class (in four cases there is no information, and “In most cases they were reckoned with the aristocracy” p. 548).¹² Membership in the ruling elite, the the

¹²They later note that “Often priests and military leaders were simply reckoned with the ‘aristocracy’ without any further specification of their actual position.” p. 549.

aristocracy, was always extended to sovereign's kin and the holders of high office. In 18 societies clan or lineage heads were automatically aristocrats (with one case with no information). Interestingly, in only four cases were landed proprietors automatically part of the aristocracy (with six missing cases) (p. 569). Perhaps this was because private property was not widespread, most land was owned communally in one form or another (p. 551-3).

As we stressed earlier, credible commitments by military elites not to be violent required the existence of an appropriable economic surplus and institutions to extract the surplus. Trade was available to deliver some of the surplus, but only to a limited extent. "The upper stratum generally has tribute as its main source of income. Tax, however, is paid by all social categories, though varying from one category to another in quantity and quality." The social system is based on reciprocity and redistribution, with redistribution favoring elites. "The ideology of the early state appears to be based upon the concept of reciprocity: all categories of subjects provide the sovereign with goods and services (tribute and tax), while the sovereign for his part is responsible for his subjects' protection, law and order, and the bestowal of benevolence. The priesthood supports the state ideology." "... the flow of goods and services is reciprocated mostly on the ideological level, and, in reality, a form of redistributive exploitation prevails." (pp. 537-9).

Karl Polanyi argued in *The Great Transformation* that early societies were based largely on reciprocity and redistribution, not markets, and therefore that economic theory had very little to tell us about the behavior of societies until markets became more general and land and labor became commoditized (Polanyi 1975). We can steal a march on Polanyi by noting that the presence of redistribution in early natural states was clearly not intended to reinforce egalitarian social norms and outcomes of hunter-gatherer societies. Just like the use of spouses as credible commitments, early natural states borrowed existing institutions whenever they could. In this case, redistribution stopped being a method of equalizing outcomes and became an instrument of reallocation of resources in a society where extensive trade and markets had yet to develop. The importance of religious institutions in redistribution facilitated the transfer.

The second historical approach is to examine the characteristics of the first fully formed states and civilizations, what are often called "archaic states." Although examining ancient Mesopotamia or Egypt does not afford us a direct view of earlier developments at the dawn of the Neolithic revolution, examination of the

first six pristine states that developed without apparent geographic predecessors does give us another angle to confront the theory with historical observations.¹³ Because these societies are relatively well studied, they provide a useful laboratory for evaluating theories of the state and state evolution. Elman Service followed this technique in his classic *Origins of the State and Civilization* (Service 1975). Service's analysis plays a central role in our thinking, not only because he was an eminent anthropologist who knows much more about these civilizations than we, but because he explicitly lays out the history and variety of existing theories of states (pp. 3-102), details the histories of the six pristine civilizations in light of those theories (pp. 166-264), then draws conclusions, both negative and positive, about the theories ability to explain the history (pp. 266-308).¹⁴

Two features of the pristine civilizations call for attention. First, they were all theocracies. They were all societies with elite social groups made up of political-religious-military elites who ruled in conjunctions with privileged economic elites. The critical point here is the close interaction between political, religious, and military authorities within these societies.¹⁵ This is a clear prediction of the theory of the natural state. Note that the prediction is not that all natural states have social hierarchies and inequality, but that these elite hierarchies will be closely interrelated.

Second, is the interaction of stability and violence in early states. Although all of the pristine civilizations ultimately changed into something else, they exhibited a inherent stability that enabled them to assemble large populations and the time needed to leave a mark in the archeological record that would last for thousands of years. Here is how Service puts it: "we have not sufficiently understood that the hierarchical apparatus of political power had itself undergone an origin and an evolutionary development along a causal

¹³The six pristine civilizations are Mesopotamia, Egypt, the Indus Valley civilization(s) in India, China, Peru, and Mesoamerica.

¹⁴Our use of Service does not imply that we think Service is the only way to think about ancient states, or that his views are more convincing than alternative interpretations, for example Freid's emphasis on conflict resolution (Fried 1967). Service does provide an accessible and accurate history of the literature and the evidence.

¹⁵So, for example, the title of Conrad and Demarest's history of Mesoamerica: *Religion and Empire* (Conrad and Demarest 1984)

trajectory that now seemed to have its own built-in gyroscope.” (pp. 290-1). In his review of the negative conclusions of his historical investigations he suggests that simple theories built on irrigation (Wittfogel 1957), property (Engels 1972), class stratification (what Service terms Morgan-Marx-Engels and also attributes in part to (Fried 1967)), or more generally war and the resolution of conflict (Fried 1967) are inconsistent with the historical record.¹⁶ In his review of the positive conclusions he stresses, repeatedly, that simply resolving conflict by developing “big men” or class stratification is not enough to explain stability. What happens instead is that successful societies figure out ways to solve the problem of violence:

“Political evolution can be thought of as consisting, in important part, of successfully ‘waging peace’ in ever widening contexts. The successful wars – or internally, the successfully applied deterrents to feud, revolt, and other disorder – are only sporadic episodes that spotlight the failure of the political system to sufficiently control the behavior of its own and other groups. After winning a war, or after the suppression of an internal rival, a maintenance regime must begin to govern, or resume governance. It is plain that this is not easy to do. It is especially difficult to continue in peace time the contrivance that is military rule of the state, for the military state seems to have been born in conflict and disorder out of a failure of governance.” (Service 1975, pp. 297-8)

The distinction Service makes is subtle, but integral to the logic of the natural state. A state that emerges simply as a military response to a current crisis will need continual crises to justify its existence. A state that enforces the peace as a direct result of its desire to generate rents need not rely on conflict for its justification or continued existence. States that use the threat of violent coercion to enforce order don’t last. “It is when (for whatever reasons) the system malfunctions and centrifugal tendencies prevail that physical coercion is used [by the state].... And as we have seen repeatedly, the resort to violent coercion was nowhere a true solution. Whenever a government succeeds in maintaining itself, this very success results in reduced violence – so that ‘good government’ begins to look like a peaceful theocracy again.”(p. 303).

Service had his own agenda, particularly the development of a evolutionary classification scheme of social development that stressed the cooperative and integrative features of states. The agenda undoubtedly

¹⁶As Service notes, and it is important to remember, the failings of these theories are often failings are the result of over simplification of the theory by its critics: “In fact, most of criticisms are of over simplified causal theories” (Service 1975), p. 266 and that much of the work that he criticizes is very illuminating nonetheless.

produced biases in Service's evidence. It is of some comfort, therefore, that a recent attack on the whole idea of evolutionary, or neo-evolutionary, theories of state formation by Yoffee produces essential agreement on these features of early states. Yoffee explicitly refutes the notion that a single institutional form fits all the early or archaic states. Nonetheless, Yoffee finds commonalities between archaic states that conform to the natural state concepts. "Power, however, is not an abstract quality of social types, but the means by which leaders attempt to control the production and distribution of goods and to manage labor. In the evolution of the earliest states, new groups were created to transform, create, and marshal the symbolic and ceremonial resources that allowed the recombination of the differentiated groups into a new societal collectivity. The earliest states.... also included numerous differentiated groups. These social groups continuously changed in their organization and membership in relation to the needs and goals, strengths and weaknesses of the political center." (p. 33.). It is in the interaction of the differentiated groups that Yoffee challenges Service's claims about uniform institutional categories, since the interaction between elites varies across societies: "The sources of power are overlapping and interpenetrating, in that actors come to have roles in more than one social corporation." (p. 35)

Yoffee describes the organization of production in pure natural state terms: "The means from agricultural production to economic power lies in the conversion of stored wealth to a system of dependencies arising from restricted access to land and labor. Eventually, organizations consisted of elites, managers, and dependants, including both craft specialists and laborers who have been attracted to, or forced into the security provided by, a land-owning and surplus-producing estate." (p. 35). He follows his conclusions about the organization of agriculture with an analysis of trade: "The second major source of economic power is through mercantile activity. Long distance, regular networks of exchange are generally found to accompany the first inequalities in access to production in early agricultural societies." p. 35.

Yoffee summarizes his argument in natural state terms as well: "In the last chapter I argued that the evolution of the earliest states and civilizations... was marked by the development of semi-autonomous social groups, in each of which there were patrons and clients organized in hierarchies, and that there were struggles for power within groups and among leaders of groups." (p. 42). The natural state emerged as a way of limiting the adverse impact of struggles for power between leaders by welding them into a hierarchy held

together by economic rents.

As previous section documents, one of the major benefits of sedentary urban living was physical safety. The ability to ‘wage peace’ was not just a critical outcome of the natural state. The construction of social institutions in which peace was an instrument of forwarding the interests of the powerful within the population, produced modern human societies.

VII. Conclusions

The Neolithic revolution involved three changes in human society: an increase in sedentary lifestyles; the domestication of plants and animals; and an increase in the size of social groups, eventually leading to villages and cities. Economic explanations of the revolution typically focus on the relative returns to hunting-gathering versus agriculture, making the perfectly reasonable argument that an increase in the relative return to agriculture drove the shift to farming. Recent empirical work in anthropology and archeology suggests, however, that increased sedentism preceded the shift to farming and it was typically areas with high standards of living in which agriculture first appeared.

We build on the new empirical archeological evidence by focusing on the changing social structures necessary to support larger organizations of people. Hunting-gathering societies were made up of many small bands of individuals, loosely grouped in tribes, with a high level of violence both within and between bands and tribes. Violence posed two problems in the Neolithic world. Sedentary farmers would be natural targets for nomadic hunters. Implementation of new farming technology required better provision of defense, and better defense probably required greater numbers and a larger social organization. Violence also limited the size of sustainable social organizations. If bands of 25 persistently fought one another, how could a well organized social unit of 100 or 1000 people be established unless violence was reduced and controlled?

Following North, Wallis, and Weingast, we develop the idea of the natural state. In a natural state military, economic, and political-religious elites create and enforce exclusive privileges to valuable resources and economic functions. Limited access to these rights create rents and the rents serve to bind the coalition together. Because the rights elites hold in land, labor, capital, and economic activities are less valuable if violence breaks out and because the elite coalition includes military elites who are the most dangerous

members of the society, military leaders are able to make credible commitments not to fight each other. The commitments are fragile, since they are only credible if a military leader loses more from lost economic rents if he is violent than he might gain from acquiring more resources and activities, so we expect that violence is reduced, but not eliminated.

The idea that the Neolithic revolution resulted from the new social institutions created by the natural state has two testable implications. First, the level of violence should be lower in villages and cities than in nomadic bands. We describe the methodology developed to ascertain whether skeletal evidence of trauma is caused by human violence and then apply that methodology to a sample of 12,000 new world skeletons. The empirical results show that violence is significantly higher in hunting-gathering populations than in villages and cities.

The second implication concerns the structure of social organization in larger social units. Although the tests are less direct, anthropologists have gathered evidence on archaic states that first arose in the past and on early states that have arisen later in history. This evidence clearly fails to refute several implications of the natural state theory. All archaic and early states control trade. The new social organizations use control of trade to generate rents within the dominant coalition. Social hierarchies and economic inequality develop in sedentary societies. To the point, what develops is a degree of specialization with a social hierarchy where the leaders in the hierarchy are an interlocking set of military, economic, political-religious elites. The specific institutional arrangements that structure elite interaction vary from society to society, ala Yoffee's claim against Service that states can be categorized into monolithic stages. Nonetheless, all archaic and early states seem to show the same overall pattern of organization predicted by the natural state theory.

The emphasis on institutional development is not meant to eclipse the importance of technological development in agriculture, building construction, irrigation, or other innovations during the Neolithic revolution. Technological development was fundamental to the Neolithic period and the millennia that followed. We do not speculate about whether institutional change or technological change came first. Until better archeological data or techniques unexpectedly allow us to ask and answer the causation question more directly, answers to the question of which came first will remain speculations. Suffice it to say that both occurred roughly simultaneously. But technological process and explanations are incapable of dealing with

the basic conundrum of the Neolithic period: how were healthy hunter-gatherers convinced to live in villages and cities where their health was measurably lower? The answer is that they were safer. Town dwellers suffered a third to a quarter of the human induced violent trauma experienced by hunter-gathers.

The Neolithic revolution included a revolution in social organizations that produced status driven hierarchies and a much more inequitable distribution of economic resources and wealth. The emergence of privileged status was a way to produce economic rents that could be used to solve the problem of limiting violence. Safer environments and protection from human predation induced larger populations to live in closer proximity, organized by economic and political-religious elites. Modern human society emerged in the form of the natural state.

Table 1: Distribution of Skeletons in the Database

Period	Native American			Euro-American	Afro-American
	North America	Middle America	South America		
1750+	627	0	0	1,201	1,380
1500 – 1749	2,580	0	39	113	0
1000 – 1499	888	236	1,095	0	0
1 AD – 999	1,642	594	382	0	0
1000 BC – 0 AD	250	0	247	0	0
Before 1000 BC	485	343	418	0	0
Total	6,472	1,173	2,181	1,314	1,380

Source: Western Hemisphere database. Grand total = 12,520.

Table 2: Logit Regression Explaining Leg, Arm or Hand Trauma
in Adult Native Americans

Variable	Coeff.	z	P> z	dy/dx
male	0.3588	2.38	0.017	0.0222
age25-34	0.5865	2.36	0.018	0.0410
age35-44	0.5121	2.11	0.035	0.0338
age45+	0.9002	3.61	0.000	0.0708
high elev	0.3867	2.04	0.042	0.0234
village	0.1459	0.54	0.590	0.0087
city	0.1728	0.51	0.609	0.0111
late-pre	0.1627	0.83	0.405	0.0101
early-post	0.1641	0.73	0.462	0.0103
late-post	-0.3858	-1.25	0.211	-0.0207
constant	-3.7111	-11.49	0.000	

N = 2,745; LR $\chi^2(10) = 34.23$; Prob > $\chi^2 = 0.0002$; Pseudo $R^2 = 0.024$

Omitted categories: female; ages 15-24; elevation under 300 meters; mobile groups;
early pre-Columbian (lived prior to 0 A.D.).

Source: Western Hemisphere database

Table 3: Logit Regression Explaining Head or Weapon Trauma in Adult Native Americans

Variable	Coeff.	z	P> z	dy/dx
male	0.2932	2.34	0.019	0.0202
age25-34	0.7709	3.81	0.000	0.0628
age35-44	0.6073	3.05	0.002	0.0453
age45+	0.7158	3.32	0.001	0.0596
high elev	0.8584	5.12	0.000	0.0589
village	-1.3031	-7.46	0.000	-0.1043
city	-1.6339	-5.83	0.000	-0.0720
late-pre	0.1674	0.92	0.358	0.0117
early-post	0.9963	4.82	0.000	0.0842
late-post	0.4426	2.07	0.039	0.0345
constant	-3.0145	-12.43	0.000	

N = 3,431; LR $\chi^2(10) = 102.51$; Prob > $\chi^2 = 0.0000$; Pseudo $R^2 = 0.051$

Omitted categories: female; ages 15-24; elevation under 300 meters; mobile groups; early pre-Columbian (lived prior to 0 A.D.).

Source: Western Hemisphere database

Table 4: Logit Regression Explaining Head or Weapon Trauma in Native American Children

Variable	Coeff.	z	P> z	dy/dx
age 5-9	0.4626	0.74	0.457	0.0029
age 10-14	1.4470	2.67	0.008	0.0139
high elev	-0.5034	-0.83	0.405	-0.0029
village	-2.8578	-3.95	0.000	-0.0388
city	-2.1687	-2.42	0.015	-0.0068
late-pre	0.8591	1.05	0.292	0.0052
early-post	2.7622	2.64	0.008	0.0411
late-post	1.5280	1.51	0.131	0.0135
constant	-4.1718	-5.13	0.000	

N = 1,490; LR $\chi^2(8) = 41.35$; Prob > $\chi^2 = 0.0000$; Pseudo $R^2 = 0.180$

Omitted categories: age 0-4; elevation under 300 meters; mobile groups; early pre-Columbian (lived prior to 0 A.D.). Note: sex is unknown for children.

Source: Western Hemisphere database

Table 5: Logit Regression Explaining Leg, Arm or Hand Trauma
in Adult European and African Americans

Variable	Coeff.	z	P> z	dy/dx
male	0.7936	3.60	0.000	0.0664
black	-0.1514	-0.70	0.485	-0.0129
age25-34	-0.0948	-0.19	0.852	-0.0079
age35-44	1.0452	2.48	0.013	0.1034
age45	1.4302	3.39	0.001	0.1579
high elev	0.5250	1.08	0.281	0.0542
city	-0.6368	-1.85	0.065	-0.0673
constant	-2.7944	-5.20	0.000	

N = 1,042; LR $\chi^2(7) = 59.30$; Prob > $\chi^2 = 0.0000$; Pseudo $R^2 = 0.079$

Omitted categories: female; ages 15-24; white; elevation under 300 meters; rural.

Source: Western Hemisphere database

Table 6: Logit Regression Explaining Head or Weapon Trauma
in Adult European and African Americans

Variable	Coeff.	z	P> z	dy/dx
male	1.2957	4.25	0.000	0.0612
black	0.7142	2.45	0.014	0.0336
age25-34	1.1903	2.11	0.035	0.0768
age35-44	1.1943	2.18	0.029	0.0695
age45+	0.9144	1.59	0.112	0.0525
high elev	1.3846	2.90	0.004	0.1171
city	-0.0701	-0.14	0.888	-0.0034
constant	-4.9643	-6.38	0.000	

N = 1085; LR $\chi^2(10) = 37.98$; Prob > $\chi^2 = 0.0000$; Pseudo $R^2 = 0.073$

Omitted categories: female; ages 15-24; white; elevation under 300 meters; rural or village.

Source: Western Hemisphere database

Table 7: Expected Probabilities of Violent Trauma among Men Aged 25-34

Group	Expected probability (%)	Per cent male	Sample size
Pre-Columbian, hunter-gatherer	13.39	47.13	715
Pre-Columbian, city	2.70	48.63	183
Early Post-Columbian, village	9.48	44.43	673
European-American, city	7.25	59.88	496
African-American, city	18.53	49.90	511

Source: Western Hemisphere database

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