# Toward an Ecological-Evolutionary Theory of the Incidence of Warfare in Preindustrial Societies*

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*Prompted by the lack of attention by sociologists and the challenge of materialist explanations of warfare in "precivilized" societies posed by Keeley (1996), this paper tests and finds support for two materialist hypotheses concerning the likelihood of warfare in preindustrial societies: specifically, that, as argued by ecological-evolutionary theory, dominant mode of subsistence is systematically related to rates of warfare; and that, within some levels of technological development, higher levels of "population pressure" are associated with a greater likelihood of warfare. Using warfare measures developed by Ember and Ember (1995), measures of subsistence technology originally developed by Lenski (1966, 1970), and the standard sample of societies developed by Murdock and White (1969), this study finds evidence that warfare is more likely in advanced horticultural and agrarian societies than it is in hunting-and-gathering and simple horticultural societies, and that it is also more likely in hunting-and-gathering and agrarian societies that have above-average population densities. These findings offer substantial support for ecological-evolutionary theory and qualified but intriguing support for "population pressure" as explanations of cross-cultural variation in the likelihood of warfare.*

> Since War is so fundamental a phenomenon its explanation must be sought in the basic conditions of life. (Davie [1929] 1968:9)

Although it is hard to think to think of a social phenomenon that is more important than war, sociologists have shown little interest in studying it. A systematic sample of publications in the top three sociology journals—*American Sociological Review, American Journal of Sociology*, and *Social Forces*—for the period from 1936 to 1984 revealed that war, broadly defined, was the topic of only 2.3% of the 1,357 articles examined, and 72% of them were in a single year, 1942 (Garnett 1988).[1] Eliminating the single "war year" in the sample reduces the percentage to 0.75%, which is not substantially different than the rate of 0.6% found in a follow-up examination of the 1,467 articles published between 1986 and 1995 (Garnett 1996), or my own calculation of 0.49% for the 815 articles appearing between 1995 and 2000.

Perhaps even more telling, however, is the fact that *not one* of the articles captured in the sample frame explored the *causes* of war.

Anthropologists have shown a somewhat greater interest in warfare, especially among preindustrial societies, but few anthropology textbooks today make more

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[1]The specific years examined were 1936, 1942, 1948, 1954, 1960, 1966, 1972, 1978, and 1984.

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than passing mention of it, and prominent researchers have recently expressed considerable skepticism regarding the impact of technological, economic, and environmental variables on the likelihood of warfare (Otterbein 1994). For example, in a recent discussion of his 1970 monograph, Otterbein remarks:

> As the analysis of the data proceeded, it became clear that ecological and economic factors had little influence, in comparison with the type of sociopolitical system, upon the warfare variables . . . Initially it was planned to organize the results of the study into three major sections, each dealing with the influence of one of the three independent variables upon the warfare variables. Since ecological and economic variables had little influence upon the warfare variables, the monograph in its present form consists of one major section entitled "the waging of war," which deals largely with the relationship between types of sociopolitical systems and various aspects of warfare. (Otterbein 1994:34)

Moreover, in his popular and generally well-received monograph on warfare, written to explode the "myth of the peaceful savage," Keeley concludes that neither population pressure, shifts to more productive forms of subsistence—gardening and farming—nor the growing size and scale of societies are causes of increased rates of warfare among societies (Keeley 1996:117–21). In place of these proposed explanations, he tentatively offers the suggestion that "bad neighbors" and "hard times" may provide the best explanations of why rates of warfare are high in some societies and settings and low in others (Keeley 1996:127–28, 138–41).

Although Keeley is certainly correct to note that "precivilized" societies were often anything but "peaceful," he has been criticized for possibly creating a countermyth, that of the "bellicose savage" (Otterbein 1997, 2000). Even more problematic, however, is the fact that others have long been on the record challenging the idea of the "peaceful savage" anecdotally (e.g., Davie [1929] 1968; Sumner and Keller 1927) and quantitatively (e.g., Ember 1978; Knauft 1987). For example, Ember (1978) found that nearly two-thirds of her sample of 31 hunting and gathering societies engaged in warfare "more than once every two years." This percentage remained high—54%—even after the bellicose "equestrian hunters"[2] were dropped from the analysis.[3]

But this recent shift in the conventional wisdom concerning the relative bellicosity or peacefulness of premoderns may only be the most recent phase of an ongoing cycle among social scientists. For, as Sumner and Keller note: "In the eighteenth century it was assumed that the primitive state of mankind was one of Arcadian peace, joy, and contentment. In the nineteenth the assumption went over to the other extreme—that the primitive state was one of universal warfare. This, like the former notion, is a great exaggeration" (Sumner and Keller 1927:368). The only constant, apparently, is our tendency to see them as being *either* peaceful *or* pugnacious.

But regardless of whether we—and the evidence—lean more toward one conclusion or the other, we can ask if we are left with only Keeley's idiographic "explanations" of warfare or if his foreclosure on materialistic explanations was premature. Using quantitative estimates of the frequency of warfare, this paper will explore and assess

[2]Equestrian hunters are something of a "hybrid" society, created by the inadvertent reintroduction of horses into North America by the Spanish in the 16th century.

[3]It is worth noting that the percentage of hunter-gatherers found, in this paper, to be engaging in warfare—61%, which excludes mounted hunters—is within the range of those (54–65%) in Ember's (1978) study.

the impact of subsistence technology and reexamine the possible impact of population density on the likelihood of warfare in a representative sample of preindustrial societies.

Although there may be no simple answer to the question of *why* human societies engage in armed conflict with one another—the proximate causes of warfare in general, and of specific wars in particular, being many and varied—circumstances and conditions that raise or lower the probability of warfare may be profitably hypothesized and tested (Otterbein 2000:802).

This approach to the question greatly reduces the range of things that need to be considered. Species characteristics of humans, such as basic emotions like anger and fear and the ability to act aggressively, can be ignored—not because they are untrue or trivial characteristics, but because, in the absence of compelling evidence to the contrary, they can be assumed to be constant across the time frame considered.[4] What we seek to identify are key features of subsistence technology and environment that are "structurally conducive" (Mayhew and Levinger 1976:94–95) to armed conflicts between human groups.

After reviewing the archaeological and ethnographic evidence and Sumner's (1913) earlier discussion, Davie ([1929] 1968:63) made a series of observations concerning the impact of subsistence technology and environment on the likelihood and violence of warfare: (1) primitive societies are more warlike than peaceful; (2) nomadic (herding) groups are more belligerent than agriculturalists; (3) mountain hunters and herders are more violent than plain and valley farmers; (4) historically, herders tend to dominate tillers; and (5) agriculturalists are by no means peaceful. These broad, largely anecdotal observations on the conduciveness of various modes of subsistence to warfare may be extended and refined by ecological-evolutionary theory (EET), originally articulated and tested by Lenski (1966, 1970). EET has been shown to provide a comprehensive and powerful framework for identifying and analyzing determinants and consequences of fundamental features of human societies (e.g., Lenski 1970; Lenski, Lenski, and Nolan 1991; Nolan and Lenski 1996, 1999). In fact, previous analyses have shown frequency of warfare to vary systematically by categories of subsistence technology, a cornerstone of EET (Lenski 1970:138–39; Leavitt 1977; Lenski and Lenski 1978:164).

EET maintains that subsistence technology is the most important single factor affecting the organization of and interaction among human societies. The major types of preindustrial societies it identifies based on their dominant mode of subsistence are, in order of increasing technological power: hunting and gathering, horticultural (gardening), and agrarian (farming). Aspects of these technologies, and the constellation of societal features that tend to articulate around them, greatly affect both the likelihood and sustainability of armed conflict. Some features, such as nomadism or the inability to produce reliable and sustained food surpluses, may discourage warfare; others, such as a sedentary lifestyle, large, periodic food surpluses, and the accumulation of assets and wealth that are subject to seizure, may encourage it.

Considering them in order, we can infer the trend in warfare that we would expect to develop across this span of technologies by this theory. Hunters and gatherers are expected to have a relatively low rate of warfare—not because they are especially nonviolent or peaceful, as numerous accounts have shown to be wrong (e.g., Sumner

[4]This is certainly true for the time period for which we have statistical data on the relative frequency of warfare among human groups—centuries or millennia, at best—but it can probably be safely extended to the emergence of "modern" humans, whether one dates that at 50,000 years ago or at 150,000.

and Keller 1927; Davie [1929] 1968; Ember 1978; Knauft 1987; Keeley 1996), but because their intermittent and limited food "surpluses" and their nomadic lifestyle cannot sustain frequent or prolonged warfare. Men can *either* hunt or fight; they cannot do both. Feuding or warring families or groups, therefore, generally find it more advantageous to separate from one another than to engage in continuous or frequent war. As Keeley (1996) and others point out, however, when they do fight, casualty rates can be quite high, and "primitive" war can be quite cruel by modern standards.

Horticulturalists are expected to have higher rates of warfare than foragers, especially if they have developed the technology to make metal tools and weapons. There are a number of reasons for this. First, there are the consequences of the sedentary lifestyle necessitated by the shift to reliance on cultivated plants and domesticated animals for most of the society's food. For example, even where land preparation for cultivation is minimal (e.g., slash-and-burn horticulture), there is greater reluctance to "walk away" from a conflict—one of the primary means of conflict resolution in hunting-and-gathering societies—since it entails a move away from the "sunk costs" of a cultivated plot. As a result, personal conflicts, jealousies, and grudges are more likely to escalate into feuds and then wars. In addition, the food growing in a cultivated plot and the domesticated animals (e.g., pigs, sheep, cattle) raised around it may themselves increase conflict by presenting neighbors with a tempting target for raiding. Differences in the fertility or desirability of various plots of land also may also sow the seeds of intra- and intersocietal conflict.

Moreover, horticulture was the first widely adopted subsistence technology that made the conquest and enslavement of people potentially profitable, and the development of metal weapons that often followed its adoption helped make it practicable. Cultivators did not have to be armed, or allowed to wander freely, to be able to produce food, and "domesticated" or enslaved cultivators could produce a sizable and sustainable food surplus. This surplus could be used to feed more warriors, who could, in turn, capture more slaves for cultivation, and thus institute a positive-feedback warfare-slavery system. The very high correlation observed between the incidence of warfare and slavery is by no means accidental.[5] The limited communication and transportation technologies of these societies were the only real constraints on the areal expanse and number of people such systems could incorporate and control.

The incidence of warfare is expected to remain high among agriculturalists because conquest of territory and the peasants who cultivate it is the primary mechanism by which elites can increase their power and wealth. Moreover, their more productive food-producing technology can support much larger armies[6] for much longer periods of time, and their more developed communication and transportation technologies would allow more wide-ranging campaigns and permit a geometric increase in the geographical expanse and the population size of the empires they could build. Warfare would likely follow regular cycles of increase and decline in such systems, during phases of empire-building, maintenance, and collapse. Thus, overall, their frequency

[5]The observed incidence of warfare in advanced horticultural societies may, however, be somewhat inflated in ethnographic datasets. To the extent that warfare triggered population-controlling mechanisms in horticultural societies, as some have argued (e.g., Harris 1974), it may have reduced pressures to intensify food-producing technology (i.e., a shift to agriculture). This would have allowed a greater proportion of warring societies to continue to practice horticulture, whereas, lacking these population brakes, more peaceful horticulturalists would have been pushed by their growing population densities to develop or adopt agriculture. By this reasoning, the great majority of societies that continued to practice horticulture into the modern era, where they could be studied and recorded, would be those who engaged in frequent warfare, more peaceful horticulturalists being more likely to have developed into agriculturalists.

[6]Professional "armies" would take the place of "militias."

Table 1. Warfare by Type of Society

| | Subsistence Technology | | | |
|---|---|---|---|---|
| Warfare | Hunting and Gathering | Simple Horticultural | Advanced Horticultural | *n* |
| Rare or absent | 73% | 41% | 17% | 30 |
| Perpetual or common | 27% | 59% | 83% | 43 |
| *n* | 22 | 22 | 29 | 73 |

Note: Adapted from Lenski and Lenski (1978:164).

of warfare is expected to be very high, especially in comparison with hunters and gatherers and simple horticulturalists.[7] Unlike a number of other evolutionary theories of warfare, EET does not focus on sociopolitical development, the purposes for warring, or the efficiency with which warfare is waged (Otterbein 1994:33–73). It focuses on the "structural conduciveness" (e.g., Mayhew 1976:94–95) of different subsistence modes to warfare.

The most comprehensive test of this thinking to date supports these arguments and hypotheses. Using frequency-of-warfare data reported by Leavitt (1977), Lenski and Lenski (1978:164) found a clear pattern of increasing warfare associated with reliance on horticulture and the development of metallurgy (see Table 1).

In this paper, we will revisit the question of whether or not warfare is systematically related to the dominant mode of subsistence, as EET alleges, and also whether or not population pressure increases the likelihood of warfare in societies. To make our tests as rigorous and generalizable as possible, we will use warfare data published by Ember and Ember (1995) for the standard sample of societies originally developed by Murdock and White (1969). The standard sample (Murdock and White 1969) of 186 cases was carefully constructed to be representative of the full range of regional, cultural, and developmental diversity among human societies. Data on a variety of variables are available in machine-readable form for this sample through the "electronic journal" *World Cultures*.

Ember and Ember defined warfare as "socially organized armed combat between members of different territorial units (communities or aggregates of communities)" (Ember and Ember 1995:19). The original codes ranged from (1) "warfare absent or rare" to (5) "warfare occurs almost constantly and at any time of the year." In the present analysis, codes 2 through 5 were collapsed and compared to code 1. Thus, the contrast is between the absence of warfare and its occurrence.[8]

Dominant mode of subsistence was coded for the standard sample according to the protocol in the appendix and in Nolan and Lenski (1999:419–20). For this analysis, four categories of subsistence technology were distinguished: (1) hunting and gathering, (2) simple horticulture, (3) advanced horticulture, and (4) agriculture. Hunters and gatherers forage for most of their food, horticulturalists grow their food in

[7]Theoretical arguments and previous research, discussed below, suggest that the relationship of subsistence with warfare may be sharpest for the dichotomy of hunting and gathering and simple horticulture versus advanced horticulture and agriculture. Therefore, we will examine the relationship for both the more detailed categories and the dichotomy of subsistence mode.

[8]It should be noted that for warfare to be coded "rare or absent," the original ethnographer had to state that it was rare or absent. In the absence of information about warfare, it was coded as "don't know" and was treated as "missing."

(shifting) gardens, and agricultural (agrarian) societies produce their food from (continuously cultivated) fields with plows pulled by animals. Advanced horticultural societies are distinguished from simple by their ability to make metal tools and weapons (i.e., metallurgy).

Table 2 shows that the frequency of warfare does vary systematically by the type of subsistence technology. The addition of agrarian societies to this table extends the earlier tests of this theory, and it also provides new information about the relationship of subsistence technology with warfare.[9] As the data in Tables 2A and 2B show, the likelihood of warfare increases through advanced horticulture and remains high in agrarian societies. Gamma, a directional measure of association appropriate for ordinal measures, is 0.351 for the more detailed set of subsistence categories and 0.478 for the dichotomy. Although issues of statistical significance are cloudy for such

Table 2A. Warfare by Type of Society

| | Subsistence Technology | | | | |
|---|---|---|---|---|---|
| Warfare | Hunting and Gathering | Simple Horticulture | Advanced Horticulture | Agrarian | *n* |
| Rare or absent | 39% | 30% | 14% | 17% | 27 |
| Present | 61% | 70% | 86% | 83% | 88 |
| *n* | 23 | 27 | 35 | 30 | 115 |

Note: Warfare is from Ember and Ember (1995); see appendix for the source and coding of it and Subsistence Technology. Gamma 0.351, Asymptotic Standard Error (ASE) 0.153; Pearson product moment correlation, 0.208, ASE 0.094; Likelihood chi-square ratio ($L^2$) = 6.002, p = 0.106.

Table 2B. Warfare by Type of Society[a]

| | Subsistence Technology | | |
|---|---|---|---|
| Warfare | Hunting and Gathering and Simple Horticulture | Advanced Horticulture and Agrarian | *N* |
| Rare or absent | 34% | 15% | 27 |
| Present | 66% | 85% | 88 |
| *n* | 50 | 65 | 115 |

Note: Warfare is from Ember and Ember (1995); see appendix for the source and coding of it, and Subsistence Technology. Gamma 0.478, Asymptotic Standard Error (ASE) 0.176; Pearson product moment correlation, 0.218, Asymptotic Standard Error (ASE) 0.092; Likelihood chi-square ratio ($L^2$) = 5.432, p = 0.02.

[a]In this table, hunting and gathering societies have been combined with simple horticultural societies in order to contrast them with the combination of advanced horticultural and agrarian societies.

[9]It should be noted that this might also extend the argument beyond Keeley's (1996) focus on "precivilized" societies to consideration of "preindustrial" ones, since it is agriculturalists who produced the surpluses that supported and provided the impetus to the development of the complex of traits denoted by the term "civilization" (e.g., urbanization, writing, government).

Table 3. Percentage of Societies with Warfare Every Year by Population Density

| | People per Square Mile | | | | | |
|---|---|---|---|---|---|---|
| Warfare | Less than 0.2 | 0.2 to 1.0 | 1.1 to 5.0 | 5.1 to 25 | 26 to 100 | More than 100 |
| Every year | 44 | 72 | 50 | 55 | 69 | 72 |
| *n* | 16 | 14 | 12 | 11 | 16 | 18 |

"samples," it is worth noting that both gammas are more that twice their standard errors (i.e., 2.29 and 2.72, respectively).[10]

Keeley argues that "population pressure" is not a contributing cause of warfare because researchers have found no consistent or simple (monotonic) relationship between population density and warfare frequency (Keeley 1996:118–21). For example, using data compiled from Murdock and Wilson (1972) and Ross (1983, 1987), Keeley shows that the percentage of societies that engage in warfare frequently—once a year—increases, declines, and finally increases across categories of increasing density (Keeley 1996:202, Table 8.3). As Table 3 shows, I find a similar pattern using complexity data from Murdock and Provost (1971) and warfare-frequency data from Ember and Ember (1995).

The problem with such a mechanistic approach to the impact of population density, however, is that it fails to take into account the fact that the impact of density on societies has always been acknowledged to be highly conditioned by the level and type of technology that they rely on for their subsistence. Even Sumner and Keller—despite their use of the catchy, but unfortunate, term "man-land ratio"—clearly recognized this:

> Animal and plant life tends to increase up to the limit of the supporting power of the environment; it cannot advance beyond that dead-line. The case of man is different; he is an animal with superior capacities for speedy adjustment which enable him to operate upon the numbers-land ratio. By the invention of various methods of getting more food out of the land he virtually increases that term of the ratio, a feat which allows of a rise in human numbers. . . . Population tends to increase up to the limit of the supporting power of the environment (land), on a given stage of the arts, and for a given standard of living. (Sumner and Keller 1927:45–46)

The "stage of the arts" is the mode of subsistence. According to Harner, "Population pressure consists of the demand on subsistence resources resulting from both the density of population and its level of technology in relation to a specific environment" (Harner 1970:68).

Population pressure thus increases as density approaches (or temporarily surpasses) the limits of the dominant technology and environment to provide subsistence

[10] Similar results are obtained with other measures of warfare. Using Sanday's (1981) measure of war, the gammas are 0.311 and 0.501 for 81 cases (1.86 and 2.85 times their standard error); using Ross's (1983) measure of "external war" they are 0.412 and 0.685 for 55 cases (2.15 and 3.87 times their standard error). A strong relationship is also found when the Ember and Ember (1995) warfare measure is broken at different values. For example, the percentage of societies with "warfare every 3 to 10 years" or more increases from 17% to 26%, 29%, and finally 47% across ascending levels of subsistence technology.

for the population. Given their different methods and needs of production, foraging societies can be highly stressed at densities of only a few persons per square mile, while intense cultivators are not stressed by densities 10 times as high. Thus, across levels of technology, density is not an accurate indicator of population pressure. Keeley indicates a vague awareness of this when he muses that "some relationship may exist between population pressure [sic] and the intensity of warfare, but this relationship is either very complex or very weak or both" (Keeley 1996:119).

To see if population pressure is related to the frequency of warfare, it is imperative to look at the effects of density within categories of subsistence technology. Furthermore, it seems reasonable to expect that it is only likely to be a significant factor when population density is greater than average for that type of technology.[11] The average density of societies relying on different types of subsistence technology is displayed in Table 5.

We can use these median densities to help identify societies that may be experiencing population pressure in our sample of societies. For instance, since the median density of hunting and gathering societies is less than one (0.6), we would expect that hunting and gathering societies with densities greater than one are more likely to be experiencing population pressure than those with lower densities. Similarly, we can split horticulturalists at 25 and 100, and agriculturalists at 100. The crudeness of the density categories in the Murdock and Provost (1971) data (see Table 4) make some of

Table 4. Percentage of Societies with Warfare by Population Density

| | People per Square Mile | | | | | |
|---|---|---|---|---|---|---|
| Warfare | 1 or less | 1 to 5 | 5.1 to 25 | 26 to 100 | More than 100 | *n* |
| Rare or absent | 38 | 15 | 21 | 26 | 13 | 27 |
| Present | 62 | 85 | 79 | 74 | 87 | 88 |
| *n* | 26 | 13 | 19 | 27 | 30 | 115 |

Note: Warfare is from Ember and Ember (1995); see appendix for the source and coding of it; density is from Murdock and Provost (1971). Gamma 0.278, Asymptotic Standard Error (ASE) 0.149; Pearson product moment correlation, 0.166, Asymptotic Standard Error (ASE) 0.093; Likelihood chi-square ratio ($L^2$) = 5.519, p = 0.238.

Table 5. Median Density of Population by Type of Society

| | Subsistence Technology | | | |
|---|---|---|---|---|
| | Hunting and Gathering | Simple Horticultural | Advanced Horticultural | Agrarian |
| Persons per square mile | 0.6 | 13.8 | 42.7 | More than 100.0 |
| *n* | 27 | 35 | 38 | 27 |

Note: Adapted from Nolan and Lenski (1999:125, Table 6.1).

[11] This is assuming that environments are roughly comparable in terms of relevant variables such as soil fertility, rainfall, and the like.

these divisions less than ideal, but they do provide a starting point for evaluating the viability of the population pressure argument.

Although the paucity of cases with densities above one person per square mile urges caution, the results as shown in Table 6A are highly consistent with the population pressure argument. Hunting-and-gathering societies with population densities greater than one person per square mile are 47% more likely to engage in warfare than those with densities less than one person per square mile (i.e., % D = 100% – 53%).

Table 6A. Warfare by Density, Hunting-and-Gathering Societies

| | Population per Square Mile | | |
|---|---|---|---|
| Warfare | 1 or less | More than 1 | *n* |
| Rare or absent | 47% | 0% | 9 |
| Present | 53% | 100% | 14 |
| *n* | 19 | 4 | 23 |

Note: Density is from Murdock and Provost (1971). Warfare is from Ember and Ember (1995); see appendix for the source and coding of it. Gamma 1.00, Asymptotic Standard Error (ASE) 0.000; Pearson product moment correlation, 0.368, Asymptotic Standard Error (ASE) 0.103; Likelihood chi-square ratio ($L^2$) = 4.502, p = 0.034.

Table 6B. Warfare by Density, Simple Horticultural Societies

| | Population per Square Mile | | |
|---|---|---|---|
| Warfare | 25 or less | More than 25 | *n* |
| Rare or absent | 29% | 30% | 8 |
| Present | 71% | 70% | 19 |
| *n* | 17 | 10 | 27 |

Note: Density is from Murdock and Provost (1971). Warfare is from Ember and Ember (1995); see appendix for the source and coding of it. Gamma −0.014, Asymptotic Standard Error (ASE) 0.436; Pearson product moment correlation, −0.006, Asymptotic Standard Error (ASE) 0.193; Likelihood chi-square ratio ($L^2$) = 0.001, p = 0.974.

Table 6C. Warfare by Density, Advanced Horticultural Societies

| | Population per Square Mile | | |
|---|---|---|---|
| Warfare | 100 or less | More than 100 | *n* |
| Rare or absent | 8% | 27% | 5 |
| Present | 92% | 73% | 30 |
| *n* | 24 | 11 | 35 |

Note: Density is from Murdock and Provost (1971). Warfare is from Ember and Ember (1995); see appendix for the source and coding of it. Gamma −0.610, Asymptotic Standard Error (ASE) 0.315; Pearson product moment correlation, −0.251, Asymptotic Standard Error (ASE) 0.180; Likelihood chi-square ratio ($L^2$) = 2.210, p = 0.137.

Table 6D. Warfare by Density, Agrarian Societies

| | Population per Square Mile | | |
|---|---|---|---|
| Warfare | 100 or less | More than 100 | *n* |
| Rare or absent | 31% | 6% | 5 |
| Present | 69% | 94% | 25 |
| *n* | 13 | 17 | 30 |

Note: Density is from Murdock and Provost (1971). Warfare is from Ember and Ember (1995); see appendix for the source and coding of it. Gamma 0.753, Asymptotic Standard Error (ASE) 0.258; Pearson product moment correlation, 0.331, Asymptotic Standard Error (ASE) 0.162; Likelihood chi-square ratio ($L^2$) = 3.379, p = 0.066.

In fact, although low-density hunting-and-gathering societies are about as likely to engage in warfare as not (53% versus 47%), *every one* of the hunters and gatherers experiencing higher-than-average population density engages in warfare. The maximum-likelihood chi-square ($L^2$) indicates that this pattern of results is unlikely to be due to chance (i.e., p = 0.034). Because of the zero cell in the upper right-hand corner of the table, gamma reaches its maximum value of 1.0, but the less sensitive Pearson product-moment correlation—the equivalent of the contingency coefficient, phi, in a 2-by-2 table—is 0.368, more than three times its standard error, 0.103.

Although the closest available breaking points for simple and advanced horticultural societies are well above their respective median densities, the predicted effect of density is not found. Table 6B shows that simple horticultural societies with more than 25 persons per square mile are just about as likely to engage in warfare as those with fewer (70% vs. 71%).[12] The results are even more problematic for advanced horticultural societies (see Table 6C). Those advanced horticultural societies with more than 100 people per square mile are actually 19% *less* likely to engage in warfare (% D = 73% – 92%). Though not statistically significant ($L^2 = 2.21$, p = 0.137), the relationship is opposite of that predicted (gamma −0.610, phi = −0.251).[13]

The impact of population pressure in agrarian societies is substantial and significant (see Table 6D). Gamma is 0.753, nearly three times its standard error (0.258), and the Pearson product-moment correlation (phi) is 0.331, more than twice its standard error (0.162); the Likelihood chi-square ratio also indicates that the results are unlikely to be due to chance ($L^2 = 3.379$, p = 0.066). Agrarian societies with population densities of 100 or more per square mile are 25% more likely to engage in warfare than are agrarian societies with lower densities (% D = 94% – 69%). Not surprisingly, Table 7 shows that pooling the data for all categories of subsistence and using the optimal breaking points for density does not produce a significant relationship (p = 0.18).

Population pressure, indexed here by above-median density for a given mode of subsistence technology, appears to be a significant factor raising the likelihood of warfare, *but only in hunting-and-gathering and agrarian societies*—technologically,

[12] Using the much higher cut-point of 100 produces the expected result, but not in a convincing way. Warfare is found in 68% of those 25 societies with densities less than 100 persons per square mile, but it is found in both—100%—of the societies with higher densities. Needless to say, with such skewed division of the data, this difference is not statistically significant.

[13] Gamma is 1.94 times its standard error and phi is 1.39 times its standard error.

Table 7. Warfare by Population Pressure Aggregated Across Categories of Subsistence Technology

| | Population Density | | |
|---|---|---|---|
| Warfare | Average or Below | Above Average | *n* |
| Rare or absent | 27% | 17% | 27 |
| Present | 73% | 83% | 88 |
| *n* | 73 | 42 | 115 |

Note: Density is from Murdock and Provost (1971). Cutting points are 1, 25, 100, and 100 persons per square mile for hunting-and-gathering, simple horticultural, advanced horticultural, and agrarian societies, respectively. Warfare is from Ember and Ember (1995). $L^2 = 1.7739$, $p = 0.1829$, phi = 0.1219.

the least and the most advanced preindustrial societies. Nonetheless, the fact that hunters and gatherers may experience significant impact at a density of *one* per mile while agriculturalists do not do so until density reaches or exceeds *100* per mile reinforces the argument that population pressure is conditioned by the dominant mode of subsistence; population pressure is not well measured across levels of technology by simple population density.

## DISCUSSION AND CONCLUSIONS

Using the best available quantitative data for the most representative sample of preindustrial societies, we have found support for two materialist explanations of warfare: ecological-evolutionary theory and population pressure. Confirming the basic tenets of EET, warfare was shown to be more likely among advanced horticulturalists and agriculturalists than among simple horticulturalists and hunters and gatherers. That warfare was also shown to be more likely among hunters and gatherers and agriculturalists of above-median population densities suggests that population pressure does play a role cross-culturally in affecting warfare. The absence of the predicted effect of population pressure in horticultural societies, however—even at densities far above their median in this dataset—indicates that that this must be viewed with some caution.

Why the data show no effect of above-average density among horticultural societies—and, in fact, show a (barely nonsignificant) negative relationship for advanced horticultural societies—remains to be explained. It may well be the case that the high incidence of warfare among virtually all horticultural societies leaves little variance to be explained by population pressure or any other variable. But these results may also indicate the importance of an unmeasured variable in this analysis—features of the biophysical environment that affect subsistence and social organization. What is needed to address this possibility is an objective measure of key dimensions of the environment comparable to that used for mode of subsistence, a measure that captures the important dimensions of the environment but is simple and available for a substantial number of cases in the Standard and Ethnographic Atlas datasets. This would provide the cross-cutting variable for subsistence technology, and it might well expose currently unmeasured variation among horticultural societies—and, perhaps,

among hunting-and-gathering and agrarian societies, too—that affect warfare and other major institutions. Development of such a measure would make it possible to truly test and refine an *ecological*-evolutionary theory of human societies.

While we await development of such a measure and a better specification of the tangled relationships among gardening, environment, warfare, and fertility, the results reported here clearly indicate that the funeral for materialist theories of warfare in preindustrial societies was indeed premature.

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## APPENDIX: CODING CRITERIA

### *Subsistence Technology*

The data used to code subsistence technology were drawn from the Ethnographic Atlas data for the standard sample of 186 societies (*World Cultures* 1985). Dominant mode of subsistence was gauged by summing scores for dependence on different modes of subsistence: hunting, gathering, fishing, animal husbandry, and agriculture, respectively (V203–V207), together with information on presence or absence of metals (V248, V249), and presence or absence of the plow (V243).[14]

After summing the individual scores for hunting and gathering to produce a composite measure of societal dependence on hunting *and* gathering, classification was accomplished by the following criteria.

1. If dependence on hunting and gathering, fishing, or animal husbandry was 6 or greater (more than 56% reliance), that mode was coded as dominant (i.e., it was coded "hunting and gathering," "fishing," or "herding," respectively).
2. If agriculture was 6 or greater, the plow ABSENT, and metals ABSENT, the case was coded "simple horticultural."
3. If agriculture was 6 or greater, the plow ABSENT and metals PRESENT, the case was coded "advanced horticultural."
4. If agriculture was 6 or greater, and the plow PRESENT, the case was coded "agrarian."

Subsistence technology comprises an ordered set of categories denoting the principal means by which a society obtains the majority of its foods and fibers. Ordered from lower to higher levels of energy harnessed, the categories are: (1) hunting and gathering, (2) simple horticultural, (3) advanced horticultural, and (4) agrarian.[15] The (cumulative) criteria of classification used in this study can be summarized as follows, where $-$ = absent and $+$ = present:

| | Plant Cultivation | Metals[16] | Plow |
|---|---|---|---|
| 1. Hunting and gathering | $-$ | $-$ | $-$ |
| 2. Simple horticultural | $+$ | $-$ | $-$ |
| 3. Advanced horticultural | $+$ | $+$ | $-$ |
| 4. Agrarian | $+$ | $+$ | $+$ |

### *Warfare*

Ember and Ember (1995:19) defined warfare as: "socially organized armed combat between members of different territorial units (communities or aggregates of communities)." Coders were instructed to examine a period of 25 years, from 15 years before to 10 years after the "ethnographic present" of the standard sample cases.

[14] More detailed discussion of the coding can be found in Nolan and Lenski (1999:419–20 and Chapter 4).
[15] Data and sample limitations make it impractical to distinguish simple from advanced agrarian societies in this dataset.
[16] Copper or bronze.