Raoul Naroll's Contribution to Archaeology

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Raoul Naroll's 1962 American Antiquity *article on the floor area of dwellings and its relation to population has had a profound impact on archaeology. Not only did it provide an objective mechanism to estimate population size and hence to evaluate demographic models of cultural evolution, it also helped to spark a wide variety of cross-cultural investigations of settlement form and its relation to social, political, and economic organization. In this article, the author offers an example of one such study focusing on the permeability of communities. Permeability is the extent to which dwellings are embedded in a community, measured by a graph-theoretical index. A holocultural analysis is used to demonstrate a strong, positive relationship between frequency of war and community permeability. The author discusses the utility of identifying this relationship for archaeological research, particularly for evaluating conflict-oriented models of cultural evolution.*

Human population growth and its effects have been issues of central concern to social scientists since at least Malthus's time. They were key to Darwin's concept of natural selection (Eiseley, 1958). They were key to Spencer's (1900) early work in cultural evolution. And they have remained key issues in cultural evolutionary theory ever since (Sanderson, 1990). The importance of population growth and the assumed sociopolitical stresses caused by it, however, increased dramatically in archaeological theory

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following the publication of Esther Boserup's (1965) *The Conditions of Agricultural Growth* and Robert Carneiro's (1970) "A Theory of the Origins of the State." Both these authors argued that human population growth is a "prime mover" of cultural evolution. Boserup argued that, contrary to Malthus's ideas, human populations do not outgrow the resources of their environment but rather create cultural innovations to transform their environments into more productive forms. As developed by Mark Cohen (1977), Marvin Harris (1977), and others, Boserup's ideas have become the basis for a powerful set of theories for the origins of agriculture, village life, and the state. Carneiro argued that, as populations grow, at some point they begin running into circumscription problems; that is, they run out of room to expand. Conflict and conquest are often the result, as is the emergence of sociopolitical domination of one society by another and of fixed social classes (conquerors and conquered). Carneiro argued that these social transformations lead directly to states, and a number of archaeologists have developed this notion into a powerful cultural evolutionary theory (see Graber & Roscoe, 1988).

Archaeologists were also becoming more concerned with their obligations as social scientists during the period when Boserup's and Carneiro's demographic stress theories were first being evaluated. Regardless of whether or not one supports the logical positivist movement promoted by the "New Archaeology," the 1970s left archaeologists with a legacy of concern for objectivity, empiricism, and rigorous hypothesis testing. When linked to Boserup's and Carneiro's demographic stress theories for the origins of agriculture and the state, the new concern many archaeologists felt for scientific testing created a pressing need for an empirical means to link population estimates with the archaeological record. And it is here that Raoul Naroll made his initial contribution to archaeology, a contribution that has lasted to this day.

In his article, "Floor Area and Settlement Population," Naroll (1962) used cross-cultural data to demonstrate that one can esti-

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mate population based on the floor area of houses. This work became the basis for testing all demographic stress theories in archaeology. It launched two decades of vigorous research, provided the justification for some of the most important archaeological projects yet conducted, and led to some of the most vigorous debates in the history of archaeology (see, e.g., the articles in Marcus, 1990). For that alone, archaeologists owe a debt to Naroll.

But, in my opinion, Naroll's pioneering work linking housing to demographics had a more profound legacy. Archaeologists recognized that, if population could be estimated by examining house size, perhaps other aspects of society could also be defined by examining houses (e.g., Hunter-Anderson, 1977; Robbins, 1966; Whiting & Ayres, 1968). And as archaeologists began trying to determine what houses could tell them about sociopolitical organization, they also began examining settlements to see what information they held. Certainly the work of Walter Christaller (1966) and G. William Skinner (1964) was profoundly influential, but I believe Naroll's legacy can be seen here too because many of the archaeologists incorporating Central Place Theory and human geography into their research were those who had first been drawn to settlement analysis through Naroll's pioneering efforts and through their interest in evaluating demographic stress theories (e.g., Sanders, Parsons, & Santley, 1979). Settlement pattern analysis has continued and remains one of the most exciting and fruitful areas in contemporary archaeological research.

As a tribute to Naroll and his contribution to archaeology, I offer the following example of current research in settlement archaeology. It follows Naroll's lead by linking ethnology and archaeology through the examination of household and community patterns. In this example, I develop a predictor of war in nonpastoralist societies. Because this predictor is based on archaeologically recoverable material, it provides a unique correlate of war for archaeological research.

COMMUNITY PERMEABILITY AND WAR: A CROSS-CULTURAL STUDY

Like population growth, war plays a major role in many theories of cultural evolution (e.g., Carneiro, 1990; Haas, 1990), but there has been little research done on archaeological correlates of war.

Most archaeologists have assumed that the presence of defensive works, mass graves of individuals with obvious traumas, military weapons, and the like are reliable predictors of war, but few of these seemingly obvious correlates have been tested adequately (a notable exception is Milner, Anderson, & Smith, 1991). In addition, there are many cases in which the archaeological record for a given site or region is not adequate to use one of these predictors. Using ethnographic data from the Human Relations Area Files, I recently demonstrated that household and community patterns reflect the presence or absence of war and can be used as a reliable predictor of the presence of war in nonpastoralist societies (Peregrine, 1993).

The Theory

I began with the basic assumption that community patterns should reflect the presence or absence of war in the same way that they reflect other aspects of sociopolitical organization (e.g., Blanton, 1993; Flannery, 1972; Wilk & Rathje, 1982). In situations in which war is present, I hypothesized that communities should be structured in such a way that households are relatively inaccessible from outside the community; that is, households should be deeply embedded in the community. Embedding households in a community would make it difficult for invaders to gain access to houses and their inhabitants and would offer a greater potential for defense than would communities in which households are less deeply embedded.

Constructing a defensive palisade would be one way to embed households in a community, but other forms of enclosures, such as courtyards and cul-de-sacs, could also be used to create deeper levels of embeddedness and inaccessibility. Medieval Japanese *masugata*-plan fortresses, constructed with a mazelike ground plan so that an invader breaching the defensive walls would be unable to navigate the streets without prior knowledge of the fortress's layout (Duffy, 1979, p. 245), are a good example of the way architects can create embeddedness and inaccessibility. Creating inaccessibility was also a primary consideration to the architects of European fortress cities, as they went so far as to "disregard the needs of civilian populations that were to inhabit [their] projected fortress cities. On many theoretical designs the citizen was not even accorded the right of easy access to his town" (de la Croix, 1972, p. 50). Streets in European fortress cities were organized

radially with the city center as a hub, allowing a garrison rapid access to any part of the defensive walls. However, the streets in these fortress cities were often offset from city gates or screened by a ring of houses, and this made access to inner parts of the city from outside the walls very difficult (de la Croix, 1972, pp. 51-52). Again, the architects appear to have been purposely incorporating high levels of household embeddedness into their defensive plans. Because both examples come from societies frequently engaged in war, it seems reasonable to hypothesize that high average levels of household embeddedness should be correlated with high frequencies of war.

To operationalize the idea of household embeddedness, I used the graph theoretic concept of permeability (Hillier & Hanson, 1984, pp. 14-15). A graph is simply a set of points (nodes) connected by lines (links) (see Hage & Harary, 1983). A community can be transformed into a graph by representing each household and each transitional space as a node and then linking these nodes by following paths necessary to access each house from outside the community (Hillier & Hanson, 1984, employ a somewhat more complex method). Figure 1 provides a simple example.

In Figure 1, node 1 represents the world outside the community; node 2 the area inside the community wall; nodes 3, 4, and 5 the residential compounds; and nodes 6, 7, and 8 the individual households. To access each household, one must enter the area inside the community wall, creating a link between nodes 1 and 2. From here one must enter one of the three residential compounds, creating three links between node 2 and nodes 3, 4, and 5. Because it is possible to move directly between residential compounds 3 and 4, there is also a link between them. Finally, there are links between the residential compounds and each household, nodes 6, 7, and 8.

I defined permeability as the average embeddedness of each household in a community, and I defined embeddedness as the number of primary nodes that must be crossed to access a given household (this might also be called the structural depth of each household). Permeability, therefore, is simply

$$\Sigma(h * d)/N$$

where h is the number of houses at structural depth d (again, defined as the number of primary nodes that have to be crossed to access the house) divided by the total number of houses in the community (see Hillier & Hanson, 1984, for alternative methods

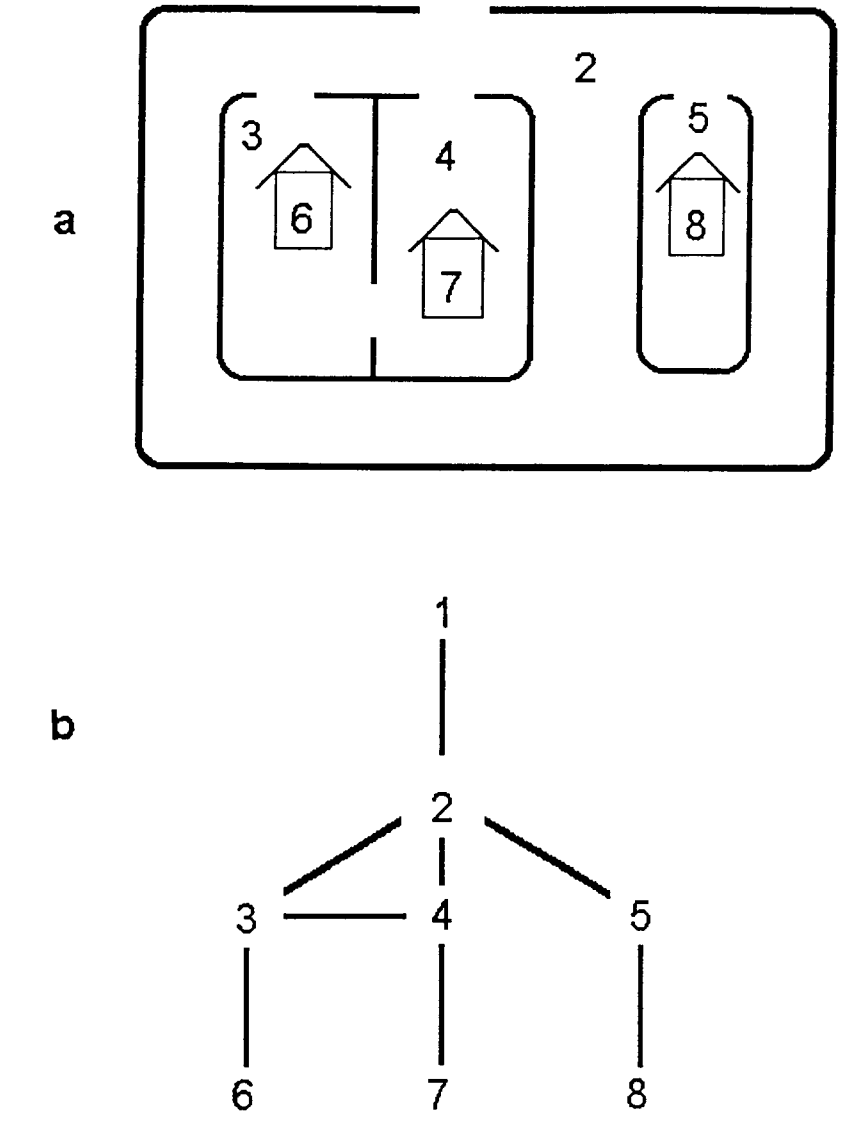

Figure 1: An Example Community (a) and Its Associated Permeability Graph (b)

of permeability analysis). For the community presented in Figure 1, each household is at a structural depth of three. The outside node counts as one, and two additional primary nodes are crossed to access each household. Because every house in the community has a depth of three, the community's permeability is also three.

The Sample

To evaluate the hypothesis that higher levels of community permeability are correlated with higher frequencies of war, I used a sample of 16 societies selected from those Standard Cross-Cultural Sample societies (Murdock & White, 1969) included in the Human Relations Area Files (Ember & Ember, 1988). Selection was based on the frequency of war each society experienced as coded by Ember and Ember (1992). Of the 16 societies, 8 were those for which war was coded as being absent (but not due to pacification; i.e., nonpacified peaceful societies). I randomly selected the other 8 societies from those 38 for which war was coded as being constant.

I assigned a permeability value to each society based on community plans I located in the Human Relations Area Files using *Outline of Cultural Materials* (Murdock et al., 1982) category 361 (Settlement Patterns) and plans of any defenses I located using category 712 (Military Installations). If there was more than one community diagrammed in the files, I chose a single plan that seemed to be the most representative or "average" of the plans presented. Several of the societies had no plans at all, and for these I used ethnographic descriptions to reconstruct a community plan. If there was incomplete or conflicting data for the society, I dropped that society from the sample and chose another at random. In some cases, the plans or descriptions used were not from the focal time period for the society (see Murdock & White, 1969), but I attempted to make sure the data I used were consistent with the focal time period. I checked the reliability of my coding by having an independent coder determine permeability values for five of the societies chosen at random, and all five matched my coded values.

The Analyses

In my initial analyses, I found that societies with high frequencies of war had significantly higher community permeability values

than did societies with low frequencies of war, but this difference was significant only among nonpastoralist societies (statistical support for this assertion is given in Peregrine, 1993). Pastoralists appear to follow a different strategy for defense, one in which groups split into household compounds arrayed across the landscape, offering none a very strong defensive position but allowing each the potential for rapid escape if one's neighbors were attacked. Because of this, I eliminated the pastoralist societies in the original sample from further analyses.

To examine whether this significant difference in community permeability formed a linear relationship with frequency of war (which could provide accurate prediction of the frequency of war in addition to its presence or absence), I selected 4 additional societies at random (all of which were, again, represented in the Human Relations Area Files) from each of the other three categories of war frequency coded by Ember and Ember (1992) and determined permeability values for each of the 12 societies as described previously. This addition created the final sample of 22 societies I used in the analyses that follow (these are listed, along with their coded values, in Peregrine, 1993).

Figure 2 shows the plot of permeability by frequency of war. Clearly there is a positive relationship, and indeed it is a significant one, with a regression coefficient of .617 ($p < .002$). However, the results do not seem strong enough, nor does the plot seem linear enough, to allow accurate prediction of the frequency of war from community permeability. In their cross-cultural research on war, Ember and Ember (1992, p. 172) found that statistical results are much stronger and more significant if cases with low coder reliability are dropped from the analyses. Ember and Ember provide reliability scores for the frequency of war codes I used, and I decided to redo the regression analysis using only those cases in which the coders differed by less than half a point on scoring the society's frequency of war (1 or 2 on the Embers' reliability scale). Figure 3 shows the results of the reanalysis. Again there is a clear positive relationship, and again it is significant. However, the regression coefficient increased only to .695 and, because there are fewer cases, the p value actually declined slightly (to $< .006$). Reliability scores were available only for one variable in this regression, and although there may have been significantly stronger results if only the more reliably coded cases on both variables were

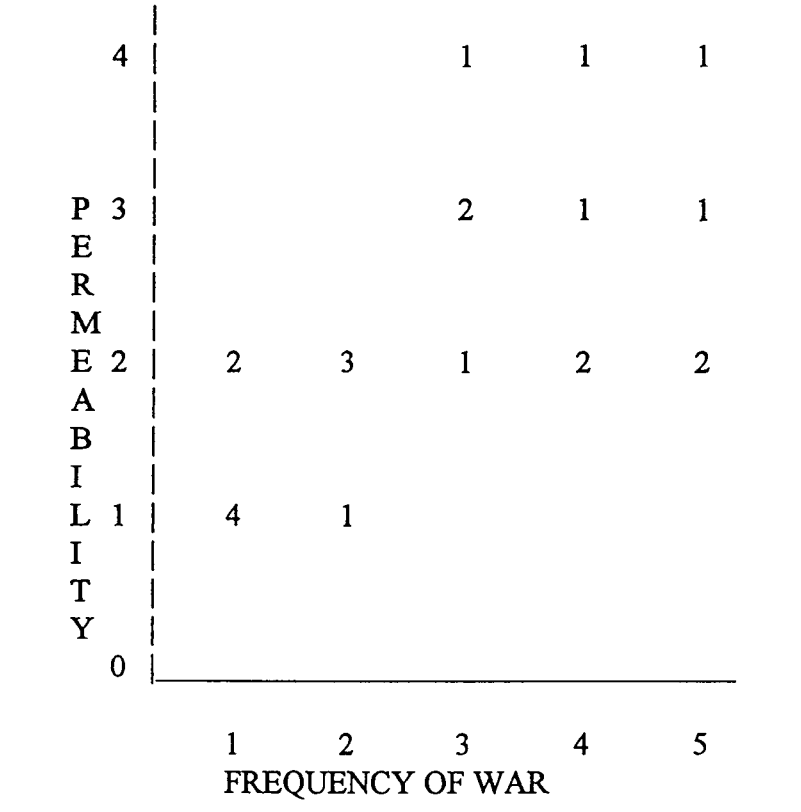

Figure 2: The Relationship Between Permeability and War

used, analyzing only those cases more reliably coded on frequency of war did not appreciably increase the strength of the statistical results.

DISCUSSION

Although community permeability does not appear to allow accurate prediction of the frequency of war in nonpastoralist societies, it does appear to be a reliable correlate for the presence or absence of war. It is obvious from Figures 2 and 3 that if one finds a community with a permeability value greater than three, one can

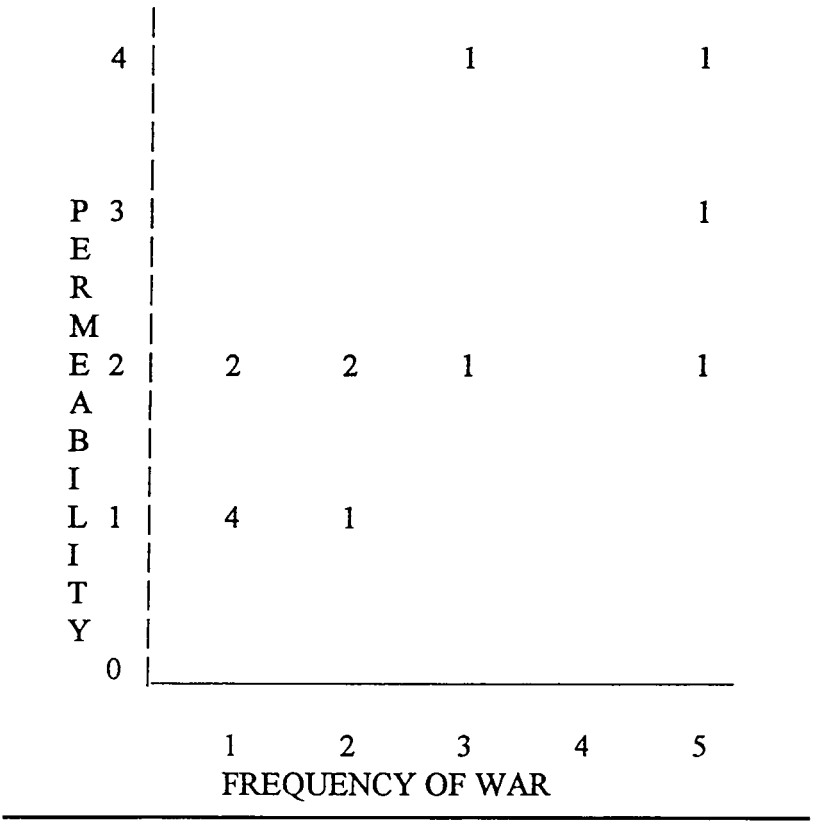

Figure 3: The Relationship Between Permeability and War; Only Those Cases With High Coder Reliability Included

be almost certain that war is present (indeed, the gamma value for the relationship between community permeability and the frequency of war is 1.00). Conversely, if one finds a community with a permeability value of two or less, one can assume that there is little or no war present.

Permeability also appears to be a particularly useful correlate of war for archaeological research. Although other potential correlates of war require specific information about technology, a large number of well-preserved burials, or the like, permeability can be readily estimated with a single trench cutting across a community. Indeed, random test pits sampling an entire community and defining its edges should provide enough evidence to estimate perme-

ability. Given the large number of cultural evolutionary models that contain war as a critical variable, the ability to reliably predict the presence or absence of war in a given case makes permeability an extremely useful index for archaeological research.

CONCLUSION: NAROLL'S CONTRIBUTION TO ARCHAEOLOGY

This study of the relationship between permeability and war is not tied directly to Naroll's study of population size and its relationship with house floor area, but it is certainly a descendant. Naroll's legacy to archaeology is his clear demonstration that ethnology can provide useful correlates of sociopolitical organization and behavior, correlates that can be used to test hypotheses in a scientific framework, correlates such as the relationship between permeability and war presented earlier. Naroll not only gave archaeology an important means to measure population size in archaeological contexts (a measure that is still robust despite numerous attempted revisions; e.g., Casselberry, 1974; LeBlanc, 1971) but also helped make archaeologists realize the power of ethnology as a key to unlocking the past.

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