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MARK N. COHEN

The intent of this paper is to criticize contemporary methodology in prehistoric demography and to suggest several new types of archaeological evidence which may be indicative of population growth and population pressure. Standard methodologies have tended to underestimate population growth in pre-agricultural societies and to underestimate the role of population pressure in causing economic change. It is argued that with increased sensitivity to additional sources of evidence, it becomes clear that population growth and population pressure are essentially ubiquitous in the archaeological record and can readily be perceived as leading to economic and technological growth culminating in the origins of agriculture.

In recent years, archaeologists have shown a growing interest in prehistoric demography, and particularly in the analysis of the relationship between demographic change and technological and social evolution. Such studies have been severely retarded by the absence of a sound methodology for dealing with prehistoric demographic patterns. Existing strategies for reconstructing prehistoric populations are subject to significant errors; more important, they are subject to errors of particular types which have biased our interpretation of prehistoric processes. It is my intention to present a critique of standard paleodemographic techniques, particularly as these have led to systematic errors in our prehistoric reconstructions, and then to offer alternative, or rather, supplementary, methods of evaluating prehistoric populations which suggest altogether different interpretations of prehistoric processes. I am particularly concerned with the argument between Malthusians and Neo-Malthusians on the one hand and members of what might be called the Boserupian school, myself included, on the other, over the relationship between population growth, the pressure of population on resources, and technological changes in food gathering strategies. In sum I will argue that standard prehistoric demography tends to bias interpretations in favor of Malthusian models whereas sensitivity to a number of other indicators of population pressure demonstrates the ubiquity of population pressure in the Pleistocene and its importance as a cause of culture change leading to the "Neolithic Revolution."

Standard techniques for reconstructing prehistoric populations are all built around the same basic model (see Cook 1972). An attempt is made to count the number of units of some parameter such as the number of houses, the total acres of sites occupied, the total acreage under cultivation, the number of rooms occupied, the number of shellfish consumed, or the number of grindstones used. This parameter is taken as representative of population at a point in time. The counts of this parameter for two or more time periods are then compared leading to rough estimates of relative population size for the periods concerned. The method assumes first that there is a fixed (though often unspecified) relationship between units of the parameter and the number of individuals in the population. The method also assumes that contemporaneity can be established for the various units counted so that we know, for example, how many houses or rooms were actually being occupied at one point in time. If strict contemporaneity cannot be established, it is assumed that the rate of consumption can be determined so that a fixed ratio of units per person per unit of time can be established (for example, the number of shellfish eaten per person per day).

The method, of course, is subject to a number of types of error. In the first place the archaeological record is only a fractional sample of past human behavior and its residue. The archaeologist does not know whether the parameter he is counting has been recovered in its entirety. Rather he must assume that his sampling error is about the same for all periods studied. Second, absolute contemporaneity among the units counted can almost never be reliably established; nor can precise measurements be made of the length of time involved in their accumulation. Finally, of course, the basic assumption that any of these parameters bears a fixed relationship to population is itself highly questionable. These errors *are* widely appreciated. The method in its many varieties does continue to be used to measure the relative sizes of sedentary populations but only with the widespread understanding that the

estimates are only approximate since they are subject to these sources of error.

These methods, however, are particularly weak in dealing with pre-agricultural or other non-sedentary populations. This is true first because temporary campsites are frequently not preserved so that the archaeological sample itself is subject to greater error. It is also true however that it is much more difficult to establish contemporaneity among temporary campsites or measure the duration of their occupation. As a result, this methodology can be applied to temporary campsites only with great care, if, in fact, it can be applied at all. The main result of this is that while statements about rates or at least directions of population growth and decline are widespread in the literature on archaeological sequences concerning sedentary populations, many archaeologists avoid making statements about growth rates among mobile populations based on the density of their site remains. As a consequence relatively little attention is paid to population dynamics among prehistoric hunting and gathering groups.

There is an even more important consequence of the widespread use of this methodology. When this method is used to compare pre-agricultural and post-agricultural populations in any region, the results are badly biased. Agriculture correlates roughly with sedentism in most regions of the world and it is obvious that sedentism, whether or not it results in actual population increases will result in marked increases in the number of sites recorded simply because permanent sites are much more likely to be preserved, and to be found by archaeologists, than are temporary campsites. Most archaeologists are conscious of this preservation differential, and most of us would avoid making specific estimates of population growth based on the frequency of pre-agricultural and post-agricultural sites. Yet, the impression of the disparity in site densities sticks in our minds. We are thus left with the impression of a population explosion accompanying the origins of agriculture which may be nothing more than the increase in recognized sites due to the differential preservation of permanent settlements.

The problem is thus compounded. On the one hand, we have no reliable way of measuring population growth in pre-agricultural, non-sedentary societies, so we tend to ignore or underestimate the potential for growth in these groups. Second, we see an abrupt rise in the number of sites correlated roughly with the origins of agriculture, resulting, I suggest, in large part from differential preservation. The combination leads us to a strong bias in favor of a Malthusian approach to population history as exemplified in the work of V. Gordon Childe (1951). Populations appear to be stable prior to the invention of agriculture after which they expand in a "revolutionary" manner.

I suggest that this impression will be reversed, however, if we consider a number of additional types of indicators of population growth, which, although they are not quantitative indicators in the sense discussed above, are, I submit, just as valid indicators of population change in a region (and particularly of population pressure) as is site or artifact density. I am referring to changes in food refuse and food-related artifacts which suggest changes in exploitative patterns which in turn can reasonably be assumed to result from population pressure (or imbalance between growing population and resources) and whose incidence may therefore be taken as a measure of that pressure.

Given the inherently conservative nature of adaptation in animal and most human populations, one might, in fact, argue that *all* changes in subsistence strategy imply population disequilibrium and stress and could thus be interpreted as representing population pressure. Such an argument, however, would perhaps be self-serving and circular. I do however maintain that changes in subsistence strategy imply population pressure when, in general (a) the changes emphasize shifts toward resources with increased caloric productivity per unit area, *and* (b) when they are not linked to the diffusion of new or complex technologies or the appearance of new resources in the ecosystem *and* (c) when they imply increasing rather than decreasing *per capita* labor costs, *or* (d) when they imply shifts to less nutritious (except calorically) foods, *or* (e) when they imply the use of less preferred foods (as evidenced in cross cultural surveys or by the fact that such resources were previously ignored although they were clearly available) *or* (f) when they imply shifts to food gathering activities of lesser prestige, or activities which are considered more odious forms of labor than the previous activities (again as measured in cross cultural survey).

In short, when a change in subsistence

patterns cannot be shown to depend on newly available opportunities and when the shift appears to be in the direction of calorically dense but otherwise less desirable resources, I believe that we are justified in assuming that such shifts represent compensation for demographic pressure. The following is a list of types of archaeological evidence which *may* be interpreted as evidence of such situations. Since many of these occurrences are capable of alternate explanations in particular cases we should hope to find several such indicators together to be sure that they represent population pressure. And, since disequilibrium between population and resources may well be caused by a variety of factors (such as climate change) other than population growth *per se*, we should hope to find these changes either occurring in situations where alternative explanations can be ruled out (where, for example, pollen profiles show no climate change) or occurring in such a general manner, widespread both in time and in space, that only a general explanation such as population growth can account for the observed pattern.

The list is as follows:

(1) When it is possible to isolate the exploitative cycle of a single group making its annual round, evidence that the range covered is increasing should indicate population pressure. (See Cohen [n.d.a] for an example of this sort of analysis on the Peruvian coast.)

(2) When a group expands into new ecological zones and new territories, population growth may be assumed especially if expansion is into new areas or new latitudes which demonstrably present new difficulties in adaptation such as increasing cold, or high altitude. The emphasis here is on the word *expansion*. Mere migration is insufficient. It should be established that the group both occupies its original zone and has moved into additional regions.

(3) When a group demonstrates decreased selectivity in the microniches it exploits, utilizing portions of its environment that have previously been ignored while continuing to exploit the old niches, demographic pressure may again be assumed. (Again, see Cohen n.d.a.)

(4) When a group increases its concentration on water based resources relative to its use of land based resources, especially where the resources represented are shellfish whose exploitation is independent of the invention of any new technology, this shift may be viewed as resulting from demographic necessity rather than choice. (See Harner 1970; Evans 1969; Cornwall 1964; Clark 1966.)

(5) When a group shifts from eating large huntable land mammals which make up a relatively small portion of the local biomass in any region but which apparently are a high prestige food in most cultures (Murdock 1968; Clark 1970) in favor of eating smaller land mammals such as rodents or even birds or land molluscs which make up a much larger portion of the land based animal biomass (Deevy 1968), but which are less desirable, low prestige items (Binford 1968 and others), demographic pressure may again be assumed.

(6) When a group shifts from the consumption of organisms at high trophic levels to the eating of organisms at lower trophic levels (in particular when the group shifts to eating plant foods) which increases the available biomass but which again runs counter to both widespread prestige values and widespread food preferences (Clark 1970; Yudkin 1969; Murdock 1968) the shift may be presumed to occur out of demographic necessity, not choice.

(7) When a shift occurs from the utilization of foods requiring little or no preparation to foods requiring increased amounts of preparation in the form of cooking, grinding, pounding, leaching of poisons, etc., population pressure is again indicated since such practices clearly expand the range of edible foods but at high labor costs.

(8) When there is evidence of environmental degradation suggesting human efforts particularly through the use of fire and land clearance resulting in the maintenance of sub-climax vegetation, it may be argued that increased human populations are increasing their interference in natural ecosystems to increase natural productivity of their preferred foods.

(9) When skeletal evidence of malnutrition increases through time it may be argued that demographic stresses are resulting in reduced quantity or quality of diet available to each individual.

(10) When the size or quality of individuals exploited from a particular species shows a steady decline through time (when for example the size of molluscs in one or several shell middens shows a decline) it may be argued that human populations are consuming resources

beyond their carrying capacity resulting in degradation of the exploited population.

(11) When an exploited species disappears from the archaeological and fossil record it may be argued that they were exploited beyond carrying capacity.

(12) When human populations show a shift toward more and more eclectic food gathering patterns demonstrating reduced selectivity in foods eaten it may be argued that they are demonstrating the need to obtain more calories from the same territory to feed denser population.

(13) When regional isolation becomes prominent as evidenced by localized differentiation of artifact styles, population pressure is again suggested. Hunting and gathering groups are characterized by the fluidity of their band structure. People move readily from group to group (Lee and Devore 1968) with the result that there is widespread homogeneity in artifact styles from group to group. I suggest that such fluidity breaks down when resources become scarce and when each group begins to invest its labor in the future productivity of its resources. Both scarcity and labor investment will force the group to discourage free movement of individuals breaking down this homogenizing process and creating regional isolation.

(14) When a group becomes sedentary and begins to practice artificial food storage these practices may also indicate population pressure, particularly if they are not linked to new resources or new technologies but rather are combined with intensive exploitation of old resources by traditional means. Sedentism, despite certain advantages, implies high labor costs in the collecting of many food items and it implies reduced dietary variety. It increases the incidence of disease; adds labor costs in the preparation of food for storage and in storage itself. It increases the vulnerability of the group to the loss of stored foods by rotting or rodent action; it increases the danger of expropriation by other human groups; and it greatly increases the vulnerability of the human population to exploitation and enslavement by other groups by tying them to particular locations. I suggest that sedentism in most cases occurs not because of newly discovered resources which *permit* year round residence in a single location, but rather because of the decline of resources associated with other parts of the traditional annual cycle or territorial impingement by other groups which *require* a group to stay in one place and to stretch the resources of one particularly productive season to cover those other periods of the year when seasonal foodstuffs are no longer sufficient.

Again, as discussed above, none of these lines of evidence alone is sufficient to demonstrate population pressure. But, several occurring together, all running counter to the manner in which we would expect human populations to behave by choice surely must represent attempts to adjust to the need for more calories or to the loss of traditional food sources. Moreover, if these behaviors occur widely enough in time and space, separated thus from particular events of climate change or other localized variables, population growth is the only plausible explanation. I submit that the archaeological record of pre-agricultural populations in both the Old and the New World shows that combinations of these trends are ubiquitous throughout the evolution of man from the time when he first demonstrated the capacity to hunt big game (i.e., beginning with populations of the Homo erectus grade). I refer those interested to Cohen (n.d.b) where this argument is developed in detail. For present purposes, I will simply call attention to some general patterns. First, the origins of agriculture correspond roughly with the cessation of terrestrial expansion by human populations. This refers not only to the colonization of new continents such as South America and Australia, but also to the expansion of populations out of game rich savanna areas into deserts and forested regions on each of the various continents (Clark 1970; Butzer 1971; Willey 1966). Second (with minor exceptions), the origins of agriculture, whether by invention or by diffusion, are universally preceded by a common series of adaptive changes: sedentism; broad spectrum, intensive, unselective use of resources; high concentration on vegetable foods, small animals and marine and fresh water resources, particularly fish and molluscs; and a high incidence of tools (grindstones, etc.) associated with the secondary preparation of food.

Analysis of the archaeological sequences of various world regions shows that the "Mesolithic" is in fact a culmination of trends which are usually traceable back with lesser intensity far into the Pleistocene. I am suggesting, therefore, that by these criteria population pressure

can be seen to be building up through the Pleistocene culminating in the "Mesolithic" which is a period of great population pressure during which spatial adjustments to pressure had, of necessity, ceased and the scramble to find new resources in old locations had consequently greatly accelerated. I suggest finally that agriculture can be seen quite regularly around the globe as simply one more in a series of adjustive strategies attempting to cope with problems created by continuing population growth.

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OF SHOE-FORM VESSELS AND ETHNOGRAPHIC ANALOGY

EDWARD B. SISSON

D. M. Varner does not make a good case for a continuity in the function of the shoe-form vessels from Oaxaca. In the neighboring Tehuacán Valley during the Late Postclassic and Early Colonial periods, shoe-form vessels served as receptacles for cremated human remains.

In his recent report on Mixe shoe-form vessels, Varner (1974:616-617) provides no data to support the assertion that the "Mixe shoe-form appears to represent survival in a marginal locale of prehistoric pottery in both form and *function*" (italics added). Undoubtedly, the Mixe use shoe-form vessels for heating liquids and for supporting comals. The Monte Alban V shoe-form vessels (Caso, Bernal, and Acosta 1967:460-463) *may* very well have served the same functions, but without additional data on the archaeological context of the vessels, the reader has no basis for judging whether or not there was continuity in function. As Varner reminds us " . . . these uses [by the Mixe] do not exclude other possibilities, especially when similar forms are found in different spatial and/or temporal contexts."

Recent excavations in the Tehuacán Valley, Puebla, have yielded 45 shoe-form vessels from three sites in the southern part of the valley—Tr62 or Coxcatlán Viejo, Tr65, and Pala. Another shoe-form vessel from north of Tehuacán is on exhibit in the Museo del Valle de Tehuacán. Together, these vessels suggest a valley-wide distribution of the form. The vessels