Research TOC

Were Early Agriculturalists Less Healthy Than Food-Collectors?

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The study of the Neolithic Revolution—why prehistoric people switched from hunting and gathering to agriculture and how that switch affected human lives and human health—has generated a good deal of controversy in recent years. The controversy may now be moving toward a new synthesis, but opinion remains divided.

Until recently, consideration of the early history of human health was largely implicit in discussions that focused explicitly on technology and on human economic choices. Prior to the mid-1960s, the study of the origins of agriculture focused on when, where, and how the principle of plant and animal domestication was discovered and on when and how that understanding diffused to other regions. Research focused on identifying the original "hearths" of invention; and controversy revolved around the number of places in which agriculture had been invented "independently" (that is, without diffusion of crops or the concept of planting seeds from other regions).[1]

Archaeologists and botanists did not ask, however, why domestication and agriculture, once invented, were adopted as a way of life by human populations. That is because, in the earlier view, the answer seemed obvious: Agriculture was simply assumed to provide a better and more reliable diet than hunting and gathering and to promote better health; to permit larger numbers of people to gather permanently in one place; to provide increased leisure time; and to underwrite construction of the great architectural landmarks which distinguish incipient civilization.[2]

In the mid-1960s three things dramatically altered our perception of the origin of agriculture. First, agricultural economist Ester Boserup offered a new model of economic growth in human history. Second, anthropologist Richard Lee presented a description of life among contemporary hunter gatherers that seemed to fit well into Boserup's model. Third, anthropologists such as Morton Fried and Marvin Harris reexamined our understanding of the basis of civilized wealth and monumental construction

Boserup,[3] studying the evolution of agricultural systems, suggested that growing population—rather than technological invention—had been the primary stimulus to economic growth in human history. She argued that simple technology such as shifting or impermanent cultivation was actually the relatively efficient technology of small and dispersed human populations; and that technological "progress," such as the adoption of continuous cultivation of permanent fields, the use of the plow, and irrigation, was actually technological accommodation to high density population, often with declining rather than increasing returns for labor. In short, she suggested that simpler technology often represented the most efficient use of labor, while advanced technology represented the efficient use of space. Boserup allowed us to think of the simple technology of small groups as a small-scale, low-density adaptation rather than as "primitive."

Lee[4] provided a description of a group of contemporary hunter-gatherers, the !Kung San of the Kalahari Desert in southern Africa, a group with very simple technology. The San, by his description, did not farm but actually enjoyed considerable leisure time, worked relatively little and enjoyed relatively good nutritional returns. Lee pointed out that they understood the principle of planting crops but could not be bothered to do so (in apparent accord with Boserup's model). He suggested that in return for labor averaging about 20 hours per week for adults, San enjoyed diets of about 2,100 calories (technically, kilocalories) per person per day combined with a healthy intake of protein, vitamins, and minerals. Further study of the San by Truswell and Hansen[5] and by Howell[6] suggested, moreover, that they enjoyed relatively good health and nutritional status and had a life expectancy at birth of about thirty years (roughly the average length of life, balancing the deaths of infants and children with the deaths of older adults, some of whom died in their sixties and seventies). This figure, although low by twentieth-century European and American standards was reasonably good compared to many eighteenth and nineteenth- century European populations; and it compared favorably with many Third World populations such as India until well into the twentieth century.[7] Apparently, such food collectors were not necessarily the least healthy nor the shortest lived of human groups.

Anthropologists Fried[8] and Harris,[9] meanwhile, argued that the great monuments of civilization should not be considered primarily as evidence of technological sophistication and affluence but rather as evidence of the coercive power of political elites who could control very large amounts of human labor. The economic surplus necessary to underwrite the building of a pyramid resulted not from a simple ability to produce more food (since even !Kung San could apparently do this if they wanted to) but from political organization, which forced people to get more and to concentrate their surplus production. The social engineering to build a pyramid was at least as important as the mechanical engineering. It was the emergence of this coercive power, they argued, rather than any technological advance, that marked the origins of civilization.

In response to the work of Boserup, Lee, Harris, and Fried, a number of archaeologists began to ask why hunting and gathering societies (now considered relatively "affluent,"[10]) ever adopted agriculture at all, since agriculture seemed to offer no obvious advantages. Many concluded that some sort of stress such as changing climate or changing sea level would have been necessary to force populations to give up a successful hunting and gathering lifestyle; and several archaeologists[11] concluded, following Boserup, that an imbalance between population and resources (caused either by resource decline or growing human population) was the stimulus to economic change. Some new theories also argued that political incentives and coercion, artificially increasing the demand for production, might have been the stimulus for agriculture.[12]

Most of these theories, however, suggested that human populations, like all animal populations, were normally self-regulating and did not normally outgrow the "carrying capacity" of their resources (the capacity of their resources to regenerate themselves).[13] Therefore, they suggested, the imbalance which necessitated the adoption of agriculture had to be a local and temporary phenomenon distorting an otherwise well-regulated equilibrium. However, recent work in the emerging field of biology called "sociobiology" has questioned whether such "self-regulation" has ever existed in the biological world and has, in my opinion, effectively eliminated this issue from discussion.[14]

In 1977, I proposed that human populations might commonly, if slowly, outgrow their resources (or at least their preferred resources, since human groups always seem to have some less desirable resources in reserve). According to this theory,[15] population growth would slowly force groups to modify their behavior and to make more and more economic and dietary compromises in much the same manner that slow inflation gradually forces people in the modern world to change their buying habits. I suggested that the adoption of agriculture was only one in a long sequence of such adjustments to population growth. This sequence also included the later intensification of agriculture, as Boserup had suggested, as well as the earlier adoption of aquatic hunting and fishing, the adoption of tools for hunting small game, and the adoption of grindstones for processing wild seeds and nuts. (The last three developments marked the Mesolithic or "broad spectrum revolution" that preceded the origins of agriculture in most regions of the world.)[16] Each of the steps leading to the adoption and later intensification of agriculture represented diminishing economic returns, I argued.

In short, I argued that slowly growing human population had forced gradual expansion of a relatively elastic resource base with ever diminishing returns for labor. An alternate theory proposed by Brian Hayden[17] also suggested that population and food technology grew in an interactive manner and had tracked one another very closely in human history; but Hayden argued that technological development was the main stimulus to growth and that the new technologies added increasing efficiency and greater certainty to the food quest.

Meanwhile, the conclusions of Boserup and Lee were being challenged from several perspectives. Some anthropologists and agricultural historians argued that empirical measurements of efficiency and the observed sequence of agricultural development in different parts of the world often did not follow Boserup's predictions.[18] Other workers with the !Kung San and their neighbors called into question both their "affluence" and their authenticity as representatives of an ancient lifeway. Wilmsen,[19] for example, suggested that San dietary intake fell well below Lee's estimates, at least seasonally. Further study suggested that the San actually were relatively inefficient foragers.[20] And it was suggested that they devoted a lot of their time to leisure because of extreme seasonal heat and dryness. It was also suggested that hot, dry seasons placed severe limits on the numbers of children that a family could rear and thereby contributed to the apparent leisure of parents in less stressful and more productive seasons.[21] Schrire[22] and others argued also that the !Kung San were not pristine remnants of an ancient way of life but creations of twentieth century political conditions in South Africa and therefore their lives had little if any meaning for studying the human past.

In an effort to sort out the meaning of the !Kung San data, I undertook a review of published data on the health and nutrition of other contemporary hunter-gatherers. I studied more than forty additional hunting and gathering societies from all of the world's continents for which at least some comparable data were available.[23] For the purposes of this review, I argued that groups like the !Kung San, even if they were not pristine remnants of ancient life, might nevertheless act as twentieth-century experiments in hunting and gathering lifestyle through which we could evaluate certain aspects of the health and nutrition of hunter-gatherer groups. For example, whether or not contemporary hunter-gatherers were "pristine," we could use them to evaluate the potential for obtaining a balanced diet by foraging in various environments; the amount of labor involved in obtaining and processing various foods; and the impact of group size and nomadism on the transmission of infectious disease.

The comparative data[24] suggested that modern hunter-gatherers are indeed commonly well nourished in qualitative terms (vitamins, minerals, protein) although calories may be in short supply at least on a seasonal basis. Anemia was very infrequent in such groups. Diseases like kwashiorkor or marasmus (protein and protein-calorie deficiency), pellagra (niacin deficiency) or beri beri (thiamine deficiency), which plague modern poor populations world-wide, essentially do not occur among hunter-gatherers (until they are forced to adopt modern diets.) In short, although they are occasionally hungry, modern hunter-gatherers are conspicuously well nourished by modern Third-World standards. Moreover, the !Kung San, living in a desert, far from being the most affluent, seem to be relatively impoverished in comparison to other hunter-gatherers. Groups such as the East African Hadza, living in game-rich areas, seem to be far more affluent and also better models for prehistoric hunter-gatherers who chose similarly rich environments in which to live.[25]

The data also suggested that small group size and the mobility which characterizes hunters seems commonly to act to protect them against parasites of various types. This relative freedom from parasites contributes to the good nutritional health of hunter-gatherers since parasitic infestation typically robs the body of nutrients in a variety of ways.[26]

In particular, intestinal parasites spread by human feces are rare among hunter-gatherers populations who tend to move on before feces accumulates and who therefore suffer relatively little diarrhea. Perhaps most important, hunter-gatherers seem to suffer relatively little of the diarrhea of infancy and early childhood that contributes so heavily to the death of children in the modern Third World.[27]

The comparative data also suggested that contemporary hunter-gatherers are at least as successful as most historic populations in rearing children to adulthood. On the average, such groups seem to lose about 20 percent of their children as infants and about

40 percent of children overall before they reach adulthood. These figures are comparable to what was true for most of Europe in the eighteenth and nineteenth centuries and significantly better than European and American cities at the beginning of the twentieth century. Adult life expectancy is not as great in most hunter-gatherer groups as Howell suggests for the !Kung. But overall life expectancy at birth averages twenty-five years or so in these groups, a figure which is still moderate by historic standards.[28]

Two relatively new lines of inquiry contributed further to the debate in the 1980s. First, optimal foraging research[29] stimulated once again by a movement in biology and involving the precise measurement of time, work, and returns for labor has resulted in the careful reevaluation of the different foraging and hunting techniques with results that are of interest to the present discussion. Several such studies suggest that, as long as large game animals are to be found with reasonable ease, big game hunting is a far more efficient activity (measured in caloric returns per hour of work) than other foraging strategies. One study suggests that hunters in rich environments can *average* 7,500–15,000 calories per hour of work.[30] Other studies suggest that once a large animal has been encountered, it can be harvested and converted to food at the rate of 15,000 to 45,000 calories per hour of work. In contrast, many of the more recent resources associated with the mesolithic or broad spectrum revolution such as small game, shellfish, and small seeds can be harvested at rates of only about one thousand calories per hour even after they are located, even with the best and most "modern" stone or iron age equipment.[31]

These caloric studies strongly support the argument that economic changes leading up to the adoption of agriculture were motivated by necessity, not progress. The implication is that prehistoric foragers are likely to have focused more heavily on big game when they were available and to have turned increasingly to secondary resources such as shellfish, small seeds, and small game not because of technological advances but only because choicer resources, particularly large game animals, became scarce. The data also suggest that nutritional health is likely to have declined over this time span rather than improved. A further implication is that modern hunter-gatherers who often rely heavily on the low-return resources may not be as well nourished as their (and our) prehistoric forebears. Most simple agricultural systems average about three thousand to five thousand calories per hour of labor suggesting that they are less efficient than big game hunting but more efficient than "broad spectrum" foraging. This may explain why agriculture began only after the broad spectrum revolution in most parts of the world.

The second major new line of evidence which emerged during the 1970s and 1980s was the development of paleopathological techniques for the direct assessment of prehistoric health from the study of archaeological skeletons, mummies, and feces. Research techniques that had previously focused on the analysis of pathological individuals or the history of specific diseases began instead to provide quantitative, statistically based descriptions of whole populations which could, with caution, be used to compare the health of human groups from different periods of prehistory.[32]

Paleopathology can assess the presence and frequency of some specific, chronic diseases such as syphilis and tuberculosis in the skeleton. (When mummies are found their preserved soft tissues permit diagnosis of a far wider range of illnesses.) Paleopathology can also assess some specific nutrient deficiencies such as iron deficiency anemia. But it can also be used to assess a number of chronic but nonspecific indicators of nutrition, health, growth, and the disruption of growth, which permit the comparison of general health between populations.

In 1982, paleopathologist George Armelagos and I organized a conference of paleopathologists for the express purpose of evaluating the significance of the adoption of agriculture for human health.[33] We asked paleopathologists working in twenty-two regions of the world to use standard paleopathological indicators to assess health trends of populations prior to, at, and after the adoption of agriculture. Although each region of the world is subject to unique historical patterns we hoped that common trends shared by various regions would tell us something about the overall health of hunter-gatherers and farmers.

I had hoped that the data would display clear declines in health *prior* to the adoption of agriculture in support of my population-pressure model of agricultural origins. In this respect the data were disappointing. Fragmentary archaeological samples most often did not permit us to recognize more than one population that had existed prior to the adoption of agriculture in any region. The few comparisons that could be made were limited by small sample size and imperfect preservation. However, throughout the Old World where preagricultural samples are available (India, the Middle East, Mediterranean Europe, Northern Europe) the data suggest that people did get smaller *before* the adoption of agriculture. In at least one region (the Mediterranean) the trend in stature is combined with other signs of declining nutrition. Since decline in stature itself is often used as an index of declining nutrition in other historical contexts, this may be an indicator of declining nutrition among prehistoric groups. I consider this the best explanation of the trend. However, various authorities suggest that declining stature is, instead, an indication either of changing climate or of changing human activities.[34] In any case, few data from this period suggest that preagricultural human beings are making "progress" in health or nutrition. One population from Peru, however, counter to my expectations, does display an increase in stature and in other indications of health and nutrition prior to the adoption of agriculture.[35]

The comparison of prehistoric farmers with their hunting and gathering forebears provided much more interesting results. In most regions of the world, early farmers, living in larger and more sedentary communities than their ancestors, also displayed higher rates of infection in the skeleton (or preserved tissues or feces.) In particular, periostitis, the non-specific infection of bone surfaces usually attributed to staphylococcus or streptococcus infection, is almost invariably more common after the adoption of sedentary farming. A comparison of mummies from Peru suggested that intestinal infection also increased after the adoption of farming.[36] The same conclusion was suggested by comparison of human feces from different periods of prehistory in the American southwest.[37] Treponemal infection (yaws) also seems to be more common after the adoption of farming (its venereal form, syphilis, seems to be a much more recent affliction, rarely if ever being diagnosed with certainty in human groups of any region before the age of Columbus). Tuberculosis is almost entirely confined to relatively recent populations living in large urban aggregates, which do not occur in the absence of agriculture.[38]

Farmers also almost invariably displayed more frequent anemia than earlier hunter-gatherers in the same region. There is some controversy about the source of the anemia. One possibility is that it reflects iron deficiency resulting from farmers' dependency on cereal crops such as maize (corn), which are poor in iron and actually tend to inhibit iron absorption.[39] A more likely possibility is that it reflects the secondary loss of iron to parasites such as hookworm, malaria, or tuberculosis, all of which become more frequent when large sedentary aggregates of people are formed.[40]

Other signs of malnutrition such as retarded growth among children or premature osteoporosis (loss of bone) among adults also seem to be more common after the adoption of agriculture. Farmers also displayed higher rates of imperfections in the enamel of teeth (enamel hypoplasia and Wilson's bands) thought to be a permanent record of severe episodes of poor health in childhood.[41] This suggests, contrary to popular expectation, that prehistoric hunter-gatherers may have been *better* buffered against stressful episodes than their descendants.

The data, unfortunately, cannot be used to assess changing life expectancy. A cemetery may not be an accurate reflection of the community from which it is derived.[42] Immigrants and emigrants skew the age distribution in a cemetery, the former adding older individuals to the cemetery who were not born locally, and the latter subtracting older local individuals. Moreover, if a population is growing rapidly, each cohort (annual crop) of babies is larger than the last and the cemetery will have a disproportionately large number of young people—producing an apparent increase in infant and child mortality even if the actual risk of dying as an infant or child has not changed. A population that is declining and producing fewer babies each year will show the opposite effect. The available data, therefore, cannot be used to show a decline in life expectancy associated with the origins of agriculture as I anticipated; but neither do they provide evidence of the improvement in life expectancy archaeologists once took for granted as a concomitant of human progress.

Overall, these data seem to me to be a fairly substantial body of evidence in support of the hypothesis that the adoption of agriculture resulted in a decline in human health. This conclusion has been challenged, however, by individuals who question the value of skeletal samples.[43] These authors point out that skeletons in a cemetery may not be a true reflection of a once-living population. (As simply one example, skeletal lesions or scars of disease take time to form, so the number of lesions in a skeletal population *might* reflect not the number who were ever sick but the number who survived the illness long enough for the lesions to form. By this argument, a high frequency of pathology in a cemetery *might* perversely be an indication of relatively good health!)

Paleopathologist Alan Goodman has responded to this argument[44] by pointing out, among other things, that enamel hypoplasia do occur in living populations in proportion to deprivation and poverty, suggesting that they are a reliable and direct indicator of health stress. My own response[45] is to point out that several different lines of evidence can often combine to bolster conclusions when no single line of reasoning is sufficient. (It is this cross-checking of one kind of evidence against another that is the real hallmark of science.) For example, archaeological skeletons regularly display an increase in frequencies of infection with the adoption of large sedentary communities associated with farming. This might, as the critics suggest, be a misleading artifact of skeletal samples. But the increase in infection with large groups and sedentism is in accordance with standard modern epidemiological expectations based on knowledge of the life cycles of parasites. Moreover, the same increase is displayed over and over again when contemporary hunter-gatherers are settled in large communities. It seems reasonable to conclude, then, that the increase in infection with the adoption of farming is historic fact and not a mere artifact of skeletal sampling.

Similarly, anemia becomes more visible in skeletal populations after the adoption of farming. But we also know that anemia is infrequent in contemporary hunter-gatherers and that rates of parasitism (the most probable explanation of anemia for most populations) increase with farming. Again it seems reasonable to conclude that the increase in anemia is a matter of historic fact. Similarly, dental defects indicating disrupted growth in children become more common in skeletal populations after farming. But observations on living groups suggest that weanling diarrhea—which is thought to be a major cause of such dental defects—also increases with sedentism suggesting that the prehistoric trend is real and not the product of a sampling error. Similarly, tuberculosis, which occurs only in relatively recent, dense, sedentary populations in the archaeological sequence is also primarily a disease of cities in the modern world, suggesting that we are not being misled about its prehistoric distribution.

In short, data from a variety of sources seem to be converging on a new way of viewing the origins of agriculture and other episodes in human history. Taken together, evidence from paleopathology, from ethnographic studies of contemporary hunter-gatherers, epidemiology or knowledge of disease mechanics, and optimal foraging research all suggest that human health declined with the adoption of agriculture—and these data also suggest more generally that much human "progress" has been a matter of diminishing returns for all but privileged groups and classes.

One final point needs to be made. One of the problems with our initial ideas about agriculture is that some of the basic assumptions—such as that agriculture represents "progress" (or indeed that human history as a whole has been about "progress")—were never tested. All ideas, no matter how plausible or how much in accord with prevailing beliefs, should be tested in many different ways.

The idea of "progress" is itself nothing more than an hypothesis that was created by scientists and scholars like ourselves who were working from similar data (although generally from *less* data and never from more data than are now available). If it is to be believed, the hypothesis of progress must be supported by empirical evidence from contemporary populations or skeletons, like any other competing hypothesis. At present it is not supported and I believe it has less actual empirical evidence in support than the alternative hypothesis offered here. I think it is time to change our thinking and our assumptions about what happened in history.

NOTES

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Research TOC