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The Neolithic Transition: An “Adaptive Compromise”

Ant 575—Human Adaptability

25 March 2003

Text Pages: 14
Bibliography: 3
The Neolithic transition is a relatively recent development in the history of human evolution, emerging in the last 10,000 years. The change from food collection to food production was the cause of many physical and cultural changes in humans. An agricultural lifestyle was adopted, replacing the hunting and gathering that had supported populations of humans for two million years. Major changes to individuals and populations occurred as a result of this shift. Childe coined the term Neolithic revolution, but admits that the transformation was not instantaneous (Ucko & Dimbleby, 1971). Although a number of different evolutionary models have been proposed as to the origins of agriculture (Curtis, 2001), all present causal factors that are somewhat long-term in nature, e.g., climate change or population growth. It is for this reason that Ammerman and Cavalli-Sforza (1984) offer the term Neolithic transition as a more suitable title for the time period in question. This paper will examine the causes and consequences of the human transition to agriculture and investigate adaptation on a population and individual level, with the expectation of finding substantial differences in health states between the two levels of the biological hierarchy.

**Adaptation and the Biological Hierarchy**

Many conflicting definitions of adaptation have been presented to the academic world from the 1950’s up to the present. For the purposes of this paper, the term adaptation will be defined as a process that bestows “relative benefit or necessity [which] can be applied to all levels of the biological and social hierarchies” (Mazess, 1975:10). Mazess’(1975) biological hierarchy involves a sequence of classification from the molecular, cellular, organ system, individual, population to the ecosystem level. A necessary component of any feasible definition concerns the notion of stress. Adaptive changes that occur on any level can be the result of
stress, defined as “not merely a large deviation of an environmental factor but a deviation that has a significant or actual or potential effect on one or more adaptive domains” (Mazess, 1975:11). Also central to Mazess’ (1975) definition is the idea that what may be beneficial to one level of the biological hierarchy may in fact be detrimental to another level. The transition to agriculture during the Neolithic is a prime example of this assertion—this paper will examine the history of some of the models concerning the Neolithic, explanations of pre-agricultural and agricultural societies, and explain how populations thrived in terms of growth and spatial-temporal spread, but did so at the expense of the health of individuals (Cohen, 1989).

**History**

The transformation from a hunting and gathering lifestyle to that of agriculture has been discussed among intellectuals since the time of ancient Greece and the book of Genesis. Writers such as Rousseau in 1755 explained the change to food production as an equation of moving from a natural to a social existence, discussing how modern humans were affected by the shift. Humans evolved into social beings and witnessed the demise of equality due to the emerging stratification of society. Food production essentially made masters and slaves out of what was once a natural coexistence (Smith, 1975). The discipline of anthropology has long concerned itself with the topic of adaptation during this salient time period. A brief historical analysis of the field explains the noticeable evolutionary bent to the early understandings of the concept of adaptation during the Neolithic transition. Early theorists such as Morgan sought to explain the path of human evolution in terms of progress from one state of civilization to another.

In the mid 19th century, history was seen as a unilinear progression from one state of being to another—evident in anthropological evolutionism. Before the 1960’s, research
questions centered around discovering the different zones where food production was established, passing over the all-important question of why agriculture replaced hunting and gathering once it had been invented (Cohen, 1989). Writers such as White, Steward, and Childe solidified common conceptions of adaptation during the Neolithic transition. Adaptation during the New Stone Age connoted a number of favorable changes on different levels. Population growth was seen as a result of the profitable new lifestyle, laying the foundation for the development of the organized city-state. A drastic improvement in the life of the individual was also presupposed of the origins of civilization. Individuals pursuing an agricultural lifestyle were seen as well-fed, healthy, living a leisurely lifestyle—as opposed to savage forest dwelling hunter-gatherers who had no established home, and who depended on unorganized, unreliable means of obtaining food (Cohen, 1989).

Some anthropologists used observations of modern hunter-gatherers to propose that a foraging lifestyle was not as laborious and unstable as was originally thought. Sahlins (1968) commented upon the popular perception of foraging groups as devoid of culture, particularly material culture, with this view being the norm before anthropological research was prominent in the west. Material culture was equated with civilization, and foraging groups were seen as being preoccupied only with thoughts of the approaching meal, unable to develop civilized society as a result. In fact, the nomadic foragers were found to be hindered by physical possessions, and time spent collecting food was noticeably less than food producers.

Lee (1968) presented information supporting Sahlins’ notion that foragers were the original affluent society, citing data he collected from the !Kung during the mid 1960s. The !Kung gathered food throughout the year, working every three or four days for two days at a time. Lee’s weekly analysis showed that the !Kung spent between twelve and nineteen hours a
week collecting food, with the most productive workers only devoting 32 hours to subsistence activities. The caloric and protein intake of the !Kung was also found to exceed the Recommended Daily Allowances set by western nations. Caloric intake was estimated to exceed the RDA by 165 calories, and the !Kung ingested thirty-three more grams of protein. Interestingly, meat from hunting was seen as a supplement or a celebrated variation from the normal vegetable diet, which comprised 60-80 percent of the diet in a year’s time by weight. Women were therefore primary in the subsistence of this foraging group. These conclusions deviated from the popular model of a male dependent, more violent and carnivorous society. Lee concludes that it is possible that a modern foraging society such as the !Kung would have had increased prosperity if they were not marginalized to certain parts of Africa.

Boserup (1981), an agricultural economist, argued that technological inventions were an adaptation to larger populations which were running out of space to produce food. These innovations included draft animals, the use of fire, and of other specialized tools such as grindstones. Speculations upon the post-Pleistocene carrying capacity of the environment surmised that there were fixed limits on certain resources available to a population (Boserup, 1981). But to approach and move beyond the carrying capacity, increasing the ratio of a population to its natural resources, was termed as “disadvantageous” (Dumond, 1975). This conclusion presented researchers with a paradigm shift where numerical population growth would be seen in a negative light to those individuals that were experiencing it. Cohen (1977) cites the importance of social factors such as pressure to possibly maintain or decrease a population’s numbers, or an increased attention to a different food source if another becomes scarce.
Some preliminary ideas about the conceptions of prehistoric life have been examined, but the paper will now focus on the environmental and social conditions faced by pre-agricultural people that ultimately led to the Neolithic transition, which in turn influenced population growth and health.

**Hunter-Gatherers in the Upper Paleolithic and Epipaleolithic**

Information about hunter-gatherers in the Paleolithic era comes from archaeological data, paleopathological and osteological data, epidemiology, and ethnography of modern populations such as the !Kung San of the Kalahari (Cohen, 1989). The Upper Paleolithic spans from 40,000 years ago to 10,000 years ago, and was characterized by large glaciers that reached far south, and by temperatures that were on average 10 degrees Celsius below modern average temperatures. This information can be determined from deep sea cores, which are an adequate determiner of the paleoclimate (Bar-Yosef & Meadow, 1995). Climate data from pollen analysis is also fruitful for determining temperature (Ammerman & Cavalli-Sforza, 1984). Mega fauna were hunted by mobile bands of people who also collected regional plants and stored large quantities of meat most likely in permafrost pits (Crowe, 2000), but climate change and possible over killing of the animals led to a change in food acquisition methods.

The recession of the glaciers approximately 16,000 years ago most likely led to fluctuations in the flora and fauna of the ecosystem. A warming trend may have indirectly caused an increase in the human population during the Late Upper Paleolithic, according to Crowe (2000). He reasoned that since humans expend more energy in colder climates in order to obtain the food resources necessary for survival, a warmer climate may have decreased the amount of food that humans needed to consume. Humans would then be able to decrease the
territory exploited, while still being able to meet the needs of the group, assuming that there were no drastic changes to the ecosystem. Archaeological data demonstrate population growth at this time, with the number of sites increasing from 40 to 100 in south-western Europe (Binford, 1971; Crowe, 2000).

The Epipaleolithic began about 14,000 years ago (Ember et al., 2002) and was characterized by an increased population, a major change in tool technology, greater cultural variation dependent on specific environments, and a noticeable increase in the exploitation of fish, shellfish, hunting of small game, and collection of wild plants (Binford, 1971). These characteristics of food-collecting were identified as “broad-spectrum” (Flannery 1968), and are seen by Cohen (2002) as preceding agriculture in the world.

This section of the paper was concerned with the eras preceding the origins of agriculture. Climate changes and the introduction of new tools were discussed. I will next discuss the aspects of the Neolithic transition, specifically domestication and its ecological consequences.

**The Neolithic Transition**

There are six known areas of the world in which agriculture developed independently. In the Middle East, the shift to food production was fully developed around 8000 years B.P. Later developments occurred in Highland Mesoamerica, Northern China, South Central Andes, and the Eastern United States. The case of agricultural development in the Fertile Crescent encompassing Iran and Iraq is probably the most well known (Rathbun, 1984) because the archaeological record provided the researcher with a clear transition from foraging to agriculture
(Smith, 1994). Agricultural development in the Fertile Crescent will be the predominant example used throughout this paper, unless stated otherwise.

Despite the conflicting theories on the origins of agriculture, all hunter-gatherer societies that made the transformation to food production altered their environment, whether it was for better or for worse. Experimentation with plants and animals led to the process of domestication (Smith, 1994). Genetic mutations of a plant species can result in the evolution of a new species when physical boundaries isolate the two groups in the environment. Human intervention can also create such a boundary which will artificially put selective pressures on the various plant species. These behavioral changes of foragers marked an important modification in the relationship between humans and other plant and animal species of the world (Smith, 1994).

Agriculture can be described as mutualism between humans and domesticated plants (Rindos, 1984). Smith (1994) described corn as the “most successful” domesticated plant, but only if human intervention continues after plants are seeded. Domesticated corn plants cannot release their seeds, which would be necessary to ensure survival to the next growing season. The corn plants literally depend on humans for survival, with humans gaining a marked increase in crop size during the harvest season due to the greater size of the kernels. Harvesting, storage, and planting of the past autumn’s seeds in the spring actually encourages plants to improve their yield, as selective pressures for reproductive success are lessened.

The selection of one or two staple crops would have resulted in the over-categorization of weeds. That is, with the proclivity to cultivate only a small number of crops, other potential crops were labeled as deleterious to the growth of the staple crop. So to create a more favorable growing environment for the chosen crop, nutrient rich “weeds” may have been eliminated as possible food sources. This decrease in dietary variety can be seen through the work of Styles
(1985). Her examination of three early Late Woodland archaeological sites in the Lower Illinois Valley explained the range of dietary resources utilized by human populations before the advent of agriculture. The author concluded that with regard to species diversity, all of the sites are similar. The sites showed many differences concerning the number of fish, birds, and mammals that were used for food. While there may have been some problems with adjusting the data due to small sample sizes, the list of species generated as food sources for this time period is extensive compared to the food sources for the Neolithic. For example, Styles (1985) listed twenty-eight different kinds of mussels that were eaten at the three sites, also mentioning seven plants that were cultivated during this time. Maize, however, was not found in the archaeological record, and therefore must not have been introduced into the Neolithic diet until later. This evidence corresponded to the explanation of broad-spectrum resources that were exploited before the rise of agricultural activities.

Single staple cultivation also left agricultural societies open to the devastating consequences of drought or destruction by pests. Occurrences such as hunger and starvation were more common after the switch to farming, as populations may not have been able to geographically escape a famine (Cohen, 1989). In terms of the episodic stress characteristic of famine or drought, Rathbun (1984) noted that transverse Harris lines on long bones and enamel hypoplasias occurred more frequently at the Neolithic site of Dinkha Tepe, compared to modern populations at the same location. Harris lines are found on the epiphyseal cartilage plate, and are characterized by a reduction in thickness of the plate. Enamel hypoplasias are deficiencies in thickness of the tooth enamel and are visible pits, lines, or bands on the crown surfaces of the teeth.
In this section, the paper was concerned with the features that characterized the Neolithic transition, including domestication and some consequences—both ecological and paleopathological—of reliance on relatively few staple crops. Next, population growth will be argued as an important consequence to the rise of food production. I will also elaborate upon the suggestion that the complex changes that occurred during the shift to agriculture were costly in terms of health (Cohen, 2002).

**Agriculture and Population Growth**

Ammerman and Cavalli-Sforza (1984) explained that archaeological settlement patterns are a reliable indicator of the transition to agriculture. By investigating the spread of agriculture through Europe, a logical connection to the idea of population growth can be made. Hassan (1981) has proffered a four-stage explanation which described relatively balanced mortality and fertility prior to the Neolithic transition. At the beginning of agricultural developments, fertility increased steadily, yet in the third phase—the beginning of the Holocene and accordingly, the Neolithic—mortality rates decreased while fertility rates continued to rise. In the fourth phase there was a cessation of growth, in which both mortality and fertility rates decreased.

Handwerker (1983) supported this four stage model, and asserted that reproductive decision making was not the cause of the first demographic transition; rather it was the result of the desire to improve chances of survival.

Weiss (1984) calculated estimates of the number of individuals in the entire *Homo* genus by starting with the date of 4.5 million years ago as the origins of *Homo*. Setting the starting population at 100,000 and by using an exponential growth model, Weiss concluded that around the dawn of *Homo erectus*, 500,000 years ago, the population would have reached 64.4 billion.
Moving up to the Neolithic, the population jumped to 99.7 billion by 10,000 years ago. Although Weiss admitted to the mutability of these estimates, he explained that the ranges will be useful for demographic and physical anthropology. Interestingly, he calculated only 400 generations between modern times and the Neolithic era.

Population size is governed in part by social factors as well. Dumond (1975) discussed the selective disadvantage of having many children spaced closely in early nomadic populations. In the Paleolithic, it would have been adaptive for the human species to have retained the ability to reproduce quickly if the population size sharply decreased. The author therefore cited the social roles within the nuclear family as the reason for reduced birth rates. The mother’s ability to fulfill her role expectations would have been hindered if many children were born without delay. In contrast, sedentary lifestyle saw a decreased need for long intervals between births. The agricultural lifestyle would have encouraged many children in the family, as the work load of crop cultivation could then be divided up among the family sooner if it was larger. Social structures such as governmental tax breaks may have also encouraged larger families (Dumond, 1975).

The final section is a summary of the health consequences of the Neolithic transition. Up until now, the focus has been on the population level of the biological hierarchy, with emphasis on the domestication of plants and the rapidly increasing population growth. The increased numbers of humans reflect a positive adaptation at the population level. However, individuals at the beginning of the Holocene saw an increase in disease rates concomitant with the development of agriculture. I propose that individual health was compromised despite the fact that populations were thriving.
The Health Consequences of the Neolithic Transition

Ammerman and Cavalli-Sforza (1984) noted the changes that occurred in the archaeological record after sedentism was adopted by humans—larger tools, more permanent storage pits and houses, and larger sites. Settlement patterns were seen as the major factor that changed when groups adopt farming. The burdens of tending to crops would warrant a move to a new location with accessible water and nutrient-rich soil, increasing the chances of survival with this new subsistence technique (Butzer, 1971). Wild wheat is today found in the seasonal rainfall zone near the Zagros mountains of Iran and Iraq. It is assumed that humans moved to the places where wheat already grew in order to begin the domestication process.

Cohen (1989) suggested that a sedentary lifestyle was related to broad-spectrum food collecting, and discussed the positive and negative sides to settling down. One positive aspect of sedentary life was the increased ability to ward off infectious diseases from zoonoses because nomadism would have lead to increased contact with animals. Acquired immunity to local parasites in children may have occurred also in sedentary populations. Lastly, the sick individuals in a group would have been easier to care for in a sedentary population. Those most at risk in large-scale populations would be children, whose parents had already survived to the reproductive age, acquiring immunity to earlier epidemics (Cohen, 1989).

Sedentism may have affected populations more negatively than positively, however. Trade routes can introduce parasitic disease, easily negating any gains that a population acquired by settling in one location. More permanent housing structures led to decreased time spent outside. Confined areas make disease transmission easier, especially in the reduced air circulation during the winter season, when food is scarcer. Cohen (1989) also noted that time spent indoors is time spent out of the sunshine, the rays of which are a natural disinfectant.
Evidence of infections is an important aspect in determining the health differences between foragers and food producers. Rathbun (1984) explained that while there was an increase in the incidence of general infections at the start of the Neolithic, there was a decreased incidence of infection of the middle ear at Dinkha Tepe during the Metal Ages—only 3% of the population with the affliction. Cohen (1987) states that most investigations into the frequencies of bone lesions and infectious disease markers support the hypothesis that infections were a debilitating factor to Neolithic populations.

Rathbun (1984) talks about the lack of an understanding or a concern with paleopathological data, that is until recently when researchers began to improve their hypotheses and methodologies in the field during the mid 20\textsuperscript{th} century. The skeletal data are fragmented for the archaeological sites of the world, but provide a somewhat adequate picture to determine the nutritional status of pre-agricultural and Neolithic peoples. Determining the direct causes of skeletal pathologies at the individual level is near impossible (Rathburn, 1984), but on the population level, comparisons between groups often illuminate evidence of differential physiological stresses, both in frequency and degree. Even though causes may remain undecipherable, stresses on a population can allow researchers to garner information regarding the changes related to health, population size, economy, and social structure that took place from the Paleolithic to the Neolithic (Cohen & Armelagos, 1984).

Population increases would also have forced groups to rely on foodstuffs that were not on their ideal menu. Cohen (1989) argues that it was these third-choice foods that became the staples of agricultural production. The plants that reproduced rapidly and plentifully, such as cereal grains with a short growth cycle, were cultivated. Some of the major agricultural grains contain phytate chemicals that bind to nutritional metals like iron and calcium, resulting in a
deficiency even if sufficient amounts are consumed. Anemia, which can be caused by iron
depleting tubers, is also a result of agricultural production. Rathburn (1984) cites the average
rate of anemia as 21% based on two Neolithic sites, Ganj Dareh and Zawi Chemi. The anemia
causes porotic hyperostosis and cranial lesions in the skeletal population. He concludes that the
increase in lesions is a result of nutritional deficiencies due to an agricultural lifestyle.

**Conclusion**

It has become clear that population size was augmented after the transition to agriculture
from hunting and gathering. This level of the biological hierarchy flourished compared to the
changes in individual health during the same time. Cohen emphasizes the point that “individual
well-being is always being traded against group success. Success…need not imply that a group
maintains the welfare of all individuals” (1989:14). This quote brings up important social
aspects of adaptation which this paper did not cover—that change in human populations does not
happen in a social vacuum. For example, social stratification and the meanings behind certain
foods—whether consuming meat is a symbol of prestige—are an important element in any
discourse on food choices or subsistence strategies.

The preliminary study presented here has described the history of the study of adaptation
to agriculture, and a progressive discussion of the changes during the Neolithic transition,
including health related to domestication, diet, disease, and comparisons to Paleolithic
progress up to our present state of civilization. The data presented in this paper illuminates the
need to reconsider the popular idea that the process of civilization is congruent to the progress of
civilization. In sum, the Neolithic transition can be seen as an adaptive compromise between the individual and the population levels of the biological hierarchy.
Bibliography


