CHAPTER FOUR

4

Figure 4.1 A painting from an Egyptian tomb shows the harvest (below) and winnowing (above) of a wheat crop.

The Origins of Agriculture

Introduction
The First Farmers

The major transition in the course of human prehistory

Wheat is one of the most important domesticated crops on Earth, an important staple food for people and animals in many parts of the world. The painting in Figure 4.1 comes from an Egyptian tomb, one of many depicting views of life in ancient Egypt. Wheat is one of the many species of plants and animals that humans have tamed over the past 10,000 years.

As we have seen our species spent the vast majority of history as hunter-gatherers. Our ancestry as food collectors, consuming the wild products of the earth, extends back more than 4 million years. Nevertheless, at the end of the Pleistocene, some human groups began to produce food rather than collect it, to domesticate and control wild plants and animals, achieving what is perhaps the most remarkable transition of our entire human past.

Agriculture is a way of obtaining food that involves domesticated plants and animals. But the transition to farming is much more than simple herding and cultivation. It also entails major, long-term changes in the structure and organization of the societies that adopt this new way of life, as well as a totally new relationship with the environment. Whereas hunter-gatherers largely live off the land in an *extensive* fashion, generally exploiting a diversity of resources over a broad area, farmers *intensively* utilize a smaller portion of the landscape and create a milieu that suits their needs. With the transition to agriculture, humans began to truly master their environment.

That a species is exploited intensively by humans does not automatically mean it will become domesticated. Although oak trees have supplied acorns for humans for thousands of years, they have not been domesticated. **Domestication** changes the physical characteristics of the plant or animal involved. The domestication process involves both the inherent characteristics of the plant or animal species (generational length, life cycle, plasticity) and the intensity and nature of the human manipulation.

Agriculture requires several principal practices for long-term success: (1) *propagation,* the selection and sowing of seeds or breeding of animals; (2) *husbandry,* the tending of plants or animals during the growth period; (3) the *harvesting* of plants when ripe or the *slaughter* of animals at appropriate times; and (4) the *storage* of seeds and *maintenance* of animals through their nonproductive periods to ensure annual reproduction. Plant propagation and husbandry involve **cultivation**—clearing fields, preparing the soil, weeding, protecting the plants from animals, and providing water.

CHAPTER OUTLINE

The evidence for early domesticated plants focuses on seed crops. The best-known early domesticates are the cereals—the grasses that produce large, hard-shelled seeds, nutritious kernels of carbohydrate that can be stored for long periods. The hard cereal grains, and occasionally the stems of these plants, were often burned during preparation or cooking in the past and thereby preserved to the present.

Root crops are not well documented in the archaeological record because they lack hard parts that are more resistant to decay. Because they reproduce asexually from shoots or cuttings, it is difficult to distinguish domesticated varieties from their wild ancestors. Asexually reproducing plants may maintain exactly the same genetic structure through many generations, because a piece of the parent plant is used to start the daughter. Such plants may also exhibit great variation within a species, making domestication difficult to document.

Root crops such as potatoes, yams, manioc, and taro may have been domesticated quite early. Archaeologists have started to identify them from prehistoric sites only recently. Animals were apparently domesticated initially for meat, with the exception of the dog. Dogs were tamed from wolves very early, perhaps 14,000 years ago in the Old World, and used for hunting and as pets, or even for food. Subsequently, however, several other animal species were domesticated and herded for food and/or kept as beasts of burden. The animals domesticated earliest were pigs, goats, sheep, and cattle. The secondary products (such as milk, wool, horn, and leather) of these, and other, domesticated species also became important, as did their function as beasts of burden.

The domestication of both plants and animals may be related to the storage of food. Such cereals as wheat, barley, corn, and rice have hard outer coverings that protect the nutritious kernel for some months, permitting the seed to survive until the growing season and offering very good possibilities for storage. Meat can be stored in the form of living tame animals that are always available for slaughter. As such, storage provides a means to regulate the availability of food and to accumulate surplus.

Questions concerning the origins of agriculture focus on *primary* centers, where individual species of plants and/or animals were first domesticated (Figure 4.2). *Secondary* areas of agricultural development received plants and animals from elsewhere, although in many of those regions, some local plants and animals also were domesticated and used along with the introduced varieties. Until recently there were six known primary centers for domestication—in Southwest Asia (Figure 4.3), East Asia, sub-Saharan Africa, Mesoamerica, South America, and North America (Figure 4.4). The earliest known domesticates—wheat, barley, rye, peas, lentils, figs, pigs, goats, sheep, and cattle—appeared in the Old World—in Southwest Asia, between the eastern Mediterranean Sea and Afghanistan—at the end of the Pleistocene. Many other plants and animals—such as bread wheat, olives, grapes, and flax—were gradually added to this list. The origins of agriculture in Southwest Asia are discussed in detail in this chapter because the archaeology is well known and the process of domestication took place there somewhat earlier than it did elsewhere.

Agriculture also was invented in East Asia, perhaps in two or three different areas, sometime before 6000 B.C. Millet was first cultivated and pigs were domesticated in North China in villages dating to roughly 6000 B.C. Rice was initially cultivated in South China, possibly as early as the eighth or ninth millennium B.C., and somewhat later in Southeast Asia, around 4000 B.C. In all probability, root crops were under cultivation in that area, along with rice, sometime between 7000 and 3000 B.C. As a result of continuing research, we can expect the dates for all of East Asia to be pushed back somewhat earlier. Plants such as African rice, sorghum, and pearl millet were domesticated in sub-Saharan Africa after 2000 B.C. Cattle and goat herding was practiced in that area, where the new domesticates appeared.

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domestication The taming of wild plants and animals by humans.

cultivation The human manipulation or fostering of a plant species (often wild) to enhance or ensure production.

In the Americas, agriculture first developed in Mexico, in northwestern South America, and in eastern North America. In Mexico, gourds and squash were cultivated during the eighth millennium B.C.; avocados, chili peppers, beans, and possibly corn were cultivated later, around 5000 B.C. These crops provide all the essential nutrients for a healthy diet, and meat protein may not have been necessary. Domesticated animals never constituted an important part of the diet in this area, although turkeys, dogs, and the stingless honeybee were domesticated. In eastern North America, several local plants such as marsh elder and goosefoot (Chenopodium) were domesticated by 1500 B.C., long before the introduction of corn from Mexico (see also "Agriculture in Native North America," p. 240).

Sites in the highlands of Peru contain evidence for the early domestication of gourds, tomatoes, beans, and potatoes by 3000 B.C. Some of these plants may have reached the mountains from an original habitat in the lowland jungles, but little is known about the prehistory of the Amazon Basin and other tropical areas of South America. Potatoes certainly were an indigenous crop; hundreds of varieties of wild and domesticated potatoes grow in this area today. In addition to plants, several animals were domesticated. The guinea pig was used for food,

Figure 4.2 The first appearance of domesticates by region and time.

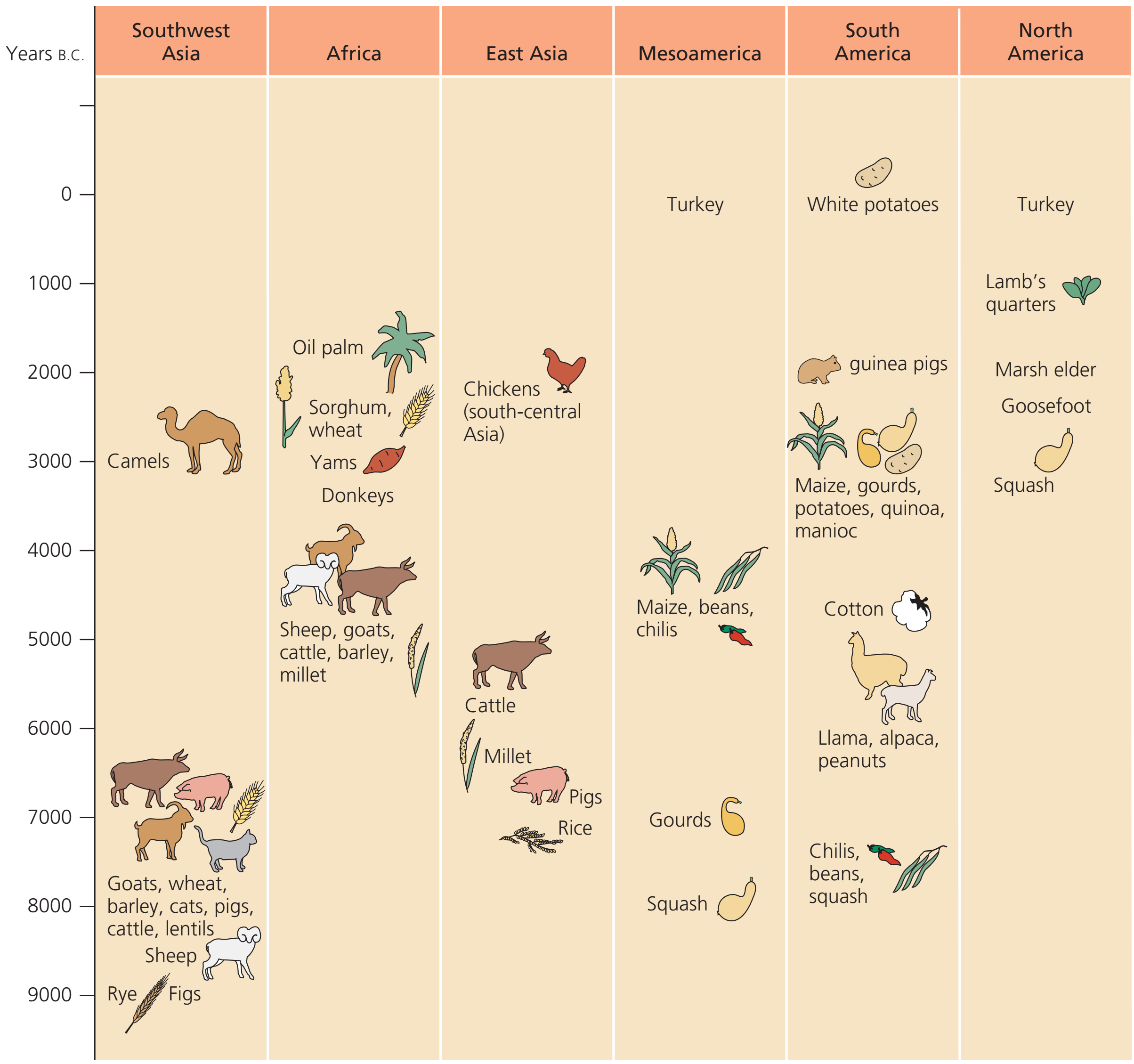


Figure 4.3 Traditional techniques for harvesting and threshing grain in Southwest Asia have not changed for thousands of years.

and the **llama** was probably domesticated and used to transport goods around the mountains of South America. The **alpaca,** a **camelid** like the llama, may have been domesticated for both meat and wool.

In recent years, two new regions have been added to the list of centers for primary domestication. Recent research efforts suggest that several seed crops (including millets, *indica* rice, pulses, cotton, and sesame) were domesticated in South Asia. In the South Pacific, specifically in the highlands of New Guinea, fieldwork in the last 30 years or so has documented the early domestication of plants such as banana, taro, and yam by 5000 BC.

In addition, the antiquity of domestication has been pushed deeper into the past in many areas. Another commonality among the cradles of agriculture is the rich environments in which farming originates. Experiments in domestication do not take place in marginal areas but amid concentrations of population and resources across the globe. It also appears that in each area where several different species are involved in the transition to agriculture, there are multiple centers of domestication within the region. A number of different groups appear to be manipulating their natural world.

Remarkable new studies are documenting this evidence. Archaeobotany is moving forward rapidly with a variety of techniques for recording information related to domestication. Microscopic investigations of starch grains in South America have identified a number of early crops, and more specific information on their origin and distribution is becoming available. Genetic studies of modern and ancient DNA in domesticated plants and animals are also providing remarkable data on species distribution and their evolution. The coming years should bring a wealth of new information on the transition to agriculture in our human past.

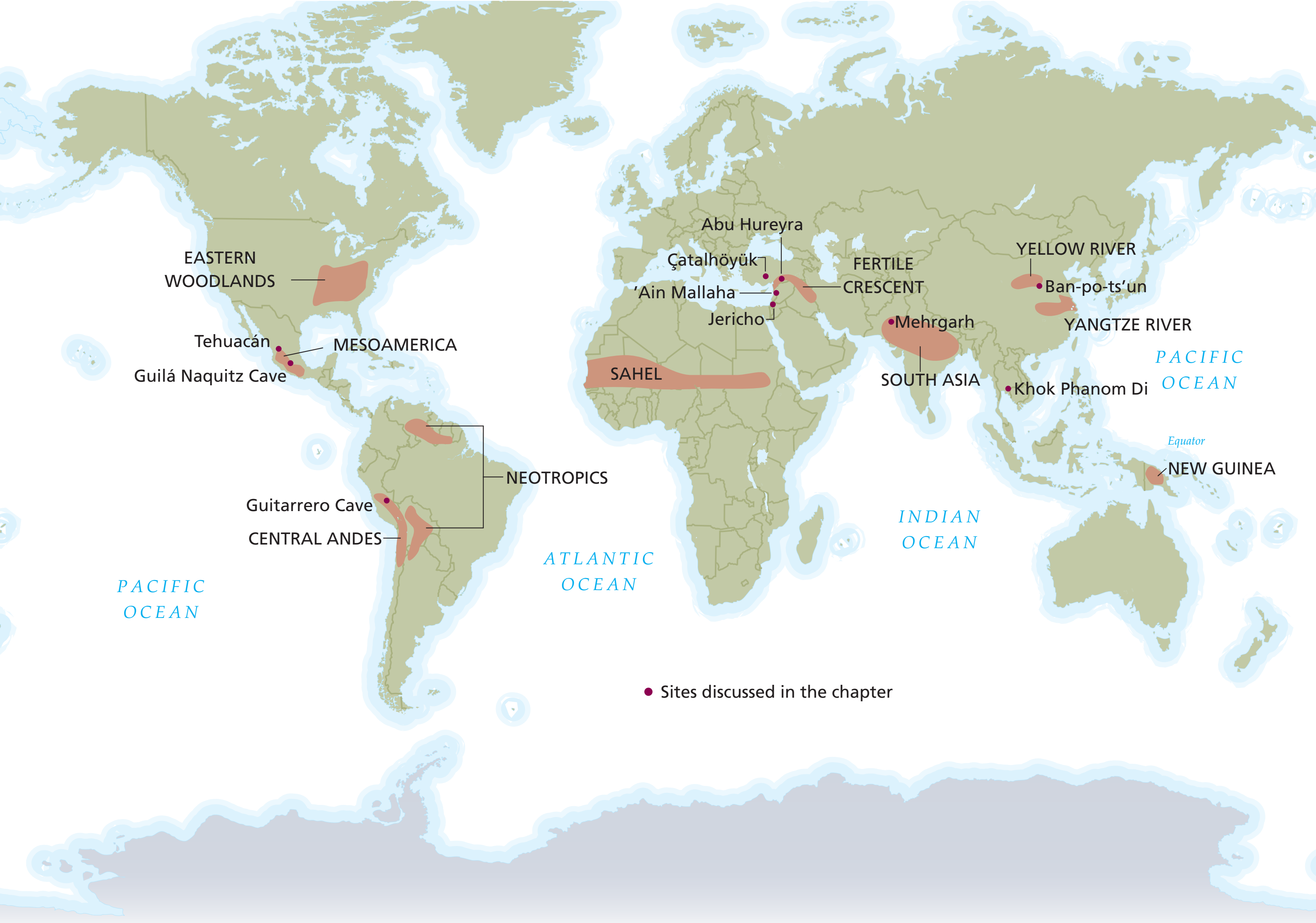
Following a discussion of various explanations for the origins of agriculture, this chapter traces the beginnings of farming in the different centers that have been identified. Because of the better quantity and higher quality of archaeological information from Southwest Asia, much of the discussion focuses on that area. Many geographic terms have been used to designate the area, including *Near East*, *Middle East*, and *Southwest Asia. Near East* refers to the Arabic countries of North Africa and southwestern Asia. The Middle East and Southwest Asia have similar boundaries, but the term *Middle East* reflects the view from Europe. Hence, *Southwest Asia* is the best way to describe the region.

In Southwest Asia, we examine one site from before the transition to agriculture—'Ain Mallaha—and two early Neolithic communities—Abu Hureyra and Jericho—to see the changes that took place. Çatalhöyük, an enormous early Neolithic settlement, documents the consequences of the Neolithic revolution in terms of completely new ways of inhabiting the world. In addition, there is exciting new evidence from several places in Southwest Asia discussed in "Big Changes," p. 000. From Southwest Asia, the tour goes to South Asia and the site of Mehrgarh, an early Neolithic community in Pakistan. In East Asia, the sites of Ban-po-ts'un in northern China and Khok Phanom Di in coastal Thailand provide some sense of the Neolithic in that part of the world. There are at least three primary centers of domestication in the New World as well, in Mesoamerica, South America, and North America. The important early sites of Guilá Naquitz

llama A woolly South American ruminant camelid, used as a beast of burden.

alpaca A domesticated South American herbivore with long, soft wool.

camelid A ruminant mammal—such as camel, llama, and extinct related forms—having long legs and two toes.



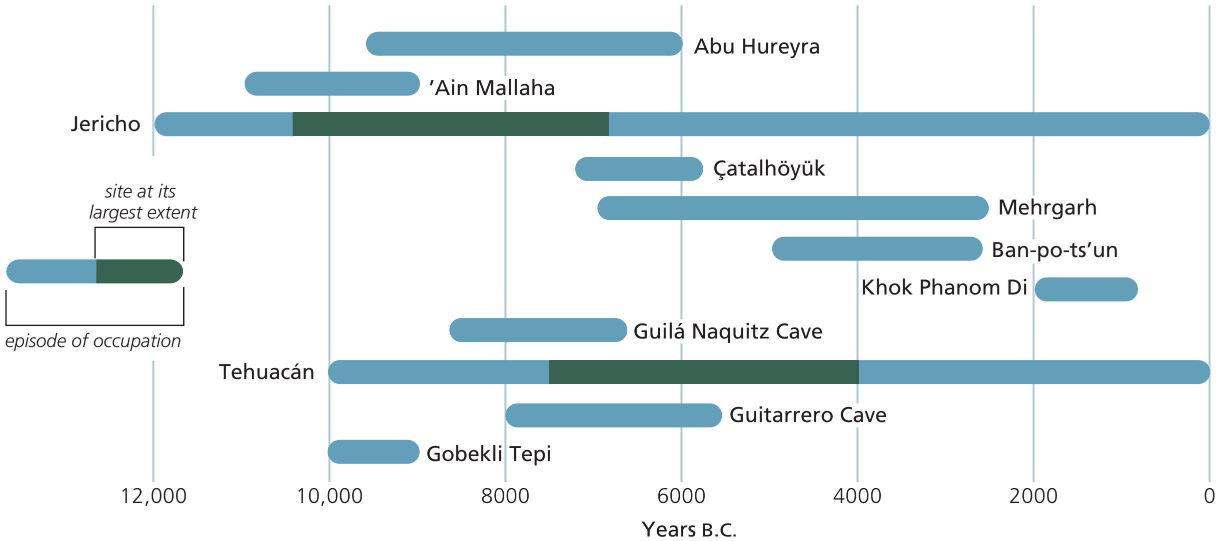


Figure 4.4 Location of and timeline for primary centers of domestication.

and in the Tehuacán Valley provide evidence of early plant domestication in Mexico. Excavations at Guitarrero Cave, high in the Andes, give us a glimpse of the process of domestication in South America.

The summary section, "Images and Ideas," considers the spread of agriculture from those primary centers, like the ripples spreading from a pebble thrown into a pond, to areas where domesticates were introduced from other places. Subsequent chapters explore the expansion of agriculture into Europe and parts of North America. We also discuss how this major change in human subsistence revolutionized economies, social organization, settlement, and ideology. Human society was never again the same after the beginnings of domestication. Even societies that continued to hunt and gather after the Neolithic were dramatically, and often drastically, affected by neighboring farmers.

Explaining the Origins of Agriculture

The how and why of farming

It is remarkable that the process of domesticating plants and animals appears to have taken place separately and independently in a number of different areas at about the same time. Read it again: The almost simultaneous appearance of domesticated plants and animals around the globe between roughly 10,000 and 5000 years ago is astounding. Given the long prehistory of our species, why should the transition to agriculture happen within such a brief period, a few thousand years in a span of over 6 million years of human existence? An important and dramatic shift in the trajectory of cultural evolution demands explanation. But such answers are hard to find.

Views on and evidence for the origins of agriculture continue to be revised and updated. We can best understand ideas about the origins of agriculture from a historical perspective, considering the early theories first. Hypothetical explanations of why domestication occurred include the oasis hypothesis, the natural habitat hypothesis, the population pressure hypothesis, the edge hypothesis, and the social hypothesis. A consideration of these ideas also reveals much about the nature of archaeology and archaeologists. Theories about the origins of agriculture have often focused on the earliest evidence from Southwest Asia and, for that reason, may not be appropriate to all places where early domestication actually occurred.

During the first half of the twentieth century, the best information on early farming villages came from riverine areas or oases with springs in North Africa and Southwest Asia—along the Nile River in Egypt or at Jericho in the Jordan Valley, for example. At that time, the end of the Pleistocene was thought to have been a period of increasing warmth and dryness in the earth's climate. Researchers reasoned that because the ice ages were cold and wet, they should have ended with higher temperatures and less precipitation. Given that view of past climate, logic suggested that areas such as Southwest Asia, a dry region to begin with, would have witnessed a period of aridity at the end of the Pleistocene when vegetation grew only around limited water sources. The **oasis hypothesis** suggested a circumstance in which plants, animals, and humans would have clustered in confined areas near water. V. Gordon Childe, one proponent of this idea, argued that the only solution to the competition for food in these situations would have been for humans to domesticate and control the animals and the plants. In this sense, domestication emerged as a symbiotic relationship for the purpose of human survival.

More recently, detailed information on climate change has come from a most unlikely place—the glaciers of Greenland. Deep corings of the ice sheets there have provided a layered record of changes in temperature and other aspects of climate for the past 100,000 years and more. One of the very interesting results of this research was the documentation of a 33% increase in atmospheric carbon dioxide at the end of the Pleistocene (Sage, 1995). Higher levels of CO_2 would foster the expansion of temperate species such as grasses, which include many of the ancestors of the major domesticated species. The full implications of such changes in the atmosphere are not yet clear, but the changes may have played a role in the transition from hunting to farming.

During the 1940s and 1950s, however, new evidence indicated that there had been no major climate changes in Southwest Asia at the close of the Pleistocene—no crisis during which life

oasis hypothesis The theory that domestication began as a symbiotic relationship between humans, plants, and animals at oases during the desiccation of Southwest Asia at the end of the Pleistocene.

The conditions of incipient desiccation . . . would provide the stimulus towards the adoption of a food-producing economy. Enforced concentration by the banks of streams and shrinking springs would entail an intensive search for means of nourishment. Animals and men would be herded together in oases that were becoming increasingly isolated by desert tracts. Such enforced juxtaposition might promote that sort of symbiosis between man and beast implied by the word domestication.

—V. Gordon Childe (1951)

The food-producing revolution seems to have occurred as the culmination of the ever increasing cultural differentiation and specialization of human communities. Around 8000 B.C., the inhabitants of the Fertile Crescent had come to know their habitat so well that they were beginning to domesticate the plants and animals they had been hunting and gathering.

—Robert Braidwood (1960)

natural habitat hypothesis The theory that the earliest domesticates appeared in the area that their wild ancestors inhabited.

population pressure hypothesis The theory that population increase in Southwest Asia upset the balance between people and food, forcing people to turn to agriculture as a way to produce more food.

edge hypothesis The theory that the need for more food was initially felt at the margins of the natural habitat of the ancestors of domesticated plants and animals; a revised version of the population pressure hypothesis.

would have concentrated at oases. The new information forced a reconsideration of the origins of agriculture. The late Robert Braidwood pointed out—in his **natural habitat hypothesis**—that the earliest domesticates therefore should appear where their wild ancestors lived. That area, the "hilly flanks" of the Fertile Crescent in Southwest Asia, should be the focus of investigations. Braidwood and a large team of researchers excavated at the site of Jarmo in northern Iraq. The evidence from this early farming village supported his hypothesis that domestication did indeed begin in the natural habitat. Braidwood did not offer a specific reason as to why domestication occurred, other than to point out that technology and culture were ready by the end of the Pleistocene, that humans were familiar with the species that were to be domesticated. At that time, archaeologists and others considered farming to be a highly desirable and welcome invention, providing security and leisure time for prehistoric peoples. Once human societies had recognized the possibilities of domestication, they would have immediately started farming.

The late Binford, challenged those ideas in the 1960s and proposed the **population pressure hypothesis.** Binford argued that farming was backbreaking, time consuming, and labor intensive. Citing studies of living hunter-gatherers, he pointed out that they spent only a few hours a day obtaining food; the rest of their time was for visiting, talking, gambling, and otherwise enjoying life. Even in very marginal areas, such as the Kalahari Desert of South Africa, food collecting was a successful adaptation, and people rarely starved. Binford argued, therefore, that human groups would not have become farmers unless they had no other choice, that the origin of agriculture was not a fortuitous discovery but a last resort.

Binford made his point by positing an equilibrium between people and food, a balance that could be upset by either a decline in available food or an increase in the number of people. Since climatic and environmental changes appeared to be minimal in Southwest Asia, Binford thought it must have been increased population size that upset the balance. Population pressure was thus introduced as a causal agent for the origins of agriculture: More people required more food. The best solution to the problem was domestication, which provided a higher yield of food per acre of land. At the same time, however, agricultural intensification required more labor to extract the food.

Binford further suggested that the effects of population pressure would have been felt most strongly not in the core of the natural habitat zone, where dense stands of wild wheat and large herds of wild sheep and goats were available, but at the margins, where wild foods were less abundant. This theory, incorporating ideas about population pressure and the margins of the Fertile Crescent, has become known as the **edge hypothesis.**

Binford's concern with population was elaborated by Mark Cohen, of the State University of New York–Plattsburgh. Cohen argued for an inherent tendency for growth in human population, a pattern responsible for the initial spread of the human species out of Africa, the colonization of Asia and Europe, and eventually colonization of the Americas as well. After about 10,000 B.C., according to Cohen, all the habitable areas of the planet were occupied, and population continued to grow. At that time, there was an increase in the use of less desirable resources in many areas. Land snails, shellfish, birds, and many new plant species were added to the human diet around the end of the Pleistocene. Cohen argued that the only way for a very successful, but rapidly increasing, species to cope with declining resources was for them to begin to cultivate the land and domesticate its inhabitants, rather than simply to collect the wild produce. Domestication for Cohen was a solution to problems of overpopulation on a global scale.

Others, arguing that the transition to farming and food storage and surplus cannot be understood simply in terms of environment and population, have developed **social hypotheses** to explain the origins of agriculture. Barbara Bender, of the University of London, and Brian Hayden, of Simon Fraser University, for example, have suggested that the success of food production may lie more in the ability of certain individuals to accumulate a surplus of food and to transform that surplus into more valued items, such as rare stones and metals. From this perspective, agriculture was the means by which social inequality emerged and egalitarian societies became hierarchical.

There are several other useful theories about why human societies adopted agriculture at the end of the Pleistocene. Geographer Carl Sauer suggested that agriculture began in the hilly tropics of Southeast Asia, where sedentary groups with knowledge of the rich plant life of the forest might have domesticated plants for poisons and fibers. Botanist David Rindos has argued that domestication was a process of interaction between humans and plants, evolving together into a more beneficial symbiotic relationship.

In a fascinating book titled *Birth of the Gods and the Origins of Agriculture,* French archaeologist Jacques Cauvin argues that the important changes associated with the "Neolithic revolution" were more cultural than economic. That is, the transition to farming involved concepts and ideas as much as or more than cultivating and herding. Specifically, he suggested that domestication was preceded by the emergence of new religious practices and symbolic behavior (Figure 4.5). The transformation of hunter-gatherers that allowed them to view their habitat in a different way also promoted the more active exploitation of that environment.

Some problems with all these theories can be seen in a brief consideration of the evidence from Southwest Asia. The earliest agricultural villages, places such as Abu Hureyra and Jericho, were indeed located at the margins of the natural habitat. Attempts to artificially reproduce stands of wild wheat there may have resulted in domestication. However, human populations were not particularly large just before agriculture. Several sites show signs of abandonment in the levels beneath those layers that contain the first domesticated plants. The most recent climatic evidence indicates that there was, in fact, a period of slightly cooler and moister temperatures in Southwest Asia at the end of the Pleistocene, which may have greatly expanded the geographic range of wild wheats and barley, making them available to more human groups and fostering the process of domestication. In combination with the evidence for changes in CO_2 at that time, the possibility becomes intriguing. At the same time, however, these species were present in North Africa and parts of Southwest Asia during the Pleistocene and were not domesticated. Other factors were at work.

Some theories may seem reasonable in one of the primary centers of domestication but not in another. The

Figure 4.5 Two statues of plaster found with several others at the site of 'Ain Ghazal in Jordan. The eyes are cowrie shells set in bitumen. The taller statue is 90 cm (about 3 ft) high. Such figures likely reflect changing religious beliefs in the Neolithic.

Change in the demographic structure of a region which brings about the impingement of one group on the territory of another would also upset an established equilibrium system, and might serve to increase the population density of a region beyond the carrying capacity of the natural environment. Under these conditions, manipulation of the natural environment in order to increase its productivity would be highly advantageous.

—Lewis Binford (1968)

Technology and demography have been given too much importance in the explanation of agricultural origins; social structure too little. . . . Food production is a question of techniques; agriculture is a question of commitment. . . . Commitment is not primarily a question of technology but of changing social relations. This account has chosen to emphasize the social properties of gatherer-hunter systems; to show how alliance structures, and the individuals operating within these structures, make demands on the economic productivity of the system; how demography and technology are products of social structure rather than independent variables.

—Barbara Bender (1978)

social hypothesis The theory that domestication allowed certain individuals to accumulate food surplus and to transform those foods into more valued items, such as rare stones or metals, and even social alliances.

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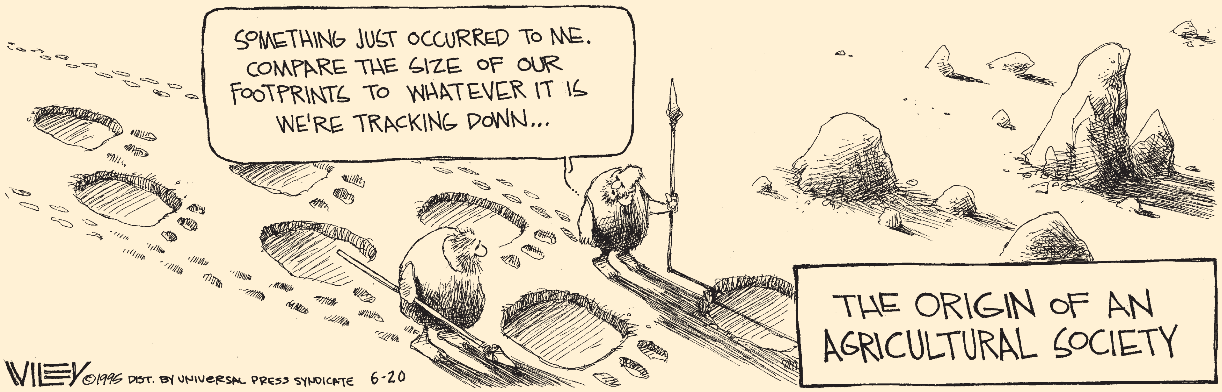


By approximately 11,000 or 12,000 years ago, hunters and gatherers, living on a limited range of preferred foods, had by natural population increase and concomitant territorial expansion fully occupied those portions of the globe which could support their lifestyle with reasonable ease. By that time, in fact, they had already found it necessary in many areas to broaden the range of wild resources used for food in order to feed growing populations. I suggest that after that time, with territorial expansion becoming increasingly difficult and unattractive as a means of adjusting to growing population, they were forced to eat more and more unpalatable foods, and in particular to concentrate on foods of low trophic level and high density.

—Mark Cohen (1977a)

Were human groups forced to become farmers, or was it a decision they made?

sequence of events in two areas is of particular interest here. In Southwest Asia, permanent settlements are known from 11,000 B.C., before the presence of direct evidence for domesticated plants or animals. Cultivated plants appeared about 9000 B.C.; animals were probably not herded until perhaps 8500 B.C. Pottery did not come into general use until around 7500 B.C. In Mesoamerica, however, the archaeological sequence reveals that domesticated plants first appeared around 5000 B.C., followed by pottery and then permanent villages several thousand years later. Domesticated animals were never important in this area. The differences in these two areas indicate that **sedentism** and cultivation are not totally dependent on each other. It is also clear that domesticated animals are not a part of the equation in all areas.

Because of the difficulties in trying to excavate phenomena such as social relations and population pressure, many of the current theories are hard to evaluate. Any adequate explanation of the agricultural transformation should deal not only with *how* it all began but also with *why* it happened rather suddenly. Population and climatic change certainly play a role in cultural evolution, but we cannot yet say precisely why plants and animals began to be domesticated shortly after the end of the Pleistocene.

The how and the why of the Neolithic transition remain among the more intriguing questions in human prehistory. Simply put, there is, as yet, no single accepted general theory for the origins of agriculture. No common pattern of development is apparent in the various areas where domestication first took place. At the same time, of course, the evidence we have is still scanty and limited. This chapter examines the origins of agriculture in more detail in the several primary centers where it first appeared: Southwest Asia, East Asia, Mexico, and South America, as well as Africa and eastern North America.

sedentism Living in permanent, year-round contexts, such as villages.

Site

’Ain Mallaha

Pre-Neolithic developments in Southwest Asia

Discussions about the origins of agriculture often focus on Southwest Asia for several reasons: (1) The earliest evidence for plant domestication from anywhere in the world is found here, (2) there is a reasonable amount of information available from excavations and other studies, and (3) Southwest Asia is often considered the “cradle of Western civilization.”

To better understand the origins of agriculture in this region, it is useful to look at human settlements that preceded domesticated plants and animals. The period just before agriculture, roughly 11,000–9000 B.C., is referred to as the Natufian. Most of the evidence for this period comes from the **Levant,** a mountainous region in the eastern Mediterranean. The period was characterized by an increase in the number of sites, and therefore people, coinciding with a period of more rainfall and abundant vegetation. The natural habitat was rich in wild plants and animals, resources that supported permanently settled communities before any evidence of domestication.

The Natufian site of ’Ain Mallaha (ein ma-LA-ha) lies beside a natural spring on a hillside overlooking the swamps of Lake Huleh in the upper Jordan Valley of Israel (see Figure 4.9, p. 192). ’Ain Mallaha was one of the earliest villages anywhere in the world, dating to 11,000–9000 B.C. The entire settlement covered an open area of about 2000 m^2 (½ acre, the size of a large hockey rink), with a population estimated at 200–300 people. Excavations between 1955 and 1973 by Jean Perrot, of the French Archaeological Mission in Jerusalem, uncovered three successive layers with the remains of permanent villages. Each layer contained a number of round houses, ranging from 3 to 8 m (10 to 25 ft) in diameter (Figure 4.6). House entrances faced downhill toward the water.

Figure 4.6 Excavations at ’Ain Mallaha exposing burials under the house floors.

The remarkable architecture consists of large substantial houses with stone foundations standing to a height of almost 1 m (3 ft). Wooden center posts may have supported conical roofs. Stone-lined square or oval hearths and bins were found in the center of the rooms or against the walls. **Mortars** and **querns**—grinding tools and surfaces for preparing grain—were occasionally set into the floor (Figure 4.7). Although the structures were built close together, the community had a centrally located open area with round storage pits.

The ground stone artifacts include plates, bowls, mortars, and pestles, indicating a need for containers at this time (Figure 4.8). Several objects are decorated with elaborate geometric designs. Carved limestone figurines of a human body, a human face, and a tortoise also were found. The flaked stone industry is rich, with more than 50,000 pieces. The bone tools include awls, skewers, needles, and fishhooks.

The animal bones found at the site come from wild pig, three kinds of deer, wild goat, wild cattle, wild horse, and

Levant A mountainous region paralleling the eastern shore of the Mediterranean, including parts of the countries of Turkey, Syria, Lebanon, and Israel.

mortar A bowl-shaped grinding tool, used with a wood or stone pestle for grinding various materials.

quern A stone grinding surface for preparing grains and other plant foods and for grinding other materials.

gazelle One of several species of small to medium swift and graceful antelopes native to Asia and Africa.

net-sinker A small weight attached to fishing nets.

Figure 4.7 Two circular houses at 'Ain Mallaha. These structures have rock wall foundations and often contain grinding equipment, storage bins, and pits. Burials were often placed in abandoned storage pits.

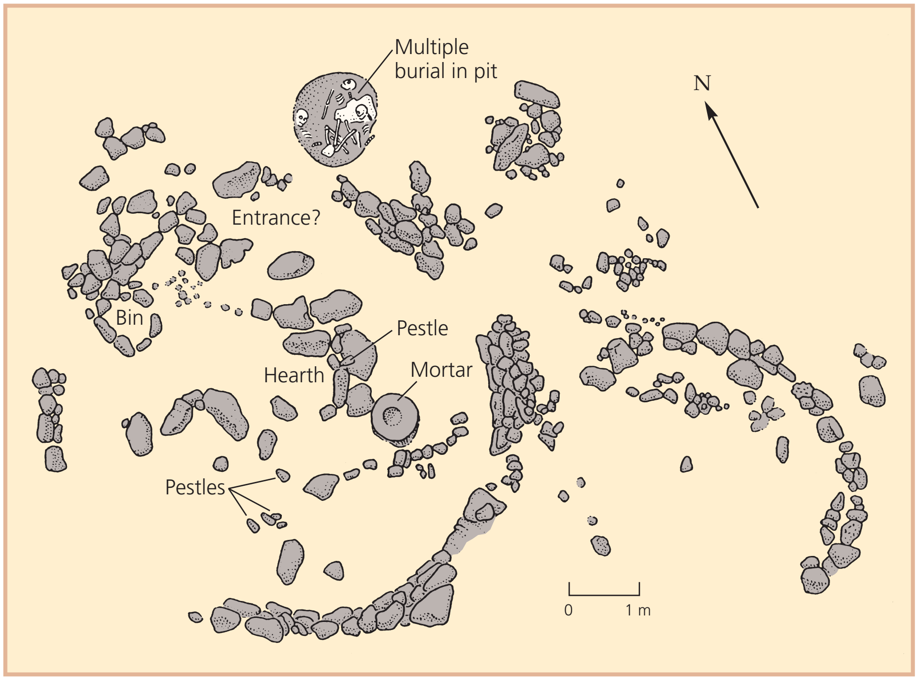
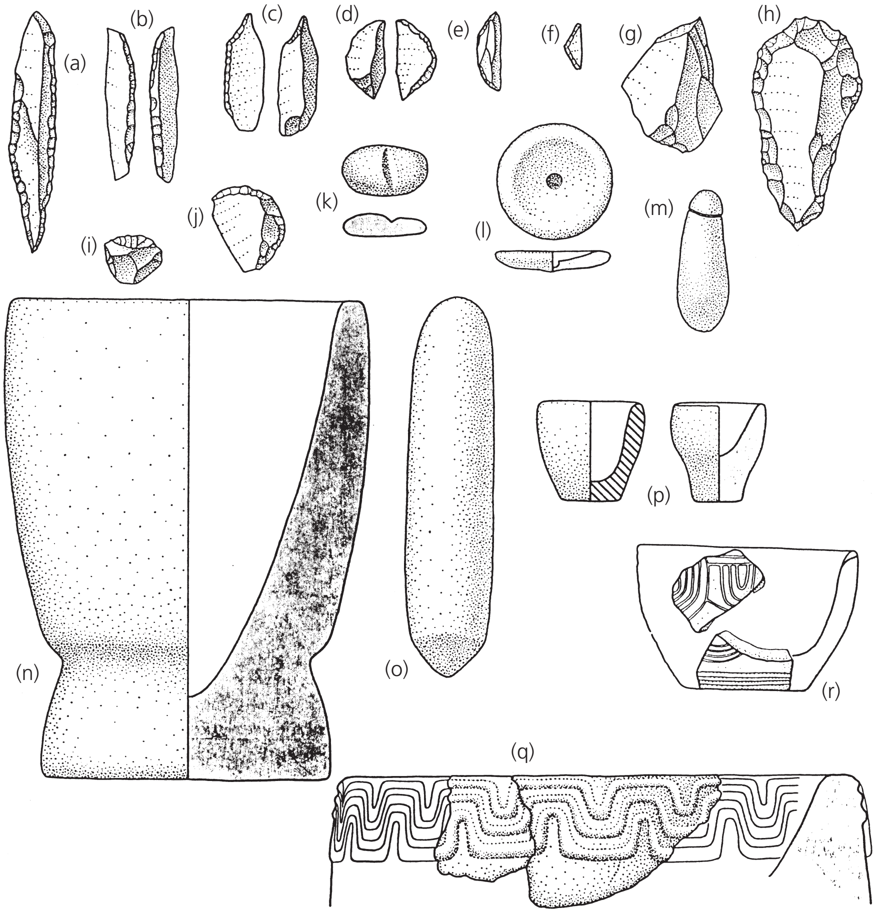


Figure 4.8 Various artifacts from 'Ain Mallaha. a–j: chipped stone tools; k–m, o: ground stone tools; n: a mortar; p–r: ground stone containers.



gazelle. **Gazelle** is the most common game animal at sites of this period. Bird, fish, tortoise, and shellfish remains also were found. The lake was clearly an important resource for these people, as indicated by the fish and shellfish remains, along with **net-sinkers.** The high incidence of decay in the teeth of individuals buried at 'Ain Mallaha suggests that carbohydrates from cereals or other plants were consumed in quantity. Wild barley and almonds were found charred in excavations, and it is clear from the abundance of **sickle** blades and other plant-processing equipment that wild cereals played an important role in the diet.

Two kinds of burials were found at 'Ain Mallaha: (1) individual interments, including child and infant burials beneath stone slabs under the house floors and (2) collective burials in pits, either intact or as secondary reburials after soft tissue had disappeared. Most of the 89 graves were found outside the houses. Abandoned storage pits were often reused for burial purposes. Many graves contained red ochre, and limestone slabs covered several of the simple graves. Four horns from gazelle were found in one grave, and in another, an old woman was buried with a puppy. Shells from the Mediterranean, and rare greenstone beads or pendants from Syria or Jordan were occasionally placed with the burials, but grave goods were generally rare.

sickle A tool for cutting the stalks of cereals, especially wheat. Prehistoric sickles were usually stone blades set in a wood or antler handle.

Concept

Wheat, Barley, Pigs, Goats, and Sheep

The appearance of the first farmers in Southwest Asia at the end of the Pleistocene

Southwest Asia is a fascinating region. Perhaps too well known today for the political problems that beset it, the area also was the home of the earliest domesticated plants and animals, as well as some of the world's first civilizations. Southwest Asia is an enormous triangle of land, approximately the size of the contiguous United States. The area is bounded on the west by Turkey and the Mediterranean, on the south by Saudi Arabia and the Indian Ocean, on the north by the Black and Caspian seas, and on the east by Afghanistan, at the edge of South Asia.

Southwest Asia is a series of contrasts. Some of the highest and lowest places in the world are found there, along with both rain forest and arid desert. Snow-capped mountains are visible from scorching-hot wastelands. Water is an important resource; arable land with fertile soil is scarce. The environment of this area can be visualized as a series of bands, driest in the south and moistest in the north. Arabia is largely sand and desert; Mesopotamia, the classic region between the Tigris and Euphrates rivers, is too dry for farming unless some form of irrigation is used. Mesopotamia has nothing to do with the origins of agriculture.

Most plants cannot survive in areas with less than 300 mm (1 ft) of rain each year. The line showing this 300-mm rainfall isobar stretches along an arc of mountains. The Zagros Mountains of western Iran, the Taurus Mountains of southern Turkey, and the highlands of the Levant along the eastern Mediterranean shore form a region where more rain falls and a variety of plants grow in abundance. The area is known as the **Fertile Crescent,** a name that reflects the variety of plants and animals that became the basic staples of many agricultural societies (Figure 4.9). This region is the natural habitat of many of the wild ancestors of the first species of plants and animals to be domesticated at the end of the Pleistocene—the wild wheats and barleys; the wild legumes; and the wild sheep, goats, pigs, and cattle that began to be exploited in large numbers at the time of the first agriculture.

Some 20,000 years ago, a series of developments began in Southwest Asia that set the stage for village farming. Climatic conditions during this period are not completely understood, but some general patterns are known. Around 18,000 B.C., global temperatures were about 6°C (10°F) cooler than they are today. A warming trend began about 14,000 B.C. and increased to a maximum temperature around 4000 B.C. Climate at the very beginning of the Neolithic, 11,000 years ago, was somewhat variable. Precipitation changes were not dramatic, but in an arid area, minor changes in rainfall can have a significant impact on vegetation. Rainfall was lowest during periods of maximum cooling around 18,000 B.C. As temperature and precipitation increased, the forest zone expanded in Southwest Asia, and the number of species was greater than it is today. After about 8000 B.C., however, continuing increases in temperature likely resulted in more evaporation, so that effective precipitation began to decline and the forest cover shrank.

Within this climatic and environmental context, a gradual change from a broad-spectrum diet, focusing on the many wild species of the region, to a diet that concentrated on a few domesticated plants and animals can be seen. In the late Paleolithic, after 20,000 years ago, groups of hunter-gatherers lived in small, seasonal camps throughout the area. Although they exploited a range of resources, they focused on

Fertile Crescent An upland zone in Southwest Asia that runs from the Levant to the Zagros Mountains.

Figure 4.9 Locations of Southwest Asian sites mentioned in the chapter. The shaded area marks the Fertile Crescent.

animals such as the gazelle. Plant foods are not common in the sites from this period.

In the period just preceding the Neolithic, there was more intense utilization of plant foods. Particularly noticeable is the range of equipment for processing plants: sickle blades and grinding stones, along with storage pits and roasting areas for preparing wild wheat. Sites were often located in areas of cultivable land, but such settlements depended on wild cereals, as evidenced in the remains of wild wheat and barley. These same locations were occupied during the Neolithic, too, probably because of the quantity or quality of arable land. Hunting continued, and more immature animals were killed, including gazelles and wild goats.

Between 9000 and 8000 B.C., changes in the size, shape, and structure of several cereals indicate that they had been domesticated. The archaeological data from Jericho and Abu Hureyra (A-boo hoo-RAY-rah), for example, mark this transition. The Neolithic, defined by the appearance of domesticated plants, began at that time. The earliest known domesticated cereal, rye, has been dated to 10,000 B.C. at the site of Abu Hureyra in Syria. In fact, eight or nine "founder" plants were domesticated during the period 9000–7000 B.C., including three cereals—emmer wheat, einkorn wheat, and barley—and four or five pulses—lentils, peas, bitter vetch, chickpeas, and maybe fava beans. (*Pulses* are the edible seeds of leguminous plants, such as peas and beans.) Flax also was domesticated during this period and probably was used for oil and fiber; linen is made from the fibers of the flax plant. The first evidence for domestication of these founder plants comes from the same areas in which their wild ancestral stock is common. For example, genetic analysis has identified the original homeland of einkorn's (a primitive wheat) wild ancestor in southeastern Turkey. The archaeological evidence can tell us when and where, but not why and how. The transition to the Neolithic was marked not by abrupt changes but by increasing emphasis on patterns that appeared during the Natufian.

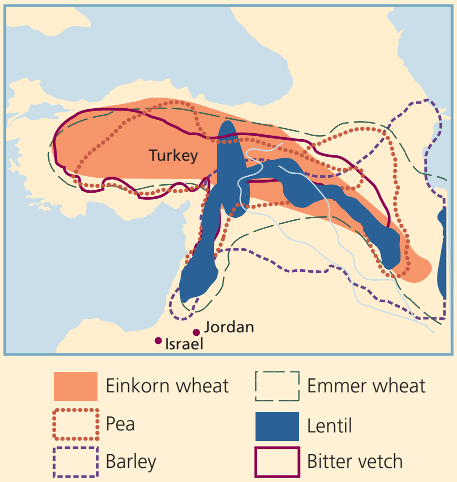
The number and the size of prehistoric communities expanded greatly during the early Neolithic, as populations apparently concentrated in settlements. The first towns appeared. Major changes in human diet, and probably in the organization of society as well, began to take place. Some of the first domesticated animals are from Hallam Çemi, a very early Neolithic site in eastern Turkey, dating to around 9000 B.C. Excavated by Michael Rosenberg, of the University of Delaware, the site was a village of small, round houses and one larger, nondomestic building with a centrally located feasting area. The food remains at the site include wild sheep and goats, along with various nuts and wild legumes. Wild cereals were not an important part of the diet. About 10% of the animal bones came from pigs. Evidence for the domestication of these pigs is seen in the sex and age of death of the animals. Most of the bones were from young female animals. It appears that the inhabitants were selecting suckling pigs to eat, supporting the argument that these animals were controlled, or herded. In addition, the teeth of the pigs at Hallam Çemi are smaller than those of their wild relatives.

By 7500 B.C., domesticated sheep and goats had made their first appearance in the Levant, and a number of changes in architecture had occurred. Pottery was invented in Southwest Asia around 7500 B.C. to serve as easily produced, waterproof containers. These dishes were probably used for holding liquids, for cooking a gruel made from wheat and barley (bread was a somewhat later invention), and for storing materials. The complete Neolithic package of domesticates, village architecture, and pottery was thus in place shortly before 7000 B.C., as the Neolithic revolution began to spread to Europe and Africa.

Was the adoption of agriculture almost instantaneous in human prehistory?

Concept

New Evidence



A series of recent discoveries from the Natufian and earliest Neolithic in the Near East have greatly revised our understanding of this period and raised significant new questions about the transition to agriculture. To understand the chronology and relationships of these new finds, it is important to review the sequence of events around the origins of agriculture in the Near East.

There is a pre-Neolithic period, known as the *Natufian*, from ca. 12,500 to 9500 B.C., which witnessed the beginnings of sedentism as hunter-gatherers first moved into small villages and subsisted on various animals, especially gazelle, and collected the abundant wild wheats, barleys, and other species that grew in the hills where they lived. Site variability and long-distance exchange of exotic materials increased, cemeteries appeared, and material culture reflects more symbolic or ritual behavior. A shaman's grave at Hilazon Tachtit in Israel documents the presence of religious specialists in the Natufian. The beginnings of large-scale architecture are seen at the site of Tell Qaramel in northern Syria where five round, stone towers, perhaps for grain storage, were constructed between 10,000 and 9650 B.C., each more than 6 m in diameter, with walls 1.5 m thick.

The first 3000 years or so of the Neolithic in the Near East are without fired clay pottery; thus, the period is known as the *Pre-Pottery Neolithic*, or PPN. The PPN is divided into two periods, an earlier PPNA, 9500 to 8500 BC, and later PPNB, 8500-6400 B.C. Everything changed with the transition to the Neolithic. During the PPNA, some communities grew in size and became nodes in economic exchange networks. Communal architecture appears in the form of large-scale stone structures at cult sites. The cultivation of wild cereals likely began during this period, but there is no reliable evidence for morphological changes in the plants due to domestication. A similar picture pertains to animals. Several wild species were likely managed, or even herded, during this period, but there is no evidence of domestic animals other than the dog.

During PPNB, growth and change continued. Major sites were now two to three times larger, and new ritual and burial practices are witnessed in dramatic artifacts and cemeteries. The burial ground of Kafar HaHoresh in Israel documents enormous new variation in the treatment of the dead and indications of emerging social inequality at this time. The site contains plastered floors and low walls but there is no convincing evidence of domestic occupation. The food remains are from feasting and the entire complex appears to be a place where the dead have their own settlement according to the excavator, Nigel Goring-Morris.

The earliest clearly domesticated plants (wheats, barley, lentils, chickpeas, flax, and others) are found in archaeological sites from this period. The first definitively domesticated animals are also known from PPNB sites. Sheep were probably the first domestic species followed shortly by goats. Cattle and pigs took a slower path to domestication and are not observably present until ca. 7500 B.C. in the later PPNB. These animals were likely managed, perhaps herded, for many years, however, before the anatomical changes that result from domestication became apparent.

Evidence of religious practices, massive public architecture, corporate activities, and the long-distance expansion of the Neolithic are some of the new data. At a site called *Wadi Faynan 16* in southern Jordan, roughly contemporary with Abu Hureyra, several large buildings have been uncovered, one a huge 22 × 19 m (70 × 60 ft), the size of a short wide basketball court, which may have been used as a community center or public building used for various activities (Figure 4.10). The people living here between 9600 and 8000 B.C. cultivated wild plants such as wild barley, pistachio, and fig trees, and hunted or herded wild goats, cattle, and gazelle.

Site

Göbekli Tepe, Turkey

Excavations at Göbekli Tepe in southern Turkey have revealed a series of remarkable shrines or centers associated with large stone architecture and remarkable art from the same time period.

Major changes are taking place in the region before the domestication of plants and animals. Farming and herding are only one aspect of the Neolithic revolution. It's not all about food and survival but rather about coping with changes in the size of population, the use of the environment, and relations with neighbors. Human society is undergoing a major transformation in economy, social relations, politics, and religion. This is a time of change and variety. Human groups in the region are auditioning new and different ways of organizing and improving their lives. New sources of food are likely necessary to support such developments, and domestication provides that enhancement. This is the beginning of a whole new way of life.

Göbekli Tepe (guh-Beck-lee Teh-peh) is a hilltop sanctuary erected on the highest point of an elongated mountain ridge near the Syrian border in southeastern Turkey. The site, currently undergoing excavation by German and Turkish archaeologists, was constructed ca. 11,000 years ago. Together with Neval Çori, it has revolutionized understanding of the Eurasian Neolithic.

Göbekli Tepe is the oldest human-made stone structure yet discovered and has been called the first temple. The site is located on a hilltop and contains at least 20 large, round structures. Each building has a diameter of 10–30 m (35–100 ft) and contains massive T-shaped limestone pillars. Two pillars were placed in the center of each circular as roof supports. Each pillar is almost 3 m (10 ft) tall and weighs up to 7 tons. Up to eight pillars were evenly positioned around the outer wall. The limestone slabs for these pillars were taken from nearby bedrock, and their quarrying, carving, and erection must have required an enormous amount of time and labor. The spaces between the pillars were lined with unworked stone, and stone benches were constructed between each set of pillars along the wall. The structures were deliberately buried after 8000 B.C., filled with sand that had to have come from a distant source.

Most of the pillars were decorated with carved relief of animals and of abstract pictograms. The pictograms may represent commonly understood sacred symbols known from Neolithic cave paintings elsewhere. The carefully carved figurative reliefs depict lions, bulls, boars, foxes, gazelles, donkeys, snakes and other reptiles, insects, spiders, and birds, particularly vultures and water fowl. Few humanlike figures have surfaced at Göbekli Tepe, but there is a bas-relief of a naked woman posed frontally in a crouched position and a decapitated corpse surrounded by vultures. Some of the T-shaped pillars depict human arms, which may represent stylized beings.

Göbekli Tepe is not a settlement or habitation site. There are no domestic houses or normal trash. The remains of food that have been found appear to be the waste from feasts. Moreover, the hilltop location is atypical for residential areas in the Early Neolithic. Göbekli Tepe appears to be a very special place—a center of activity, of ceremony, of common cause, and of change and transformation.

Site

Abu Hureyra

Hunter-gatherers and early farmers in northern Syria

www.mhhe.com/priceip7e

For a Web-based activity on Abu Hureyra, see the Internet exercises on your online learning center.

In 1974, the site of Abu Hureyra in northern Syria was submerged beneath the waters behind a new dam on the Euphrates River. Fortunately, in 1972 and 1973, before the water level in the reservoir rose and flooded the area, rescue excavations uncovered parts of this site, one of the largest early Postglacial communities in Southwest Asia. Excavations were conducted by A. M. T. Moore, of the University of Rochester, and his colleagues.

The **tell**—an accumulated mound of occupation debris—covered 11.5 ha (about 30 acres), with deposits from the Natufian and the early Neolithic up to 8 m (25 ft) high in some places. One million cubic meters (1.3 million cubic yards) of earth were removed during the excavations. The primary component of the tell was the decayed mud walls of the generations of houses that were built there, along with the artifacts and food remains left behind by the inhabitants. The layers indicated an uninterrupted occupation of the mound from approximately 10,500 B.C. to 6000 B.C., through the Natufian and the Neolithic periods in Southwest Asia. Abu Hureyra thus contains one of the best available records of the changes that took place as farming and herding first began (Figure 4.10).

The mound lies at the edge of the Euphrates River, with the river floodplain on one side and dry, level steppe on the other. The area today receives approximately 200 mm (8 in) of rainfall per year; cultivation is difficult without irrigation. During the Natufian occupation of the site, however, the climate was warmer and wetter. An open forest of oak and pistachio trees grew on the steppes nearby, with dense stands of wild grasses among the trees. These grasses, probably no more than 1–2 km (about 1 mi) distant, included wild wheats, rye, and various pulses (lentils and legumes).

The Natufian settlement was located on the northern side of the tell, adjacent to the Euphrates River. The settlement may originally have been placed here along the migration route of the gazelle herds. These animals were killed in great numbers during the spring migration. The settlement consisted of small, circular pit dwellings dug into the original ground surface. These structures had a framework of wooden posts supporting the wall and roof. Almost 1 m (3 ft) of debris accumulated during this first phase of occupation, between approximately 10,500 and 9000 B.C. The population of the site is estimated to have been between 200 and 300 at that time.

Clearly, the bulk of their food came from the wild plants, some of which were staples. The plant remains at the site indicate a year-round occupation in both the Mesolithic and the Neolithic periods. The excavators used sophisticated techniques at Abu Hureyra to recover more than 500 liters (140 gallons) of plant remains from the site. From the Natufian levels, there was evidence for wild lentils, hackberry fruit, caper berries, and nuts from the turpentine tree, related to pistachios. Most intriguing, however, were the remains of wild wheat, barley, and rye.

Around 10,000 B.C., the climate became cooler and drier and the nearby stands of wild cereals and other plants retreated more than 100 km (62.5 mi) to the higher elevations of the Fertile Crescent. Fruits and seeds of drought-sensitive plants from an oak–pistachio open woodland disappeared at Abu Hureyra. Then wild lentils and other legumes declined. Local vegetation around the site appears to have changed from moist, woodland steppe to dry treeless steppe. Wild wheats continued to be consumed at the site even though their habitat in the area had

tell A mound composed of mud bricks and refuse, accumulated as a result of human activity.

been eliminated. The excavators believe that the Natufian inhabitants practiced plant husbandry of wild cereals before changes in the glume and rachis brought about by domestication were evident.

Significantly, the earliest known domesticated plant, rye, appeared at that time. Grinding stones and milling equipment also point to the importance of cereals in the diet during that period. Experiments by Gordon Hillman, of the University of London, were designed to estimate the amount of time needed for wild cereals to change to the domesticated variety through the process of cultivating and harvesting the wild seeds and replanting them. This study indicated that the domestication of the plants could have taken place within a period of less than 300 years, perhaps no more than 25 years.

Shortly after the initial domestication of rye and the probable cultivation of wild wheats, lentils and legumes reappeared in the deposits and increased. By 8500 B.C., the range of domesticated plants included rye, lentils and large-seeded legumes, and domesticated wheats. Clearly, plant domestication began in the Natufian period at Abu Hureyra, perhaps in response to the disappearance of the wild stands of these important foods.

Two tons of animal bone, antler, and shell also were removed during the excavations. Shells from river mussels, fish bones, and bone fishhooks indicate that the inhabitants obtained food from the Euphrates River, as well as from the surrounding hills. Gazelle bones dominate the lower layers at Abu Hureyra and constitute 80% of all animal bones from the Mesolithic and early Neolithic periods. By the beginning of the Neolithic, however, sheep and goats had been domesticated and were being herded. After 7500 B.C., the number of gazelle bones dropped sharply, and sheep and goats became much more important in the diet (Figure 4.11). During the subsequent phases of the Neolithic at Abu Hureyra, domesticated cattle and pigs were added to the larder.

Abu Hureyra grew quickly to become the largest community of its day,

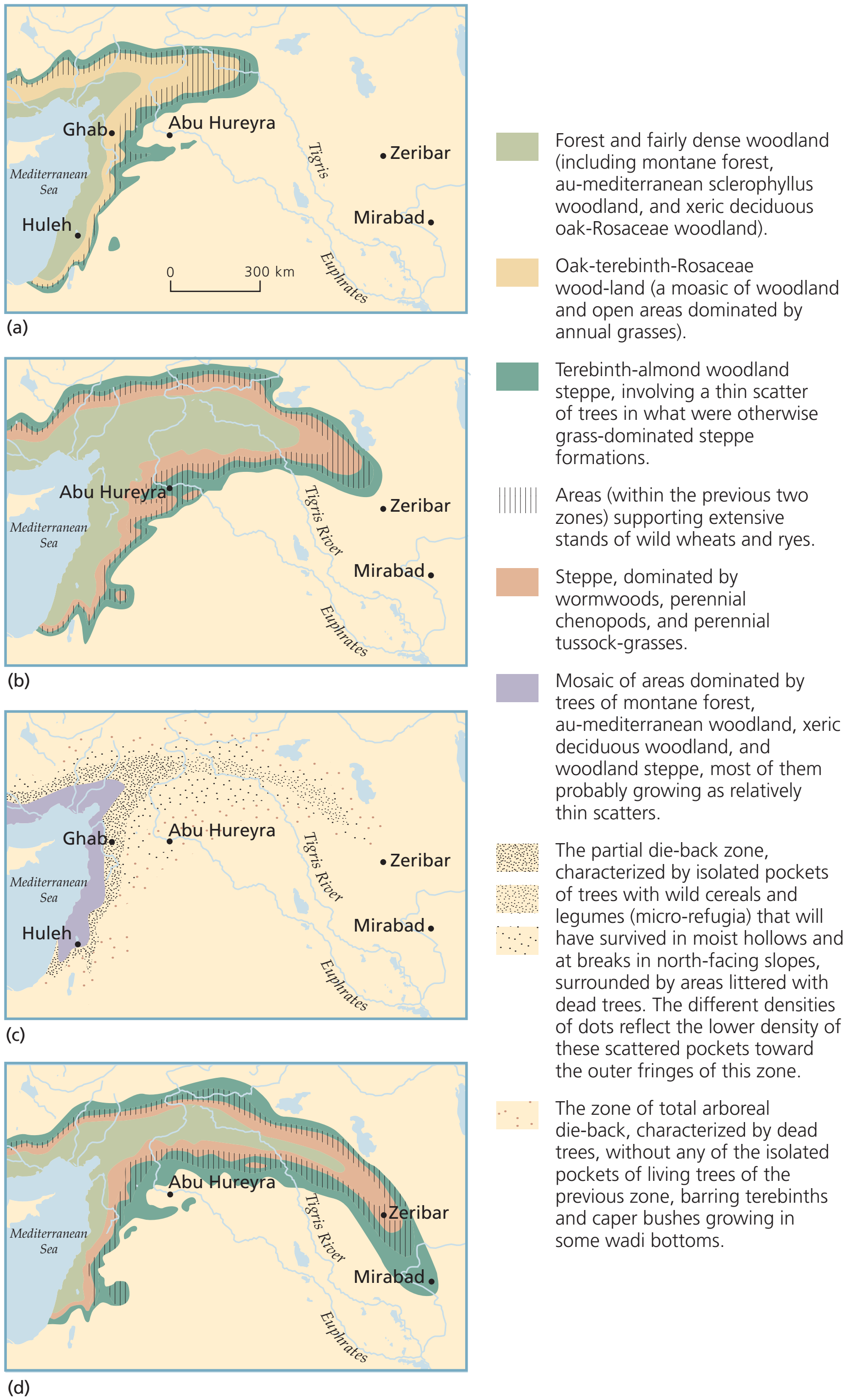


Figure 4.10 The landscape of Southwest Asia at the end of the Pleistocene. These four maps show a sequence of changing vegetation for four periods of the late Pleistocene and early Holocene. Note particularly the changes at Abu Hureyra, where the vegetation goes from (a) grass steppe, to (b) lightly forested with wild wheats and ryes during an episode of cooler and wetter conditions around 12,000 years ago, and then reverts to (c, d) dry grass steppe. These changes may have important implications for the domestication of plants. The four named locations (Huleh, Ghab, Zeribar, and Mirabad) are sites where environmental data for this reconstruction were obtained.

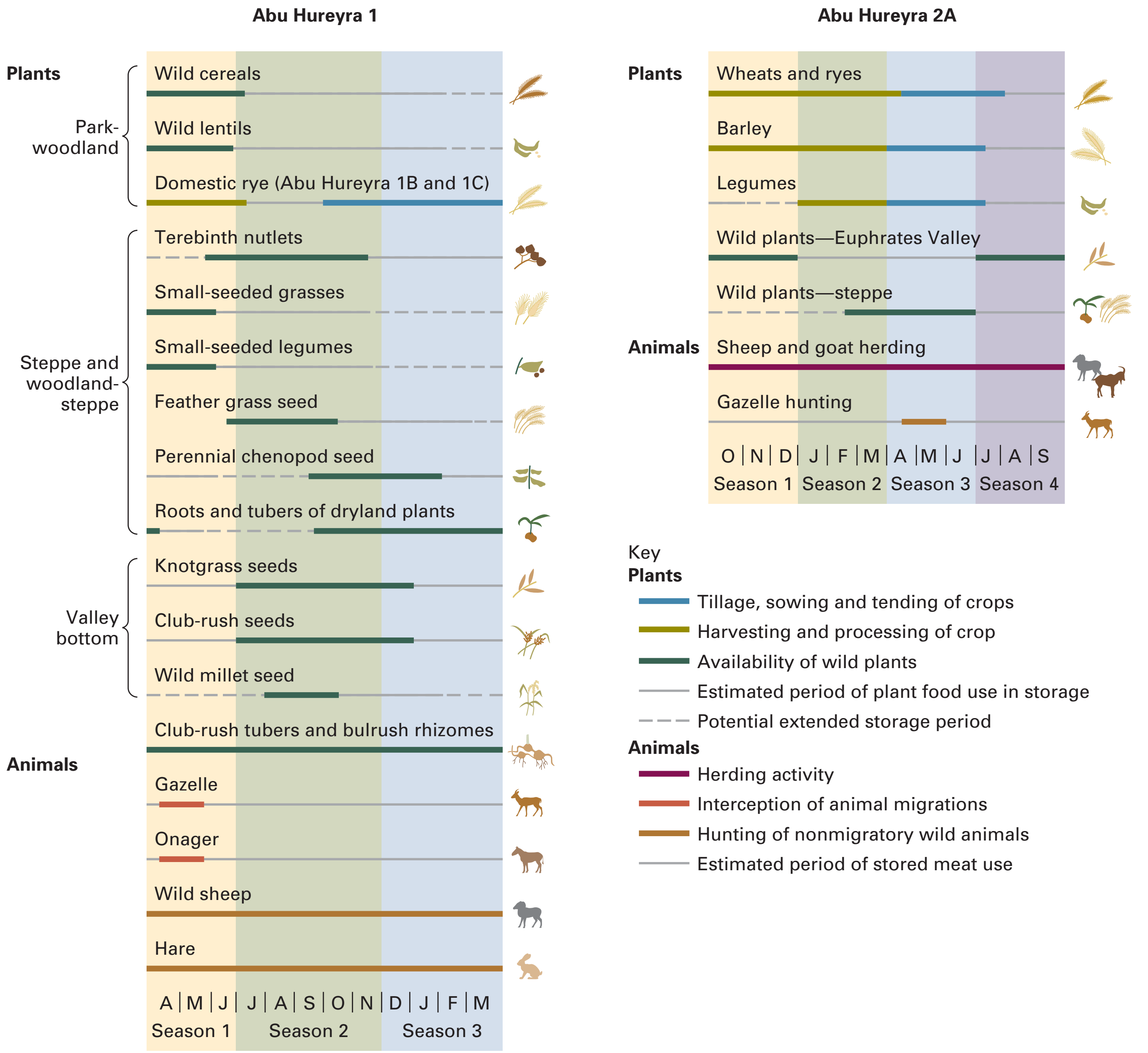


Figure 4.11 The seasonal availability and use of plants and animals at Abu Hureyra during the pre-Neolithic and the Neolithic. During Abu Hureyra 1, ca. 12,000 years ago, there were no domesticated plants or animals, and a wide variety of species contributed to the diet during all seasons of the year. In the Early Neolithic (Abu Hureyra 2A), ca. 10,500 years ago, domesticated plants and herded sheep and goats played an important role in subsistence. Wild plants remained important, and the seasonal hunting of wild gazelle continued to supplement the food provided by herds of domestic sheep and goats. In later periods, the wild species declined in importance.

with 2000–3000 inhabitants in an area of about 11.5 ha (30 acres). Houses were rectangular, with mud-brick walls that were plastered and whitewashed (Figure 4.12). Plaster also was used to make heavy rectangular containers. Clay was used for beads and figurines, but pottery was not present in this level of the site. The importance of this community is documented by the quantity and variety of exotic materials that arrived there through trade and exchange: cowrie shells from the Mediterranean or Red Sea, turquoise from the Sinai Peninsula, and obsidian, malachite, agate, jadeite, and serpentine

TABLE 4.1 Changes in Environment, Economy, and Settlement Types at Abu Hureyra

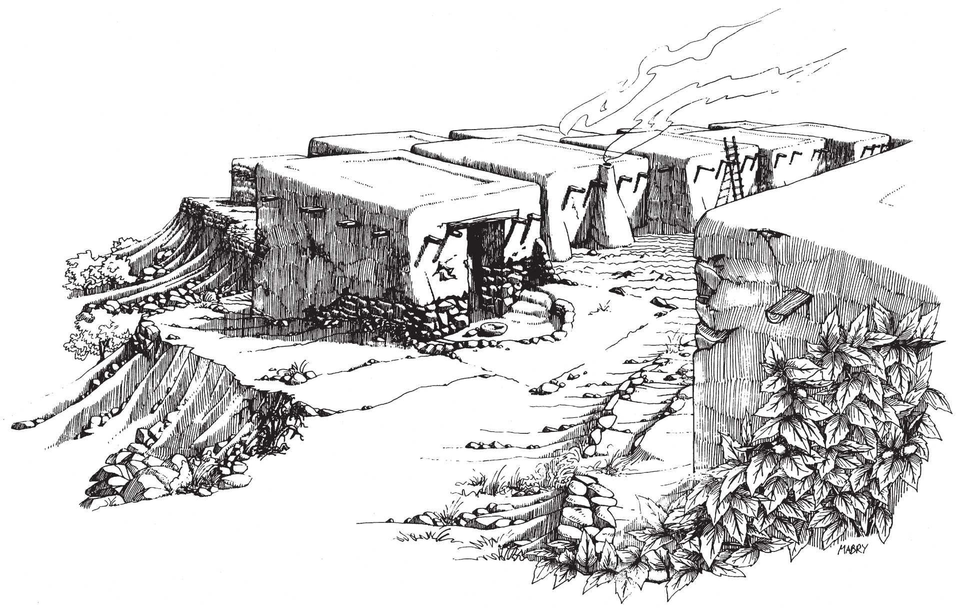
Years B.C.	*Period*	*Environment*	*Economy*	*Settlement*	*Other Sites*
6000 6300			Mixed farming cereals, legumes, sheep, goats, cattle, pigs	7 ha clustered mud-brick houses	
7500	Neolithic		Cereal and legume cultivation, sheep and goat husbandry	> 16 ha clustered mud-brick houses	Çatalhöyük
8500		Decline in gazelle	Cereal and legume cultivation, plant gathering, gazelle hunting, domesticated sheep and goats	8 ha clustered mud-brick houses	Asikli
9000	Intermediate		Cereal and legume cultivation, plant gathering, gazelle hunting	Huts	Jericho, 'Ain Ghazal
9500		Cooler and drier; retreat of forest; dry, open steppe	Wild einkorn wheat out of habitat. Domestication of rye, plant gathering, gazelle hunting	Timber and reed huts	'Ain Mallaha, Jericho, Hallam Çemi
10,000	Natufian	Younger Dryas			
10,500		Open, rolling steppe and grassland with nearby park woodland of oak and pistachio, wild cereals and legumes	Gathering wild plants, hunting gazelle	Pit dwellings	

from the mountains of Turkey. These rare stones were made into large, thin "butterfly" beads, often found in burials. Table 4.1 summarizes the various changes at Abu Hureyra from 10,500 B.C. to 6000 B.C.

By 6000 B.C., Abu Hureyra had been abandoned. A similar pattern is seen at other Neolithic sites in the Levant at that time. It seems likely that increasingly arid conditions reduced agricultural productivity and made herding a more viable enterprise. It may be at that time that nomadic herding became the dominant mode of life, much like that of the pastoralists who still roam parts of Southwest Asia with their herds of sheep and goats.

The evidence from Abu Hureyra indicates that cultivation began in ancient Southwest Asia in a small, sedentary village of hunter-gatherers around 10,000 years ago during a period of environmental change. The disappearance of the habitat for wild species coincided with the early domestication of rye and eventual cultivation of wheat, lentils, and legumes. But the transition from dependence on wild, gathered foods and hunted animals to domesticated varieties took 2500 years. Not all families were initially involved in farming, and the number increased over time. The first sheep and goat husbandry appeared around 8500 B.C., followed by that of cattle and pigs. The general sequence involves settlement in villages, followed by plant cultivation and subsequent animal herding. This pattern of a gradual transition from food collection to production is typical in most parts of the world.

Figure 4.12 An artist's reconstruction of houses from the early Neolithic in Southwest Asia. These houses had rock wall foundations with walls and roofs of timber and reeds covered with mud. In areas lacking rock, such as Abu Hureyra, the foundations were made of mud brick.



Concept

Archaeobotany

The study of prehistoric plant remains

Preserved plants in archaeological sites are rare unless the remains have been carbonized, generally through burning or oxidation. Such burned plant materials can sometimes be obtained through a process called **flotation.** Excavated sediments are poured into a container of water (Figure 4.13), and the lighter, carbonized plant remains float to the top (Figures 4.14 and 4.15). In addition to the kinds of plants used, the major issues in **archaeobotany** (the study of the prehistoric use of plants) including the contribution of plants to the diet, medicinal uses, and domestication—concern the origins of agriculture.

The archaeobotany of Southwest Asia is of particular interest because of the evidence for early domestication in this area (Table 4.2). Two varieties of wheat (emmer and einkorn), two-row barley, rye, oats, lentils, peas, chickpeas, and other plants were originally cultivated in Southwest Asia. The wild forms of these species are still common today, as they were in the past. Wild emmer wheat has a restricted distribution in the southern Levant. Wild einkorn wheat is relatively widespread in the northern and eastern sections of this region. Wild barley grows throughout the Fertile Crescent. All these wild grasses grow well in disturbed ground around human settlements. Einkorn was probably domesticated in southern Turkey, and emmer may have been first cultivated in the Jordan Valley.

Agronomist Jack Harlan, of the University of Illinois, participating in an archaeological project in southern Turkey in the 1960s, experimented to find out just how much food was available from wild wheat. Dense stands of wild einkorn wheat grow on the slopes of the mountains in that area. This wild wheat is more nutritious than the hard winter red wheats grown in the United States today. Harvesting when the wheat was ripe, Harlan collected more than 1 kg (2 lb) of cereal grain per hour with his hands and even more with a sickle. He estimated that a family of four could harvest enough grain in 3 weeks to provide food for an entire year. If this wild wheat was so abundant and nutritious, why was wheat domesticated? The answer probably lies in the fact that wild wheats do not grow everywhere in Southwest Asia, so some communities may have transplanted the wild form into new environments.

Although artifactual evidence for the use of plants (e.g., sickles, milling stones, storage pits, and roasting areas) exists in a number of areas, domesticated varieties cannot be distinguished from wild types without actual plant parts or grain impressions in clay bricks or pottery. Archaeobotanist Gordon Hillman, of the University of London, studied wild einkorn and observed that simple harvesting had no major impact on the genetic structure of the wheat. Only when specifically selective harvesting and other cultivation techniques were applied could changes in the morphology of the seeds be noted. Such a pattern suggests that certain characteristics of domesticated wheat and barley, which show definite morphological differences from the wild ancestral forms, must have been intentionally selected. Results from Hillman's experimental studies suggest that the change from wild to domesticated wheat may have occurred in a brief period, perhaps 200 years or less.

According to Hans Helbaek, an archaeobotanist who worked on the issue of plant domestication, the most

flotation A technique for the recovery of plant remains from archaeological sites. Sediments or pit contents are poured into water or heavy liquid; the lighter, carbonized plant remains float to the top for recovery, while the heavier sediments and other materials fall to the bottom.

archaeobotany (or **paleoethnobotany)** The study of plant remains from archaeological sites.

important characteristic of a domesticated species is the loss of natural seeding ability. The plant comes to depend on human intervention to reproduce. This change also permits humans to select the characteristics of those plants to be sown and reproduced, leading to preferred characteristics. Another major change in domesticated plants is their human removal from their natural habitat and adaptation to new environmental zones. The distribution of the wild ancestor of einkorn wheat is shown in Figure 4.16, p. 202. New conditions of growth would obviously select for different characteristics among the members of the plant species. Certain varieties do very well when moved to a new setting.

Wheat is an annual grass with large seed grains that concentrate carbohydrates inside a hard shell. Grain at the top of the grass stalk is connected by the **rachis,** or stem. Each seed is covered by a husk, or **glume** (Figure 4.16). The major features that distinguish wild and domesticated wheat are found in the rachis and the glume. In wild wheat, each rachis of a seed cluster is brittle, to allow natural seed dispersal by a mechanism known as **shattering.** The glumes covering the seeds are tough, to protect the grain until the next growing season. These

Figure 4.13 A Dausman flotation machine in use. Water in the tank is used to separate lighter plant remains from soil and other sediments. The archaeologist uses a hose to spray some of the recovered materials.

Figure 4.14 In this photo, the charred seeds and charcoal separated by flotation are being captured in a cheesecloth sieve.

TABLE 4.2 Common Food Plants in Early Neolithic Southwest Asia

Einkorn wheat, wild and domesticated forms
Emmer wheat, wild and domesticated forms
Rye, wild and domesticated forms
Barley, wild and domesticated forms
Chickpeas, domesticated form
Field peas, domesticated form
Lentils, wild and domesticated forms
Common vetch
Bitter vetch
Horse bean
Grape, wild and domesticated forms
Caper
Prosopis (mesquite)
Fig
Hackberry
Turpentine tree
Wild pistachio

rachis The stem that holds seeds to the stalk in wheat and other plants.

glume The tough seed cover of many cereal kernels.

shattering A natural mechanism of seed dispersal.

Figure 4.15 An assortment of seeds and other plant remains from an archaeological site.

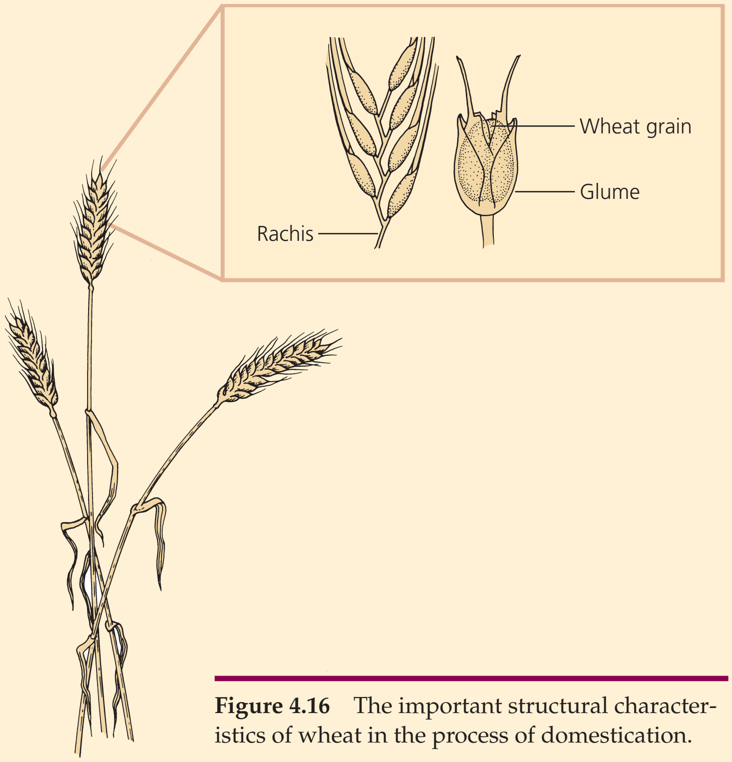


Figure 4.16 The important structural characteristics of wheat in the process of domestication.

two features, however, are counterproductive to effective harvesting and consumption by humans. Because of the brittleness of the rachis, many seeds fall to the ground before and during harvesting, making collection difficult. The tough glume must be roasted so that threshing can remove it.

Domesticated wheats exhibit a reverse of those characteristics: a tough rachis and a brittle glume. These changes enable the seeds to stay on the plant so that they can be harvested in quantity and the glume can be removed by threshing without roasting. With these changes, the wheat is dependent on humans for seeding and therefore, by definition, is domesticated.

One of the most exciting recent developments in paleoethnobotany has been the use of the scanning electron microscope. This instrument, with very high magnifications, has enabled researchers to identify minute scraps of charred plant remains that would otherwise be missed at archaeological sites. Electron microscopy also is being used to recognize edible plants such as roots and tubers, which were previously invisible in archaeological deposits.

Site

Jericho

One of the oldest continuously inhabited places in the world

The walls of Jericho fell to Joshua and the Israelites sometime around 1300 B.C. The place had been occupied, however, for thousands of years before their arrival. In fact, the walls of Jericho tumbled down almost twenty times in the course of its history, from either earthquake or siege. Jericho is a tell, a massive mound of 2.4 ha (6 acres) composed of mud bricks and trash, accumulated to a height of 22 m (70 ft) during its long period of occupation (Figure 4.17). The layers of the tell built up at a rate of roughly 26 cm (almost 1 ft) every century.

Jericho (or Tel es 'Sultan, as it is known in Arabic) is one of the oldest continuously inhabited places on Earth. Since at least 10,000 B.C., Elisha's Fountain, the spring at Jericho, has witnessed virtually continuous human settlement. The freshwater spring floods the area beneath it and supports an oasis of luxuriant vegetation in the midst of the hot and arid Jordan Valley, lying

And it came to pass at the seventh time, when the priests blew with the trumpets, Joshua said unto the people, Shout; for the Lord hath given you the city . . . and the people shouted with a great shout. . . . The wall fell down flat . . . and they utterly destroyed all that was in the city . . . with the edge of the sword . . . and they burnt the city with fire, and all that was therein.

—Joshua 6:16

Figure 4.17 The ancient tell of Jericho, located near a major spring at the northern end of the Jordan Valley in Southwest Asia. The tell is a mound of the accumulation of 10,000 years of human occupation.

Figure 4.18 A plastered and painted skull from Jericho. The plaster remodeling of the features of human heads is found at several early Neolithic sites in Southwest Asia and may reflect an increasing reverence for ancestors.

275 m (900 ft) below sea level. The mound itself was abandoned sometime before A.D. 1, as settlement spread to the surrounding low area.

The biblical connection has made Jericho a place of major interest and importance for archaeologists in Southwest Asia. Today, the tell resembles the surface of the moon. Craters and trenches mark the excavations of many archaeological projects that have explored these accumulated layers since 1873. British archaeologist Dame Kathleen Kenyon exposed a number of levels beneath biblical Jericho containing remains from the Bronze Age, the Neolithic, and the Mesolithic.

Evidence from the early Neolithic (8500–7600 B.C.) at the bottom of the tell is of interest here. Because the mound is so deep, these lowest levels could be reached only by narrow trenches. The residential structures and artifacts exposed in Kenyon's excavations were similar to those from other Southwest Asian sites from this period. Closely packed round houses contained interior hearths and grinding equipment.

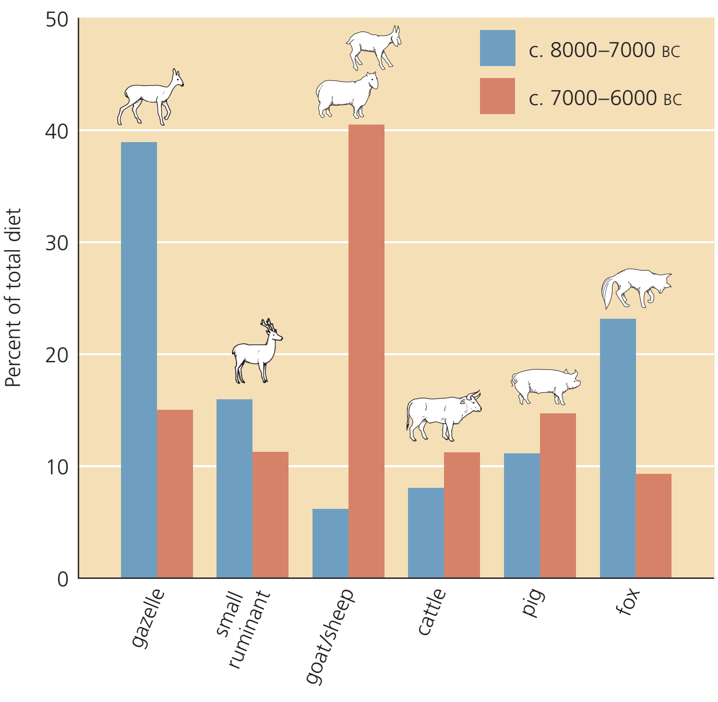


Figure 4.19 Changes in the consumption of animals between 8000 and 6000 B.C. at Jericho. Notice especially the shift from wild gazelle to domesticated sheep and goat.

Headless burials were uncovered in the houses at Jericho; skulls were found separated from the skeletons (Figure 4.18). Kenyon estimated that the early Neolithic community at Jericho had a population of 600 people.

Gazelle bones were abundant in the lowest layers at Jericho. This important game animal probably was exploited by large drives that captured a number of animals simultaneously. Aurochs, wild boars, and foxes also were eaten. Many animals present in the surrounding hills were not hunted, including wild goats, oryx, hartebeest, and wild camels. In later periods, gazelles declined in importance, replaced by sheep and goats (Figure 4.19). The presence of equipment for processing grain (sickles and grinding stones) and storage suggests that cereals were important in the lowest levels. In the slightly higher early Neolithic layers, these cereals were domesticated and probably cultivated in the fertile soil of the Jericho oasis.

The inhabitants of early Neolithic Jericho traded various items over long distances. Materials such as salt, tar, and sulfur came from the area around the Dead Sea. Turquoise was brought from the Sinai Peninsula, cowrie shells from the Red Sea, obsidian from Turkey, and greenstone from Jordan. The reasons for such exchange probably lie in the importance of contacts with neighboring communities and in the accumulation of status items for some portion of the community.

Long-distance exchange and expansion appear to have been hallmarks of the early Neolithic, probably reflecting the success of early agriculture and associated economic systems. Evidence for the spread of domesticates, architecture, and other components of the prepottery Neolithic seen at Jericho and elsewhere in the Levant appears on the island of Cyprus shortly before 8000 B.C. The colonists brought domestic cattle and wild deer with them to the island, traveling at least 80 km (50 mi) across open waters of the eastern Mediterranean.

Most remarkable of Kenyon's discoveries from this period was a large stone tower (Figure 4.20), wall, and ditch, which appeared to encircle the site. These structures were built at the beginning of the eighth millennium B.C. The wall itself is 1.8 m (6 ft) thick at the base, narrowing to 1.1 m (3.5 ft) at the top, and stands 3.6 m (12 ft) high today, buried under the accumulated deposits of Jericho. The rubble-filled stone tower also was completely buried, at a height of 8.2 m (27 ft). The tower was built inside the wall and has a diameter of 9 m (30 ft) at the base. An interior staircase with 22 steps leads from the bottom to the top. In front of the wall is a deep ditch, which added greatly to the height of the total structure. The ditch is 2 m (6.5 ft) deep and 8.5 m (28 ft) wide, cut into the bedrock under the site. Such a construction project would have been a major undertaking by a small community in the eighth millennium B.C. The tower and wall were abandoned by 7300 B.C. and rapidly disappeared under the accumulating layers of the tell.

The significance of these structures has been the focus of discussion and debate. Kenyon suggested that the tell was completely encircled by the wall and ditch, with towers placed at regular intervals. However, only one tower was exposed in the excavations, and the wall was not found on the southern, lower, side of the mound. Numerous unanswered questions have arisen regarding the nature of the enemy, the materials to be protected, the location of the tower *inside* the wall, the reason for its abandonment, and the size of the population. Comparable fortifications are not seen at other early Neolithic sites in Southwest Asia, and a massive defensive structure seems out of place.

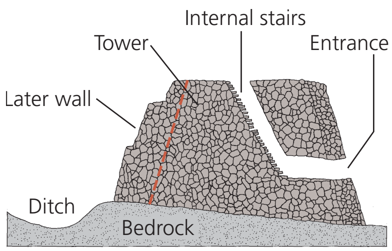
Ofer Bar-Yosef, of Harvard University, examined the evidence for fortifications at Jericho and found it lacking. Bar-Yosef interprets the wall and ditch as a defense against nature rather than against humans (Figure 4.21). In this arid region, flash floods are common, and each rainfall moves a great deal of sand and silt from higher ground to lower areas. Such erosion and deposition would have been aggravated by land clearing and the removal of trees and shrubs by the inhabitants at the site. Sediments may have accumulated on the upslope side of the tell of Jericho and at other early Neolithic sites.

To counteract this rapid accumulation of sediments at the edge of their community, the residents of Jericho, Bar-Yosef argues, built the wall and dug the ditch to hold back the sediments. The rock-cut ditch at Jericho filled with water-transported sediments shortly after it was dug. The wall was thickest in the middle portion, where the sediment accumulation was heaviest. The large tower inside the wall is another matter. Bar-Yosef has noted the excellent preservation of the tower to its total height in the tell. He argues that there was likely a mud-brick structure on top of the stone tower, a building for communal storage or religious activities that made the tower a very special place in the settlement. The tower thus may represent an early shrine or temple for the community, a concept that was later transformed into the monumental ziggurats of the Mesopotamian states.

Around 7500 B.C., major changes in the architecture, artifacts, and animals occurred at Jericho. Houses became square, constructed with what have been described as "hog-backed" bricks—large, cigar-shaped mud bricks with a herringbone pattern of thumbprints on the top. Domesticated animals became important at that time; sheep and goats constituted almost half of the animal bones, along with a few wild cattle and pigs, gradually replacing the gazelle. Pigs and cattle were possibly in the process of change, because their bones were slightly smaller than those of the wild forms but not as small as those of the domesticated forms.

Figure 4.20 The tell at Jericho. Excavations have exposed a circular stone tower.

Figure 4.21 The tower, wall, and rock-cut ditch at Jericho.



Concept

Archaeozoology

The study of animal remains

Why were plants and animals domesticated about the same time?

www.mhhe.com/priceip7e

For a Web-based activity on archaeozoology, see the Internet exercises on your online learning center.

The companion of paleoethnobotany, **archaeozoology** focuses on the hard body parts of animals that survive—bone, teeth, antler, ivory, scales, and shell. Studying these materials, archaeozoologists attempt to answer questions about whether animals were hunted or scavenged, how animals were butchered, how much meat contributed to the diet, and the process of domestication.

Archaeozoologists are trained to identify the genus or species of an animal from small fragments of bone, as well as the age and sex of the animals, how the animal was butchered and the bone was broken, and how many individual animals are represented in the bone assemblage. Fracture patterns in long bones may reveal intentional breakage for removing marrow. An analysis of cutmarks on bone may provide information on butchering techniques.

The study of animal domestication is also an important part of archaeozoology. Four major criteria are used to look for domesticates: geographic evidence, abundance, morphological changes, and herd demographics. Geographic evidence involves discovery of animal species outside their natural habitat and presumes human involvement. However, environments changed dramatically in the past, as did the geographic distribution of animal species. Thus geography is a difficult criterion to use. Increases in the abundance of a species in the layers at a site are often taken to indicate domestication, but again this evidence is not particularly reliable. Numbers of animals may increase for a variety of reasons, including environmental change and increased hunting.

Herded animals show certain morphological changes in size and body parts that provide direct evidence for domestication. Domesticated species are generally smaller than their wild ancestors. The shape of the horns often changes in the domestic form, and the microscopic structure of bone under-

Figure 4.22 The distribution of wild einkorn wheat (*Triticum boeoticum*) and of wild goats (*Capra aegagrus*) in Southwest Asia and Egypt is indicated by the shaded areas.

archaeozoology The study of animal remains from archaeological sites.

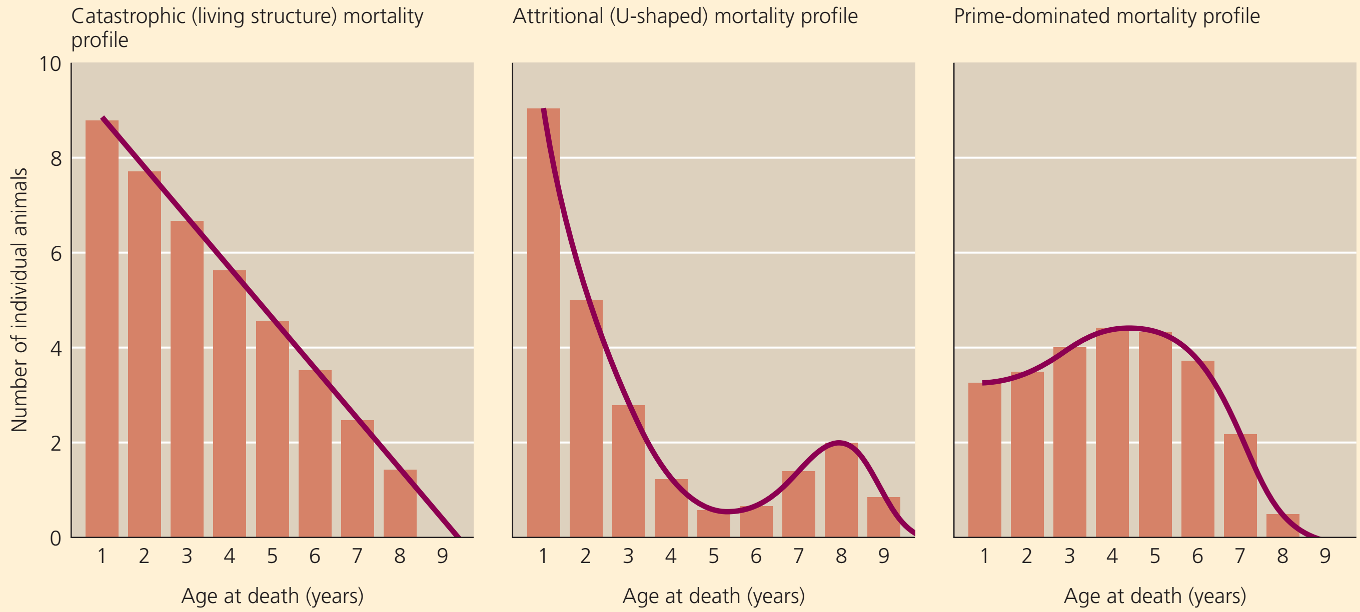


Figure 4.23 Three hypothetical age profiles for animal populations used by archaeozoologists to look for indications of human control and domestication. A catastrophic pattern would reflect that all the animals in the herd died at the same time. An attritional pattern is the normal life-and-death cycle for an animal herd in which very young and very old animals are more likely to die. The prime-dominated mortality curve is the pattern that appears when humans eat a predominance of young males, a common herding practice. Females and a few older males are kept for the reproduction of the herd.

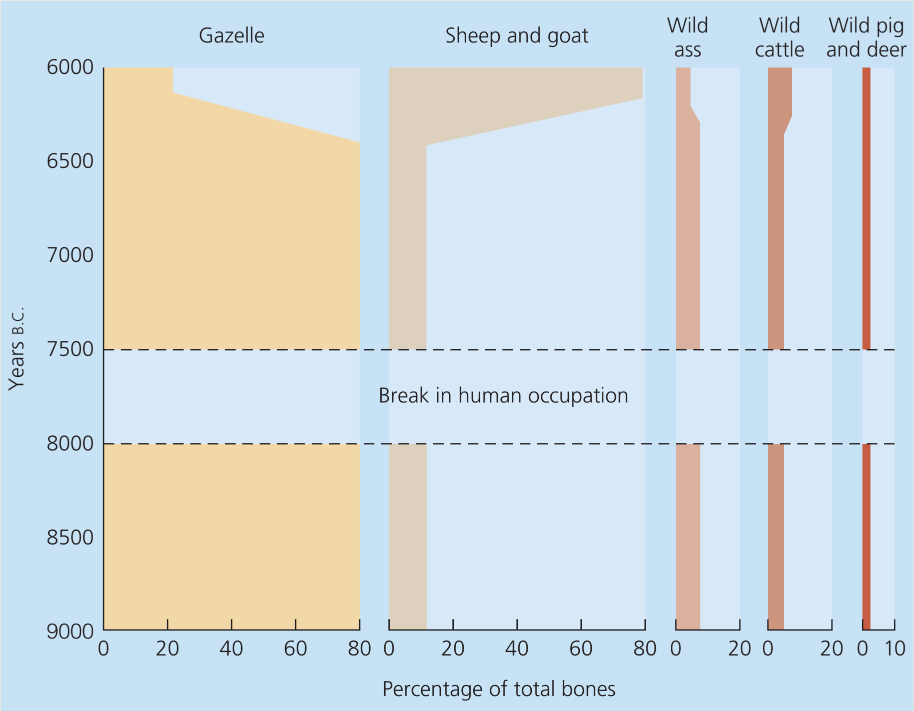
goes modification in domestic animals. Other traits may be selected by herders to increase the yield of milk, wool, or meat. However, because such biological change takes many generations and requires physical separation between wild and domestic animals, the earliest stages of domestication may not have been recorded in the bones and horns that remain (Table 4.3).

Brian Hesse, of the University of Alabama–Birmingham, and Melinda Zeder, of the Smithsonian Institution, have used herd demographics to document early animal domestication in Southwest Asia (Figure 4.23). They estimated the age and the sex of animals that had been killed at prefarming sites in the Zagros Mountains of western Iran and used this information to study whether hunting or herding was practiced. The basic principle relies on the fact that herded animals are slaughtered when the herder decides; for most species, this means that the average age of death for domesticated animals is younger than for wild animals. Hunted animals are killed in chance encounters, and the proportion of adults is higher in such situations.

The ages of animals are most frequently determined by an assessment of tooth eruption and wear, along with information about changes in bone. All the known sites in the Zagros Mountains before 10,000 years ago show similar slaughter patterns for sheep, goats, and red deer; bone assemblages contain primarily adult animals, indicating that all were hunted in the wild. However, a number of sites contain assemblages after 10,000 years ago that are dominated by the bones of younger animals. In each case, the younger groups are sheep or goats, proportionally higher than in a normal wild herd.

At Abu Hureyra, a study of the bones of wild gazelles and domesticated goats and sheep has provided new information on the process of animal domestication (Figure 4.24). Around 11,000 years ago, the site was occupied by prefarming hunter-gatherers who hunted gazelles in large numbers. The gazelle bones and teeth include the remains of many young animals. The teeth, in particular, indicate that both newborns and yearlings were common in the faunal assemblage, along with adults of all ages. This pattern of newborns, yearlings, and adults, and the absence of animals of ages in between, indicates that most of the animals were killed during the same time each year, shortly after the calving period in late April and early May. These hunters were taking entire herds of gazelles as the animals migrated north

Figure 4.24 Changes in animal species at Abu Hureyra, Syria, between 9000 and 6000 B.C. The width of the bars indicates the relative abundance of the species. The most pronounced change is the decrease in gazelles and the increase in sheep and goats between 6500 and 6000 B.C. There was an absence of human occupation at this site between 8000 and 7500 B.C.



during early summer. They probably used a technique that would drive an entire herd into an enclosure or series of pitfalls, where all the animals could be killed. These hunters were so effective that the number of gazelles in the area dropped dramatically, to less than 20% of all the animals at the site, by 7500 B.C.

Goat and sheep domestication may have been a solution to the problem of decreasing numbers of gazelles. Sheep and goats were slaughtered throughout the year, in contrast to the seasonal hunting of gazelles at Abu Hureyra. Goat and sheep bones constituted about 10% of the faunal assemblages until 7500 B.C., after which they very rapidly became the predominant component, at almost 80%. This period was about 1500 years after plant domestication had been initiated at the site; wheats and barley at that point provided a significant portion of the diet. It also was some 3500 years after the initial occupation of the site, documenting the sequential stages of sedentism, plant cultivation, and animal domestication typical of Southwest Asia. Such information suggests a very complex picture of animal and plant domestication in Southwest Asia at the end of the Pleistocene.

TABLE 4.3 Important Animal Species in Neolithic Southwest Asia

Gazelle
Goat, wild and domesticated forms
Sheep, wild and domesticated forms
Roe deer
Fallow deer
Cattle, wild and domesticated forms
Pig, wild and domesticated forms
Onager
Bear
Jackal
Hare
Wildcat

Site

Çatalhöyük

The first city, central Turkey

Large communities began to appear shortly after the domestication of plants and animals in Southwest Asia. By 8000 B.C., 'Ain Ghazal and Jericho had populations in the hundreds, sizably larger than those in pre-agricultural settlements. And by 7250 B.C. the first "city" had appeared at the site of Çatalhöyük (sha-TAL-who-YUK) in central Turkey (Figure 4.25).

The tell of Çatalhöyük is huge, 600 m (1900 ft) long, 350 m (1000 feet) wide, and almost 20 m (65 ft) high (Figure 4.26). This massive mound of houses, garbage, and burials accumulated within a period of little more than 1000 years and was abandoned around 6000 B.C. At least twice as large as early Neolithic Jericho, covering 13 ha (32 acres), Çatalhöyük was a large settlement of perhaps as many as 2000 families—on the order of 10,000 people.

The original excavations at this ancient settlement were conducted by James Mellaart, of the University of London, during the 1960s. Several

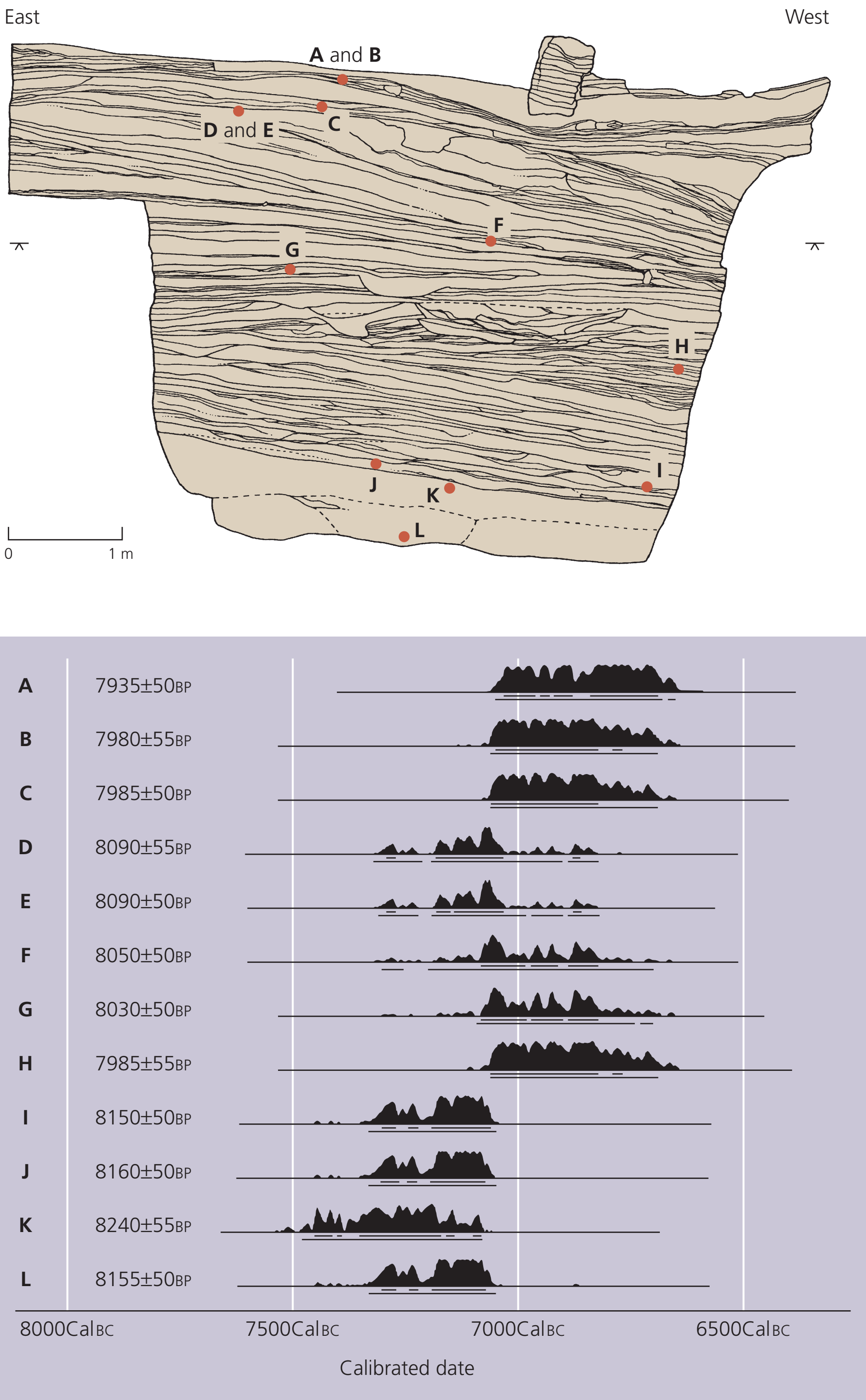


Figure 4.25 Stratigraphy (top) and radiocarbon dates (bottom) from a deep-sounding at Çatalhöyük. The section drawing shows 4 m of the complex stratigraphy and the location of the radiocarbon samples. The graph of AMS radiocarbon dates shows the probability curves for the age of each sample. The center of each line of hills is a good estimate for the age of the sample. The dates indicate that the oldest occupation at Çatalhöyük was around 7250 B.C.

Figure 4.26 An aerial view of the Neolithic mound of Çatalhöyük. Paths on top of the mound lead from the excavation headquarters to major excavation areas.

What role does sedentism play in the transition to agriculture?

seasons of fieldwork at the site exposed numerous walls and floors of rooms and houses. Houses were built closely together in one, two, or three stories around small courtyards (Figure 4.27). The houses were very similar, with a rectangular floor plan of approximately 25 sq m (30 sq yd), about the size of a large living room today. The houses were divided into a living area and a smaller storage area. Furniture—benches, sleeping platforms, ovens, cupboards, and storage bins—was built into the house. The houses had no doors, and access was likely through their flat roofs.

A number of burials also were found in the houses at Çatalhöyük. These burials of men, women, and children were under the floors and sleeping platforms (Figure 4.28). The bodies appear to have been exposed for some time before burial. Grave goods with the burials included jewelry such as necklaces, armlets, wristlets, and anklets of stone or shell, copper and lead beads, and weapons. A few burials contained rare objects such as stone vessels, ceremonial daggers, obsidian mirrors, polished maceheads, cosmetics, and metal beads and rings.

One of the remarkable things from the first excavations at Çatalhöyük was the large number of the structures, perhaps 20%, that appeared to have been shrines (Figure 4.29). The walls of these shrines are elaborately decorated, sculpted, and painted with a variety of remarkable figures and designs, including vultures, bulls, wild cats, and humans. Some of the paintings show women giving birth to bulls; others depict hunting scenes or vultures with headless humans in their talons. One of the paintings portrays an erupting volcano with a large settlement at its base. In addition, a number of sculptures and figurines have been excavated (Figure 4.30).

New excavations in the 1990s exposed more of the site and investigated in more detail the purpose and function of the various structures. These excavations, directed by Ian Hodder of Stanford University, suggest that households used their space for both domestic and ritual purposes and that the shrines may simply have been more elaborate households.

Two or three generations of a family were often buried under the house floor. The first burials in the houses were infants and young children; later

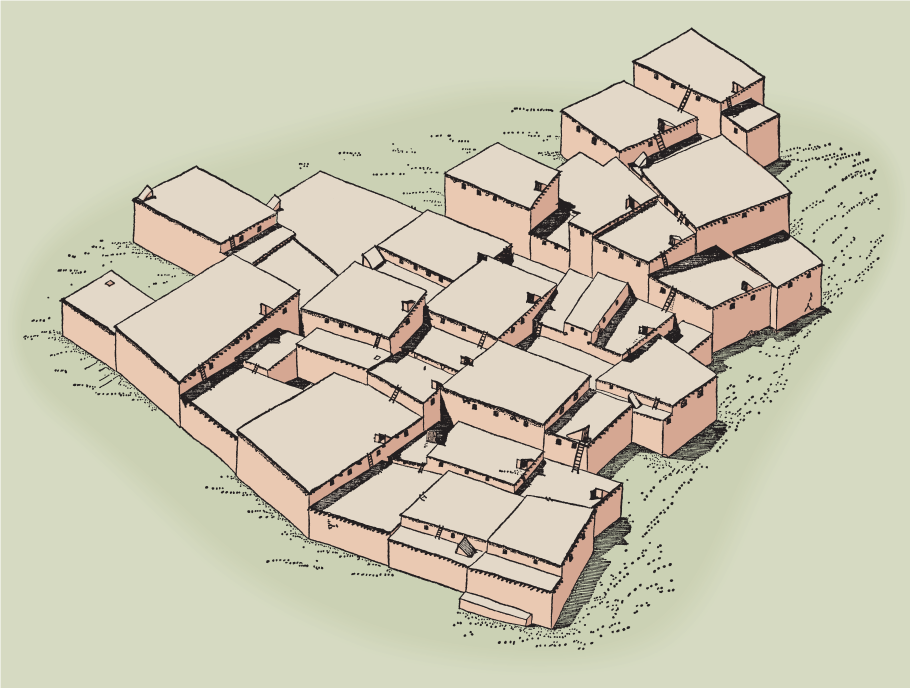


Figure 4.27 An artist's reconstruction of complex architecture at Çatalhöyük, showing the closely packed, multistory buildings of timber and mud brick. This view reconstructs only a small part of the settlement.

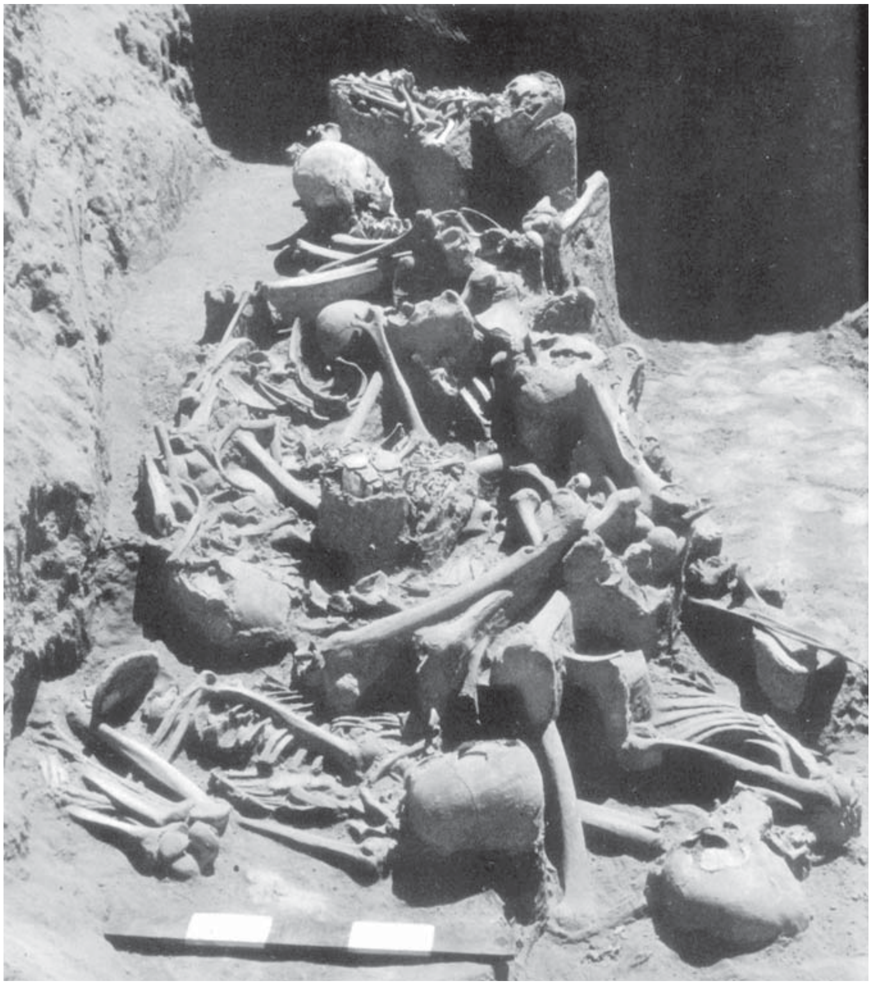


Figure 4.28 A group of burials beneath a platform in one of the houses.

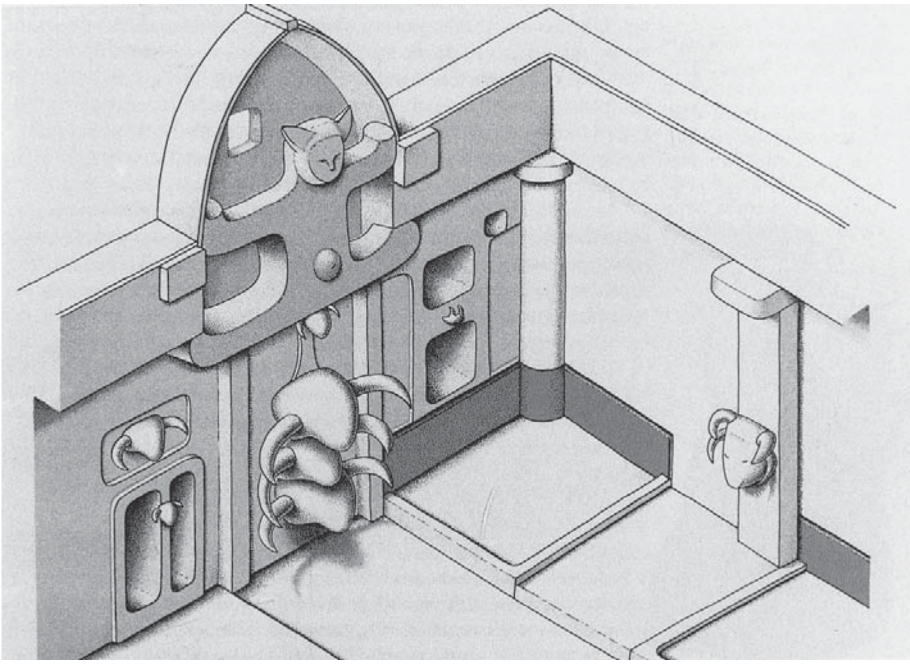


Figure 4.29 An artist's reconstruction of one of the shrine rooms at Çatalhöyük. A catlike goddess gives birth to a ram above three bulls' heads.

Agriculture quickly changes the way human society looks archaeologically. What are some of those changes?

burials were older adults. This pattern suggests a family life cycle represented in the burials. Houses may have been destroyed after the family had died. The paintings and sculptures on the walls of the houses are likely associated with the burials and may have been added to commemorate the deceased. David Lewis-Williams, of the University of Witwatersrand, South Africa, has described the artwork as a symbolic membrane connecting the living to the spirit world.

Analysis of the animal bones and plant remains has provided much new information about the site. The inhabitants depended heavily on wild flora and fauna. Important plants in the diet included domesticated wheat and barley, wild tubers and grasses, lentils, and fruits and nuts such as acorns, pistachios, crab apples, and hackberries. Cattle were an important part of subsistence at the site, but it is not yet certain whether they were domesticated. Domesticated sheep and other species also were killed and eaten. There are no indications of differences in status, represented by wealth or surplus, among the houses. Çatalhöyük appears in many ways to have been a huge village of farmers rather than a complex and varied city.

Çatalhöyük was clearly a prosperous center, however, probably because of its control of the obsidian trade. **Obsidian** is produced by volcanoes; molten silica sometimes flows out of a volcanic core and hardens into this stone, which was highly sought by prehistoric makers of stone tools. Obsidian, like glass and flint, fractures easily and regularly, creating very sharp edges.

In the past, obsidian was often traded or exchanged over long distances—hundreds of kilometers or more. It is available from only a few places, limited by proximity to volcanic mountains and the chance formation of a silica flow. Most sources for obsidian are known because they are rare and the material is unusual. It also is possible to fingerprint different flows of obsidian through minor differences in the chemical composition of the material, which is specific to each source, allowing pieces found elsewhere to be traced to the places where they originated.

obsidian Translucent, gray-to-black or green, glasslike rock from molten sand.

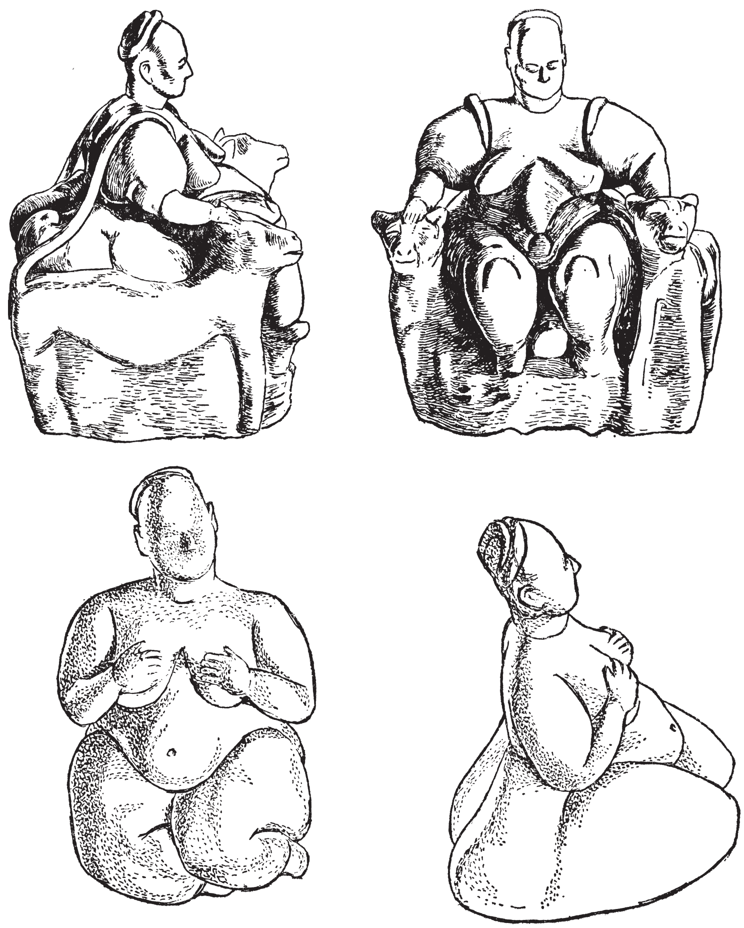


Figure 4.30 Two clay female figurines from the excavations at Çatal-höyük (front and side view of each).

The sources of obsidian in Southwest Asia, the Aegean area, North America, Mexico, and elsewhere have been studied using such methods. Most of the obsidian in Southwest Asia comes from sources either in the mountains of Turkey or in northern Iran, both outside the Fertile Crescent. The sources of obsidian found at early Neolithic sites provide information on both the direction and the intensity of trade. Sites in the Levant generally obtained obsidian from Anatolia; sites in the Zagros used Armenian material. The percentage of obsidian in the total flaked stone assemblage at these sites indicates that sites closest to the sources used a great deal of obsidian, whereas those farthest away obtained only a small amount. At Jericho, for example, 700 km (400 mi) from the Turkish sources, only about 1% of the stone tools were made from obsidian.

Çatalhöyük is located almost 200 km (125 mi) from the major obsidian source in Turkey. Nevertheless, most of the chipped stone tools at the site were made of obsidian. In addition to finished tools, many unfinished obsidian artifacts were found, along with large amounts of raw material. It appears that obsidian was moved in huge quantities to Çatalhöyük. From here the obsidian was traded over a wide area of Southwest Asia. In return, the inhabitants of Çatalhöyük received copper, shell, and other exotic materials. Clearly, the importance of obsidian as a desired object in trade was an essential factor in the rise of Çatalhöyük. Trade and exchange of various materials accelerated greatly during the Neolithic.

Remarkable as Catalhöyük is, there is another site, 100 km (62.5 mi) distant, that is even more extraordinary. Although this mound, called Asikli, is 1000 years older than Çatalhöyük, it is almost as tall. This site contains little evidence for domesticated plants or animals. At Asikli, a population of several hundred individuals lived in a large group of mud-brick houses surrounded by a stone wall. There are at least ten levels of occupation in the mound, and the same arrangement of houses and cobbled streets is seen in each level. There is also a cluster of larger, public buildings at the site that might have been a temple complex.

Site

Mehrgarh

New evidence for the early Neolithic in South Asia

Figure 4.31 Multiroom, rectangular structures uncovered during excavations at Mehrgarh.

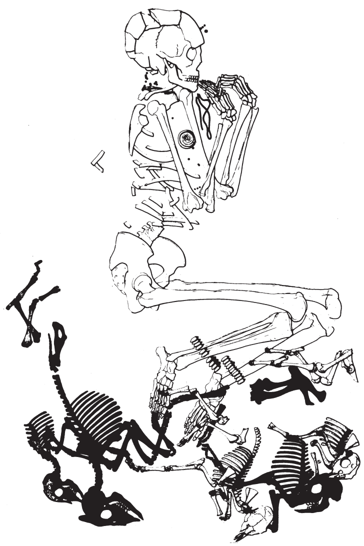


Figure 4.32 A grave from an early level at Mehrgarh containing an adult male buried with several body ornaments and five young goats.

The Indus civilization, one of the world's early urban societies, emerged in South Asia, the subcontinent now composed of India, Pakistan, Bangladesh, and Nepal. The largest communities of this ancient civilization—the cities of Harappa, Mohenjo-daro, and others—were centered on the Indus River system in Pakistan. Until the 1970s, however, little was known about the antecedents of this ancient society. In the late 1960s, it was suggested that plant and animal domestication did not reach the subcontinent of South Asia until after 4000 B.C. The prevailing opinion was that migrants from the west, who made metals and wheel-thrown pottery, brought an agricultural way of life to South Asia just a few centuries before the rise of the Indus civilization.

More recent archaeological findings, however, have revealed an older, more indigenous picture of agricultural origins in the Indus River drainage. One key for this new perspective has come from a long-term research program, conducted by the French Archaeological Mission and the Pakistani Department of Archaeology, at the site of Mehrgarh (meh-her-GAR), located in the Kachi Plain about 200 km (120 mi) northwest of the Indus River. The site is also interesting because of its location immediately below the Bolan Pass, which cuts through the mountains that connect the Indus River Valley with highland Baluchistan and Iran (Southwest Asia).

In 1974, the first fieldwork at Mehrgarh, by Jean-François Jarrige and his colleagues, focused on a small mound. At that time, however, older pottery was collected over an area of several hundred hectares adjacent to the mound. Large-scale excavations in this area have yielded a sequence of deposits dating to the seventh millennium B.C. The earliest occupation level at Mehrgarh lacked pottery, although clay was used to make bricks for the construction of substantial, multiroom, quadrangular structures (Figure 4.31) and **anthropomorphic** figurines. A count of plant impressions in the mud bricks by Lorenzo Costantini found that barley was the most abundant cultigen in this early level. This barley had several distinctive local characteristics and may not have been completely domesticated. Other cereals grown at that time include smaller amounts of einkorn wheat, emmer wheat, and a kind of bread wheat. Whereas the wheats appear to have been imports from the west, it remains unclear whether barley was as well.

As in the early Neolithic sites of Southwest Asia, gazelle was the most abundant of the wild animal species, which included sheep, goat, cattle, swamp deer, and a large South Asian antelope. Some goats have been identified anatomically as domesticated. In each of two burials from an early level of the occupation, five young goats were placed at the foot of an adult male, whose body was covered with red ochre (Figure 4.32). These early graves also contained a diverse combination of body ornaments made from exotic materials such as seashell, turquoise, and **lapis lazuli.**

After 6000 B.C., important subsistence shifts occurred at Mehrgarh, and the first ceramic vessels began to be used. Richard Meadow, of Harvard University, has noted a reduction in the body size of the goats, sheep, and humped zebu cattle (*Bos indicus*) at the site, which he interprets as evidence for domestication. The relative abundance of wild species decreased, and the proportion of cattle bones increased greatly, suggesting that cattle husbandry may have begun about the same time at Mehrgarh as in sites to the west (Figure 4.33). Therefore, whereas sheep and goats may have been brought to Mehrgarh already tamed or domesticated, archaeological as well as recent genetic evidence suggests that local humped cattle were indigenous to South Asia.

Between 6000 and 4000 B.C., domesticated barley, well adapted to floodplain irrigation, was the predominant cultigen. Charred seeds of the plumlike jujube fruit (*Zizyphus jujuba*) and date pits (*Phoenix dactylifera*) also have been recovered. Cotton seeds were found with wheat and barley grains after 5000 B.C., the earliest date for cotton in the world.

At that time, Mehrgarh was a well-planned community composed of compartmentalized mud-brick structures that served primarily as storage rooms. Features found in other parts of the settlement include circular fireplaces, containing burnt rocks for **stone boiling,** with bone and other debris nearby. These areas may have been used for large-scale food processing or cooking, or some other kind of communal activity.

Both specialized craft production and extensive long-distance trade, so evident at the major centers of the later Indus civilization, had clear antecedents millennia earlier at Mehrgarh. By 4000 B.C., the community had spread over tens of hectares and included specialized centers where fine ceramic ware was made. For roughly the next 1500 years, Mehrgarh was an important craft center. Wheel-thrown pottery was mass-produced, and beads of lapis lazuli, turquoise, and carnelian were perforated with cylindrical drill bits made of **jasper** and rotated by a **bow-drill.** Fragments of crucibles used to melt copper also were found at Mehrgarh.

The archaeology at Mehrgarh, along with recent studies at other contemporary sites, has revised South Asian prehistory. No longer can we envision the inhabitants of the Indus River drainage as simple recipients of inventions from the west. Nor can we attribute the rise of the Indus civilization after 2600 B.C. to the diffusion of ideas from Mesopotamia. We now recognize a sequence in South Asia that documents a prepottery Neolithic phase and the indigenous domestication of humped zebu cattle, along with the development of highly specialized local craft industries.

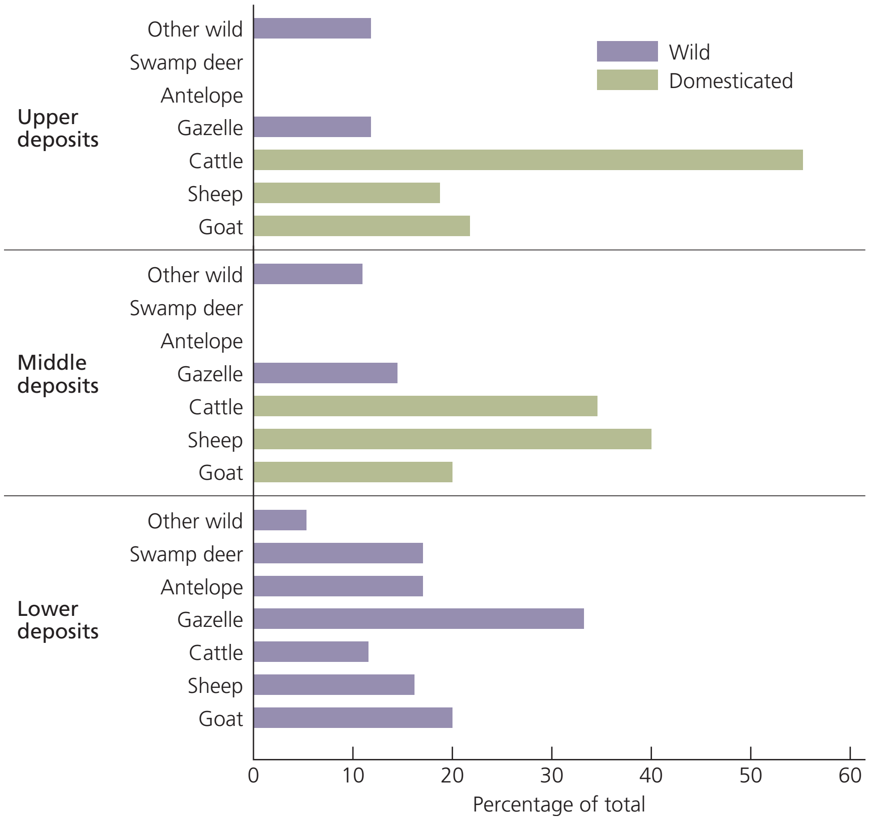


Figure 4.33 The transition from hunting to herding at Mehrgarh. In the lower deposits, all the species present are wild, including gazelle (*Gazella*), goat (*Capra*), sheep (*Ovis*), cattle (*Bos*), antelope (*Boselaphus*), and swamp deer (*Cervus*). After 6000 B.C. (middle deposits), the reduced size of cattle, goat, and sheep bones at Mehrgarh indicates that these animals were domesticated. After the Neolithic (upper deposits), domesticated cattle were dominant.

anthropomorphic Having human form or attributes.

lapis lazuli A semiprecious stone of deep blue color.

stone boiling The process of heating stones in a fire and then adding them to containers to boil water or cook other foods.

jasper A high-quality flint, often highly colored.

bow-drill A device for perforating beads or other small objects, in which a bow is used to rotate the shaft of the bit.

Concept

Pottery

Ancient containers: A key source for archaeological interpretation

"Pottery is . . . the greatest resource of the archaeologist," wrote the famed Egyptologist W. M. Flinders Petrie (1904, pp. 15–16). Indeed, ceramics are the most common kind of artifact found at most post-Paleolithic sites. Since pottery has many purposes—cooking, storage, serving, and carrying materials—many different pieces can be used by a single household at the same time. Moreover, pottery vessels are fragile and often have to be replaced. However, fragments of pottery, or **potsherds,** are very durable and normally preserve better than many other ancient materials found in archaeological contexts.

Figure 4.34 A Mexican woman making a pottery vessel using a *molde,* a flat, roughly finished clay plate that has traditionally been used in parts of Mexico to turn vessels by hand.

Ceramic artifacts also are important because they can be good **temporal markers,** sensitive indicators of specific time periods. In his study of ancient Egyptian pottery, Flinders Petrie was one of the first archaeologists to recognize how decorative styles change. In addition to chronological sensitivity, pottery vessels have a series of distinctive technical, formal, and decorative attributes that can tell us many things about the lives of the people who made, traded, and used them.

Worldwide, the increasing importance of pottery has in many cases roughly coincided with a greater reliance on domesticated foods. Fired clay containers provide clean storage for food and drink and can be used for preparing food over a fire. The earliest securely dated pottery vessels, found at Yuchanyan Cave in South China are 15,000 to 18,000 years old. Why did pottery occur so late in human history? Ceramic vessels do have liabilities: They are relatively heavy and often fragile. Many mobile foragers did not use ceramics, preferring lighter containers, such as net bags, gourds, and baskets. In the preceramic levels at Mehrgarh, for example, the inhabitants used baskets coated with water-resistant bitumen. Clearly, the development of and reliance on ceramic vessels is associated with life in more settled communities. Yet some sedentary groups, such as the Native Americans of northwestern North America, did not use pottery, relying instead on a diverse array of woven baskets for storage. And pottery did not simply appear with agriculture. In both Mexico and Southwest Asia, plant domestication preceded the use of ceramics by more than a thousand years. Conversely, the world's oldest ceramic containers are cooking vessels made by mobile foragers in South China.

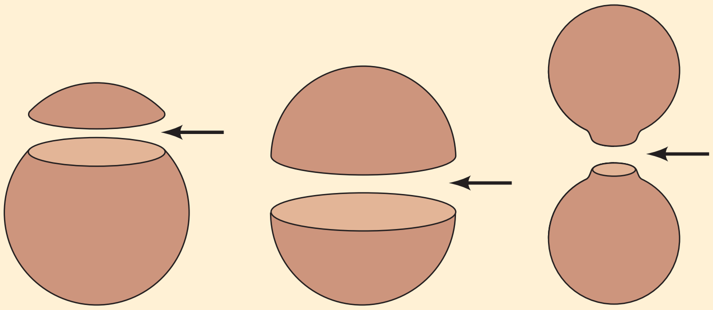


Figure 4.35 Early pottery forms in Mexico were based on cross sections of gourds.

The late advent of pottery is curious because ceramic technology had been used by human societies for some time. Baked clay figurines were made at Paleolithic sites in the former Soviet Union and eastern Europe as early as 30,000–20,000 years ago. Clay figurines and mud bricks were made in the Levant 10,000 years ago, yet pottery did not appear locally until around 7000 B.C. Settled farming villagers used ground stone bowls long before they made ceramic containers. In the Americas, ceramic vessels were not made until several thousand years later, when they first appeared in lowland South America. The earliest pottery containers in Mexico and North America date to 3000–2000 B.C., before the advent of fully sedentary villages.

Figure 4.36 A funerary urn from a prehispanic tomb in Oaxaca, Mexico, dating to A.D. 600–800. This elaborate urn stands 15 cm high and was made using a variety of small molds to form the arms, the headdress, and other elements that were then attached to the main vessel.

The earliest pottery in both Eurasia and the Americas was crafted by hand (Figure 4.34). Generally, early pottery vessels were either built up in a series of clay coils or modeled from gourds (Figure 4.35). However, by roughly 4000 B.C., **wheel-thrown pottery** had become an important commodity throughout Southwest and South Asia. The potter's wheel permits a single worker to make a greater number of vessels more quickly. Such pottery is also highly uniform in size, shape, and appearance. In the Americas, fired clay vessels continued to be handmade (sometimes including the use of molds; Figure 4.36) until the European introduction of the potter's wheel in the sixteenth century A.D. Some scholars have attributed the Eurasian invention of the potter's wheel to the presence of wheeled vehicles, absent in the Americas. Yet the potter's wheel may have preceded the use of the wheel for transport in Eurasia. Furthermore, we know that some Native American groups were familiar with the concept of the wheel, because wheeled toys have been found in archaeological contexts. The absence of the potter's wheel may be related to the relative difficulty and inefficiency of transporting ceramic vessels long distances in the aboriginal Americas, where there were few domesticated beasts of burden, no wheeled vehicles, and generally less widespread sea transport than in Eurasia and Africa.

Compare and contrast the context in which fired clay vessels were adopted or developed in three areas of the world.

potsherd A fragment of a clay vessel or object.

temporal marker A morphological type, such as a design motif on pottery or a particular type of stone tool, that has been shown to have a discrete and definable temporal range.

wheel-thrown pottery Pottery that is made using the potter's wheel.

Site

Ban-po-ts'un

A Neolithic village in northern China

Botanists have long recognized that many Chinese food plants were indigenous to the region. Prior to the last half century, however, archaeologists believed that the "idea" of agriculture, along with the knowledge for domesticating animals and making pottery, had diffused to the rich soil of the middle Huang (Yellow) River Valley in northern China from elsewhere. Before 1960, the few known Neolithic sites with their characteristic black-and-red pottery were assigned to the Yangshao culture and presumed to date to around 3000 B.C. The general view that products from Southwest Asia arrived in China about that time was supported by the presence of small amounts of foreign domesticates, such as wheat and barley, at known Yangshao sites, along with larger quantities of a locally domesticated grain (millet) and domesticated pigs.

In the past 40 years, however, information about the Chinese Neolithic has undergone a major transformation. Thousands of new Neolithic sites have recently been discovered in various areas of the country. Dozens of these sites have been excavated, and several earlier sites have been recorded (Figure 4.37). Early Neolithic sites in North China with millet and pigs have now been dated to the sixth millennium B.C., and the age for some Yangshao sites has been pushed back to 5000 B.C. Equally significant has been the discovery of Neolithic sites, such as Peng-tou-shan, Shang-shan, and Ho-mu-tu in South China, that predate 6000–5000 B.C. At these more southerly sites, the staple food plant was rice, not millet. Charred husks of domesticated rice from Shang-shan, a small sedentary village in the lower Yangtze River valley, have been dated to 8000 B.C. The origin of agriculture now appears to have been an indigenous process in North and South China, since in both areas local cultigens have been found to be more abundant and earlier than exotic domesticates.

The best-known Chinese Neolithic site, Ban-po-ts'un (ban-POT-sun), is not the oldest but rather the first to have been excavated extensively. (Work was completed between 1953 and 1955.) Located on a loess terrace about 9 m (30 ft) above a tributary of the Huang River near the city of Xian, Ban-po-ts'un

Figure 4.37 Location of Ban-po-ts´un and other sites mentioned in the text. The distribution of Yangshao sites is shown in yellow.

covers 5–7 ha (12.5–17.5 acres). Roughly 100 houses, some circular and others square, were surrounded by a defensive and drainage ditch (Figure 4.38). Many of these structures were excavated, and the evidence indicates that the occupation at Ban-po was long and continuous. In one instance, five superimposed house floors were uncovered.

Many of the houses were semisubterranean, 3–5 m (10–16 ft) in diameter, with floors roughly a meter below the ground surface. Each house had timber beams that rested on stone bases, supporting a steeply pitched thatched roof. Floors and interior walls were plastered with clay and straw. One or two circular or pear-shaped fire pits, modeled in clay, were situated at the center of most of the dwellings. Storage pits and animal pens were interspersed among the houses at the center of the settlement.

At Ban-po, the principal crop was millet (*Setaria italica*), which was cultivated in the rich, soft-textured loess soils that surround the village. Such agricultural tools as bone hoes, polished stone adzes, axes, knives, and digging-stick weights were abundant at the site. Chestnuts, hazelnuts, and pine nuts supplemented the grain diet. The inhabitants of Ban-po-ts'un grew **hemp,** probably for use as a fiber. Silk production is suggested by a neatly sliced silkworm cocoon that was recovered. Numerous **spindle whorls** (for spinning thread) and bone needles also were found. Impressions of cloth, as well as baskets and mats, provide more evidence of weaving.

Pigs and dogs were the principal domesticated animals, although cattle, sheep, and goats also were utilized. Bone and quartz arrow points, bone fishhooks, and net-sinkers all were present, along with plentiful bones of several varieties of deer. Thus hunting and fishing contributed to the diet at Ban-po.

Ban-po-ts'un has yielded more than 500,000 pieces of pottery. Six pottery **kilns** were recovered beyond the ditch at the east side of the settlement, outside the residential zone (Figure 4.39). Most of the vessels were handmade into a distinctive redware. Whereas cooking pots tended to be coarse and gritty, water vessels and food-serving bowls were made of a finer clay. Cord-marking was the most common surface decoration, although basket, textile, and fingernail impressions also were used. The black-painted **geomorphic** and **zoomorphic** Yangshao designs were applied primarily to bowls and jars (Figure 4.40).

The inhabitants of Ban-po were buried in one of two ways. Infants and small children were placed in large redware pottery jars and interred near the houses. The cemetery for adults was located outside the enclosing ditch at the north end of the settlement, where corpses were placed in pits 2 m (6.5 ft) deep and arranged in rows. With very few exceptions, each individual was buried separately in an extended position. Ceramic vessels

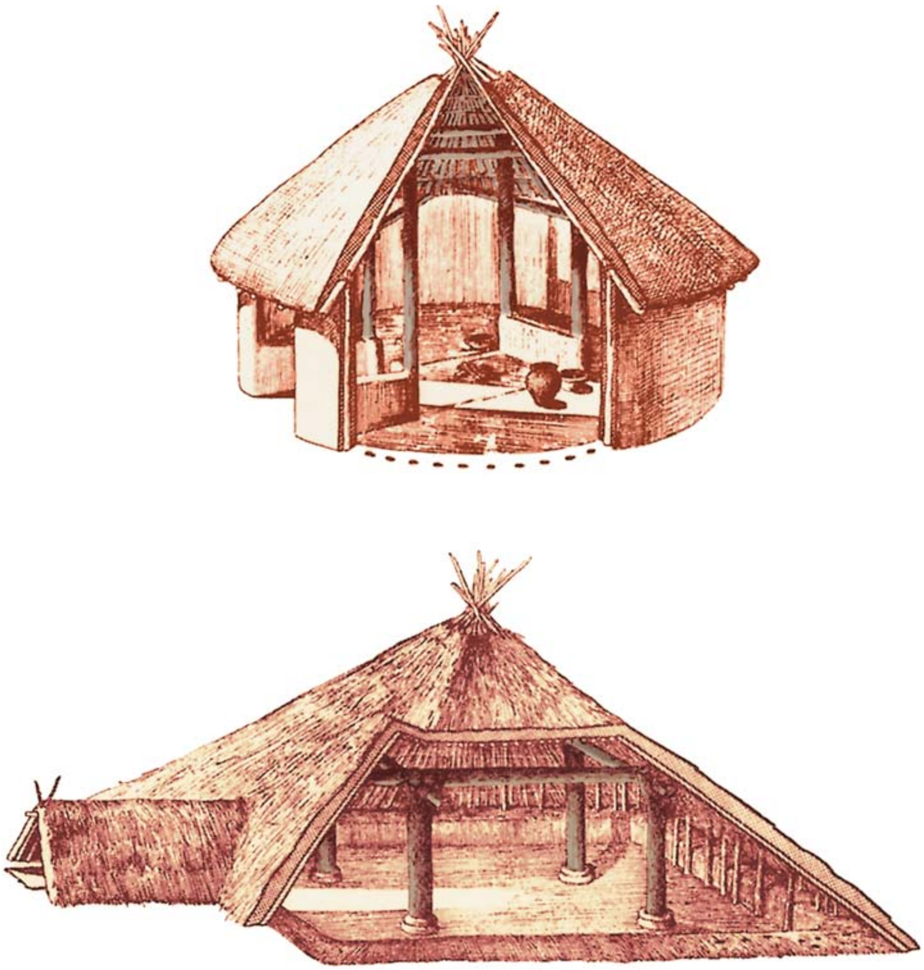


Figure 4.38 An artist's reconstruction of houses at Ban-po-ts'un. Circular structures are believed to have housed a single family; the larger, square structure is thought to have been a communal clan house.

hemp A tall annual plant whose tough fibers are used to make coarse fabrics and ropes.

spindle whorl A cam or balance wheel on a shaft or spindle for spinning yarn or thread from wool, cotton, or other material; usually made of clay.

kiln A furnace or oven for baking or drying objects, especially for firing pottery.

geomorphic Having the form or attributes of surface features of the earth or other celestial bodies.

zoomorphic Having animal form or attributes.

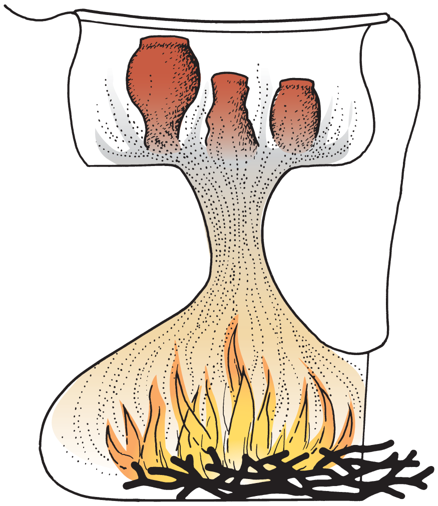


Figure 4.39 A drawing of a reconstructed section of a pottery kiln at Ban-po-ts'un.

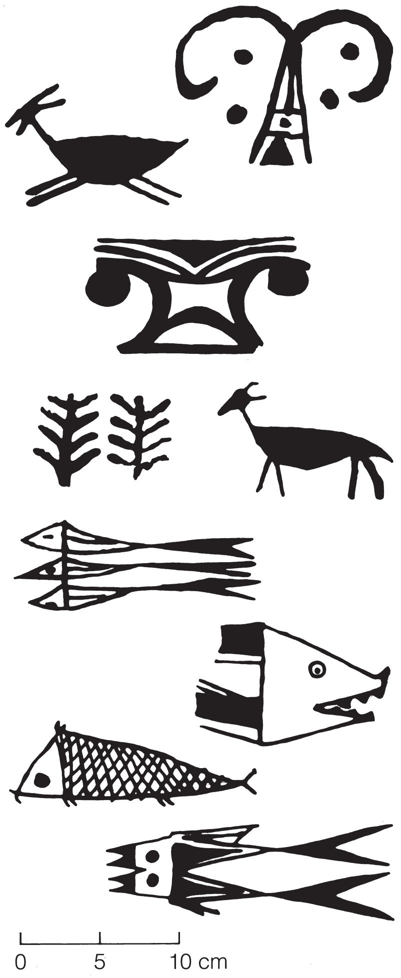


Figure 4.40 Examples of black-painted zoomorphic and geomorphic designs on Yangshao pottery.

were included with the body in most of the graves. In a few instances, larger quantities of goods were found. The most elaborate burial was a child, who was placed in a wooden tomb that included a green jade pendant, a string of 63 bone disk beads, four ceramic vessels, and three stone pellets.

Toward the end of the occupation at Ban-po, a large rectangular structure was erected on a manmade platform (20 × 12.5 m, or 65 × 41 ft) at the center of the village. The platform was ringed by a low wall that originally may have been the foundation for a higher wall of posts. Unlike the residential dwellings, this structure was plastered with a white limy substance that had been hardened by baking. The structure also had a hard earthen floor that appears to have been destroyed in a fire. Although some archaeologists might consider this special central structure to be a possible indicator of emergent social inequalities, Chinese archaeologists interpret the building as a communal assembly hall or clan house.

The purposefully planned layout of Ban-po-ts'un, with a large central building surrounded by a nucleated residential area inside a ditch, and exterior pottery-making and cemetery facilities, was very similar to other contemporary Yangshao villages. For example, Chiang-chai, near Ban-po, had concentric circles of oblong and rectangular houses surrounding four large structures that faced a central village plaza. Chiang-chai also was ringed by a defensive system of ditches, and the cemetery area and pottery kilns were located outside these earthworks. At all well-studied Yangshao sites, the dwelling and cemetery areas are spatially distinct.

Concept

Rice

One of the world's most important grains

Today, the most important staple food for half of the world's population is rice. Each year, the plant supplies 20% of the total calories consumed worldwide. In fact, among the world's major grain crops, rice is the only plant that is harvested almost solely for human consumption.

Yet despite its worldwide significance, archaeologists know relatively little about how or where rice was first domesticated. Although the plant is now cultivated in a variety of environments, it was originally indigenous to the tropics. Rice is an annual grass that shares many characteristics with wheat, barley, oats, and rye. The rice plant belongs to the genus *Oryza. Oryza* contains two cultivated species, the Asian *Oryza sativa* (Figure 4.41) and the West African *Oryza glaberrima*, each of which includes a multitude of variants. Archaeologists know less about *O. sativa* than they do about early domesticated wheat, barley, or corn; *O. glaberrima* is even more of a mystery.

East Asia seems to have been the focus for early experimentation and cultivation of *O. sativa.* On the basis of recent archaeological research in China, archaeologists believe that rice cultivation may have occurred as early as the eighth or ninth millennium B.C. along the middle Yangtze River. By 6500 B.C., rice had become an important component of the diet at sites both to the north and along the lower Yangtze River to the east. In South China, large quantities of rice stalks, grains, and husks were preserved at the waterlogged prehistoric village of Ho-mu-tu, excavated between 1973 and 1978. The settlement contains houses raised on wooden piles above a lakeshore. Excavations revealed rice in stratigraphic levels extending back to the late sixth and early fifth millennia B.C. In one place, the rice remains were 25–50 cm (10–20 in) thick, suggesting that a threshing floor may have been preserved. Both wild and domesticated varieties have been identified at Ho-mu-tu. Remains of bottle gourds, water chestnuts, and sour **jujubes** were recovered, as were acorns and other nuts. The faunal assemblage includes wild deer, elephant, rhinoceros, tiger, and turtle, as well as domesticated water buffalo, dog, and pig.

Cord-impressed pottery was found at Ho-mu-tu, and similar ceramic wares have been recovered, along with rice, at other recently excavated sites in South China. Some of these latter sites are earlier, dating to the mid-seventh millennium B.C. Rice, with both wild and domesticated characteristics, also has been recovered at excavated sites in Thailand, where it may pertain to as early as the late fourth millennium B.C. In Southeast Asia, where rising sea levels have covered many Neolithic sites, even earlier evidence of rice domestication may lie underwater.

We still have fewer answers than questions about rice domestication. Drawing on recent research, scholars have proposed two principal models. One proposes that rice was initially domesticated in the middle and lower Yangtze River valley in southern China, from where it eventually spread throughout the Asian continent. The other model suggests that rice was domesticated from its wild ancestor in two different areas of eastern Asia and that rice also may have been independently domesticated farther to the west, on the Indian Peninsula. Nevertheless, the processes surrounding the domestications and the precise timetable for the spread of cultivated rice across southeastern Asia remain largely undeciphered.

Figure 4.41 *Oryza sativa*, the cultivated Asian species of the rice plant.

jujube A small, edible fruit from an Asian tree of the buckthorn family. The fruit has one seed in the center, somewhat like a cherry.

Site

Khok Phanom Di

The documentation of the spread of rice into Southeast Asia

www.mhhe.com/priceip7e

For a Web-based activity on Khok Phanom Di, see the Internet exercises on your online learning center.

In 1952, geographer Carl Sauer proposed that the cradle for the world's earliest agriculture should lie in mainland Southeast Asia, rather than in Southwest Asia, as most scholars still believed. Sauer thought that the highly diverse, tropical, and riverine environments of Southeast Asia would have provided a superb locale for the fishing and farming way of life that he surmised would constitute the earliest stage in the transition to agriculture. Like the Russian botanist Nikolai Ivanovich Vavilov before him, Sauer was aware that the wild ancestors for a wide array of modern cultigens (root, tree, and seed crops) had been traced to Southeast Asia.

For over a decade, few prehistorians gave serious consideration to Sauer's ideas because of an absence of information to evaluate them. Moreover, his proposal did not conform to the traditional views of mainland Southeast Asia as a kind of cultural recipient or backwater area that obtained most technological advances from India or China. For Thailand, traditional archaeological reconstructions suggested that the earliest domesticates came from North China after 3000 B.C.

During the 1950s, the most relevant archaeological materials for tropical Southeast Asia belonged to the Hoabinhian complex, known from a series of limestone caves and shell middens. Because this complex was not well dated, the presence of cord-marked pottery with edge-ground stone axes in the upper deposits of several Hoabinhian sites was presumed to signal the introduction of agriculture from North China.

In the mid-1960s, Chester Gorman began a research project in the uplands of northern Thailand to elucidate the local Hoabinhian hunting-gathering pattern and to document the possible shift to plant cultivation. He began at Spirit Cave, in the rugged, hilly terrain near the Burmese border (Figure 4.42), where excavations revealed a stratigraphic

Figure 4.42 Locations of the Southeast Asian sites mentioned in the text.

temper A nonplastic material (such as sand, shell, or fiber) that is added to clay to improve its workability and to reduce breakage during drying and firing.

Figure 4.43 The site of Khok Phanom Di is the large, tree-covered mound on the horizon. The site, surrounded by the flat floodplain of the Bang Pakong River, lies 22 km (14 mi) from the present shore of the Gulf of Siam.

sequence of two cultural levels. The lower deposits, dating from 9000 to 5500 B.C., contained standard Hoabinhian chipped stone artifacts and grinding stones. Polished adzes, cord-marked and burnished pottery, and polished slate knives, similar to tools used to harvest rice in Java today, were found in the upper soil layers, which have been dated by accelerator mass spectrometry (AMS) to the second millennium B.C. The most unexpected findings, however, resulted from the careful study of plant remains.

The first archaeologist to carefully sieve the excavated soil from a Hoabinhian site, Gorman found a great variety of seeds, shells, husks, and other plant parts. Food plants such as butternut, almonds, cucumbers, water chestnuts, a few beans, and peppers were recovered, as were remains of the stimulant betel nut, candlenuts (probably used for lighting), and the bottle gourd, a probable container. None of the recovered plant species differs significantly from its wild prototype, indicating that the plants were not domesticated. Nonetheless, a wide variety of plants was intensively utilized, possibly involving the tending or fostering of some species.

Significantly, the remains of rice were absent at Spirit Cave. Yet rice has been recovered at other sites broadly contemporaneous with the later occupation of Spirit Cave. At Non Nok Tha, a habitation mound in the lower northeastern part of Thailand, clear impressions and carbonized remnants of rice chaff were found in potsherds. Apparently, the ancient potters, like their modern counterparts, mixed the plant materials into their clay as a fiber **temper** to improve the workability of the clay and to reduce breakage. In spite of disagreements over whether the rice was domesticated, analyses by Charles Higham, of the University of Otago, New Zealand, of the animal remains from Non Nok Tha, and contemporary levels at the more northerly site of Ban Chiang, have revealed an increasing reliance on domesticated animals—cattle, pigs, chickens, and dogs—at these sites. Yet hunting and gathering also continued to be important for subsistence.

Cultivated rice has been recovered at Khok Phanom Di (COKE fa-nome DEE), which translates from Thai as "Good Mound." This coastal site, a 5-ha (12.3-acre) mound that rises 12 m (39 ft) above the surrounding floodplain in a rich estuarine setting near the Gulf of Siam, was occupied between 2000 and 1500 B.C. (Figure 4.43). The first settlers may have been attracted by the broad estuary, its inexhaustible supply of food, abundant potting clay, and a river that facilitated exchange with other regions. Most of the artifacts recovered from the earliest layers relate to fishing and the manufacture of ceramic vessels (Figure 4.44). Recovered bones from animals known to inhabit the nearby mangrove swamps, such as macaques and pigs, reveal hunting activities. The saltwater estuary was not conducive to rice cultivation, so Higham believes that the earliest rice at the site was obtained from inland farming communities by exchange. The coastal inhabitants of Khok Phanom Di also exchanged for exotic ornaments made from shell, ivory, and slate. Hoes and harvesting knives made from shells found in later levels indicate that rice was cultivated late in the occupation of the site. Dog, the only domesticated animal present at the site, also was found in the later levels.

The inhabitants of Khok Phanom Di invested significant energy in mortuary ritual. Excavations into the site's mound exposed over 150 graves. Many of the bodies were covered with red

Figure 4.44 Excavations at Khok Phanom Di have revealed a 7-m (23-ft) deep sequence of occupations spanning 500 years from approximately 2000 B.C.

Figure 4.45 "The Princess" of Khok Phanom Di. This woman in her mid-thirties was interred wearing a garment that had been embroidered with more than 120,000 small shell disc beads. She wore a necklace of 1000 I-shaped shell beads and a shell bracelet on her left arm. Two large shell discs were placed on her shoulders.

bier A stand on which a coffin or a corpse is placed.

metallurgy The art of separating metals from their ores.

ochre, wrapped in shrouds, or placed on wooden **biers.** Grave offerings included well-made pottery that was brilliantly burnished and incised with complex designs, shell beads, and bangles fashioned from fish vertebrae. An especially rich grave, sometimes referred to as "The Princess," was accompanied by thousands of small shell beads, richly ornamented black pottery vessels, a clay anvil, and a potter's kit that included two burnishing stones (Figure 4.45). The remains lay under a pile of clay cylinders that once had been destined to become pottery vessels. The nature and richness of the burial goods have been interpreted as evidence that the woman was a potter of high status. Yet individuals thought to be her descendants were interred with few grave offerings, suggesting that status may have been achieved through personal endeavor and was not entirely determined at birth or ascribed.

The burials at Khok Phanom Di reveal significant social differences in a sedentary community of hunter-gatherer-cultivators in a rich estuarine setting who exchanged with newly established inland farming communities. Although rice was not originally domesticated at Khok Phanom Di (but rather to the north in South China), the presence of cultivated rice there documents its arrival in Southeast Asia by the second millennium B.C.

In recent decades, knowledge about the early Holocene in Southeast Asia has expanded significantly. We have learned that the broad-spectrum Hoabinhian complex extended more deeply into the past than had been previously believed and that plant tending may have contributed importantly to the diet. A more dramatic transition occurred during the past several millennia B.C. with the introduction of cultivated rice, as seen at Khok Phanom Di. At other settled villages, such as Non Nok Tha and Ban Chiang, the inhabitants lived in houses built on piles or wooden stilts, buried their dead in low mounds, and made socketed spearpoints and adzes as well as adornments of bronze. The appearance of these objects in northeastern Thailand around 1500 B.C. is significant in that they represent some of the world's earliest known bronzeworking, or **metallurgy.** More than 800 metal ornaments and weapons were uncovered at Ban Chiang, and many more were found at Non Nok Tha. At these later settlements, rice agriculture and domesticated animals constituted the bulk of the diet.

Although much has been learned, many questions remain. We cannot evaluate the importance of indigenous tropical domesticates, such as yam and taro, because these root crops preserve so poorly in the archaeological record. The specifics of rice adoption remain a bit sketchy, although recent research places the original hearth for this key grain in South China. Consequently, although Sauer's hypothesis for indigenous Southeast Asian plant domestication may eventually hold for certain tropical roots, fruits, and tubers, concerted archaeological studies over the past decades now indicate that the region's staple grain—rice—was probably introduced into the region from South China.

Site

Guilá Naquitz Cave

A preceramic seasonal campsite in Mexico

Kent V. Flannery spent the day before Christmas of 1964 in the foothills of the eastern Valley of Oaxaca, in southern Mexico, searching for the best site to study agricultural origins in Mexico. Having just completed several seasons of fieldwork as the faunal analyst on Richard MacNeish's interdisciplinary team in arid Tehuacán 150 km (90 mi) to the north (see "Tehuacán," p. 232), Flannery wanted to see what form early agriculture might have taken in a more humid valley with greater farming potential (Figure 4.46). On that December day, Flannery found a preceramic occupation at Cueva Blanca, a site that, he says, more than any other launched his Valley of Oaxaca Human Ecology project (Figure 4.47).

On Christmas day, heartened by the previous day's finds, Flannery began to prepare a research proposal. A year later, with support from the Smithsonian Research Foundation, he returned to Oaxaca. On January 26, 1966, less than a week after beginning a reconnaissance of caves in the area, he found a rockshelter with lots of chipped stone debris and half of a projectile point on the ground surface. This small overhang, named Guilá Naquitz (ghee-LA nah-KEETS), which means "white cliff" in the native Zapotec language of Oaxaca, was subsequently excavated (Figure 4.48).

At Guilá Naquitz, Flannery and his field crew carefully peeled away the layers of preceramic occupations dating to 8750–6670 B.C. On the basis of careful retrieval and analysis of the floral, faunal, and artifactual remains found in the cave strata, Flannery suggested that the shelter of Guilá Naquitz was occupied seasonally between August and December by small groups, or **microbands,** perhaps composed of a series of nuclear families. As in the rest of the Mexican highlands at that time, the ancient inhabitants of Oaxaca were mobile, living in several different

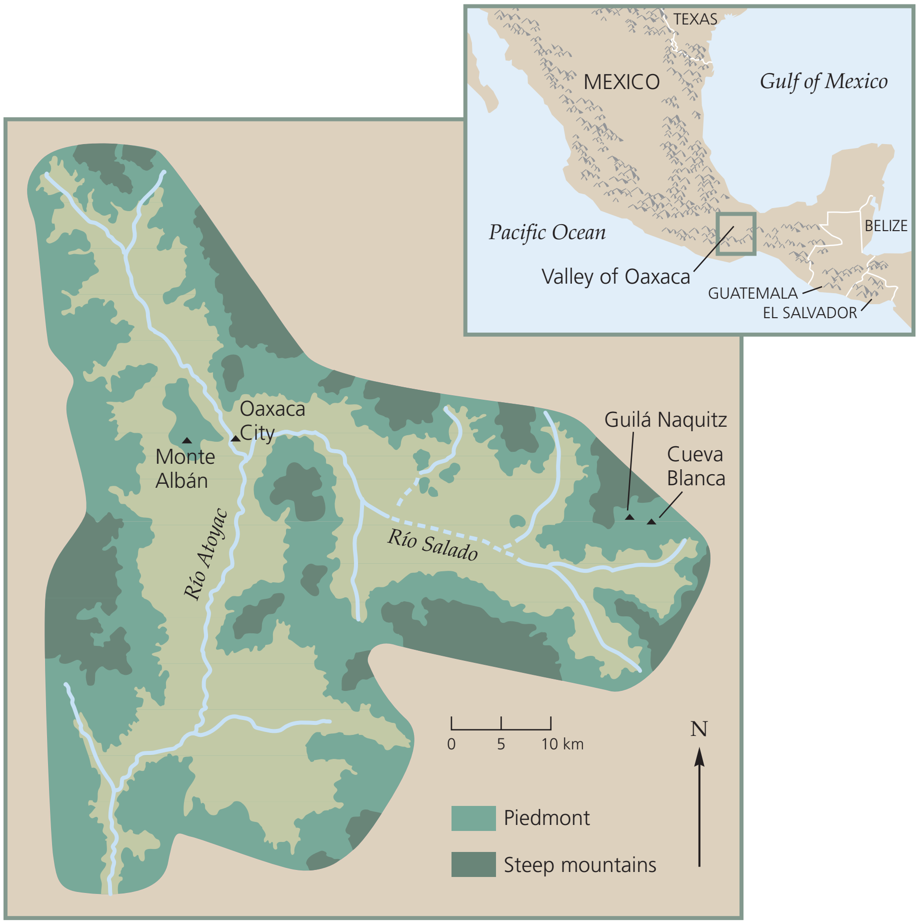
We have indicated that the research problem we chose for ourselves at Guilá Naquitz was to develop a model that would not only deal with some of the underlying and more universal aspects of early domestication but also tie that process into the specific cultural pattern for the Valley of Oaxaca.

—Kent V. Flannery (1986)

Figure 4.46 Regions of Mesoamerica mentioned in the text where evidence of early agriculture has been recovered.

microband A small family group of hunter-gatherers.

Figure 4.47 The locations of Guilá Naquitz Cave and Cueva Blanca in the Valley of Oaxaca.



camps during the course of their yearly activities.

The archaeological contents of the cave strata indicate that the inhabitants of Guilá Naquitz consumed a diversity of plant foods, such as acorns and the roasted heart of **maguey** plants (also called agave, the source of tequila and mescal today), which could have been collected in the thorn forest surrounding the site (Figure 4.49). Other plant foods, such as the seeds of the pod-bearing **mesquite** tree and hackberries, were brought back to the cave from the flatter grassland below. A small part of the diet, one that increased slightly over time, came from squash and bean plants, which may have been tended or cultivated in the disturbed terrain around the site. The use of wild squash may have been a first step toward eventual domestication. Bruce Smith, of the Smithsonian Institution, has recently restudied squash seeds and fragments (*Cucurbita pepo*) recovered from early levels at the site. Accelerator mass spectrometry (AMS) dates taken on some of these remains indicate the presence of domesticated squash just after 8000 B.C. Neither maize cobs nor maize kernels were identified in ancient levels. The variety of nuts, seeds, fruits, and cactus eaten during late summer and early autumn was supplemented by a small amount of venison and rabbit meat. Although deer and rabbit bones were not abundant at Guilá Naquitz, this meat still provided much of the protein consumed in the cave.

The subsistence activities of the inhabitants of Guilá Naquitz were rather conservative, changing little over the millennia of intermittent occupations. Perhaps this continuity should not be surprising. Two nutritionists, J. R. K. Robson and J. N. Elias, concluded that the diet of the cave occupants compared favorably with the contemporary diet in the United States, providing similar

maguey Any of several species of arid-environment plants with fleshy leaves that conserve moisture.

mesquite A tree or shrub of Mexico and the southwestern United States whose beanlike pods are rich in sugar.

Figure 4.48 Excavations in progress at Guilá Naquitz Cave. Many of the species of cacti and thorny bushes outside the cave have seeds or fruits that were eaten by Archaic foragers.

levels of nutrients and exceeding caloric requirements with a lower intake of food.

Whereas seasonally abundant plant foods could have been collected near the cave, stone for making tools was taken from quarries up to 50 km (30 mi) away. This better raw material was used primarily for projectile points, while more local, but less suitable, rock sources were used for more disposable tools, such as scrapers and worked flakes.

Besides recording the collection and processing of plant foods and the butchering and consumption of animals, the archaeologists at Guilá Naquitz documented the manufacture of tools, the digging of pits to store acorns, the use of fire pits to prepare food, the processing of plant fibers into strands that were used to make nets (Figure 4.50), and the collection of leaves for bedding in the cave. Years of multidisciplinary study by Flannery and his colleagues illustrate how archaeologists can reconstruct the events of the past into a credible picture of ancient life just before the advent of agriculture in the highlands of ancient Mexico.

Figure 4.49 Large maguey plant in the eastern Valley of Oaxaca. In addition to being a source of food and drink, the plant provides fibers that were used to make ropes, nets, and other woven goods.

Figure 4.50 A fragment of knotted net from Guilá Naquitz Cave. Such nets were used as bags for transporting food to the cave.

Concept

Zea mays

The mysterious ancestry of corn

Maize—or corn, as it is familiarly known in the United States—was unknown in Europe before the arrival of Columbus in the Americas in 1492. By that time, the plant was cultivated by native inhabitants over much of the tropical and temperate portions of the Western Hemisphere. The great adaptability and plasticity of maize is evidenced by its position as the second or third most important food plant on Earth and its current worldwide distribution (Figure 4.51). Botanical studies, however, indicate that the ancestor of modern corn (*Zea mays*) was native to southern or western Mexico.

Botanists and archaeologists have puzzled over the ancestry of maize. Domesticated varieties of such cereals as wheat, barley, and rice are structurally nearly identical to living wild species. The principal difference is that, whereas in the domesticated varieties the edible seeds tend to remain fastened on the plant, the wild varieties have shattering **inflorescences.** As mentioned earlier, shattering is a mechanism by which the seeds of the

Figure 4.51 The great diversity of modern maize, one indication of the tremendous adaptability and genetic plasticity of the plant. These varieties come from many regions of Mexico, and they prosper under different environmental and topographic conditions.

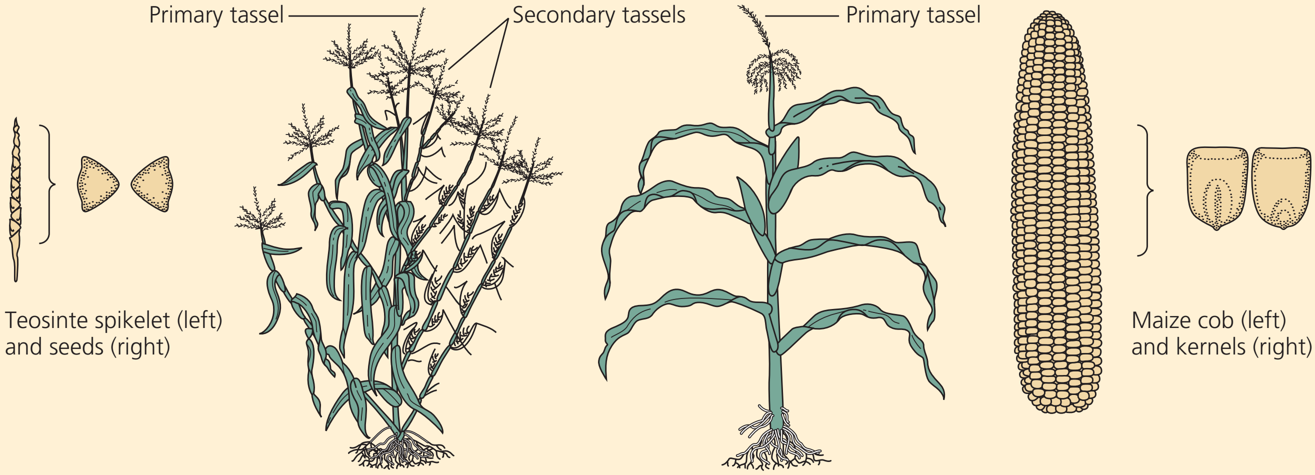


Figure 4.52 The teosinte and maize plants. Although the kernels are different, pollen from teosinte, the likely ancestor of maize, is almost indistinguishable from the pollen of early corn.

plant are dispersed naturally. The most recognizable feature of domesticated maize, the massive husked ear, is not present even in wild grasses most closely related to maize. In fact, the nonshattering ear of domestic corn, with its surrounding husks, inhibits seed dispersal, so that without farmers to remove and plant kernels from the ear, modern maize could not reproduce for even one or two years. Because of its structure, George Beadle, a renowned plant geneticist, referred to domesticated maize as a "biological monstrosity."

Because of this pronounced difference between the ears of domesticated maize and related wild grasses, the debates over the origins of maize have been more contentious and, until recently, have achieved less consensus than discussions about the origins of most other domesticated seed plants. Although a few experts still hold the view that there was once a wild species of maize (with ears like maize) that has since become extinct (no such plant has ever been found), most participants in the debate have returned to a previously popular position that the ancestor of maize was a variety of **teosinte,** a giant wild grass so closely related to *Zea mays* that most botanists place it with corn in the same species (Figure 4.52). Teosinte still grows in the foothills and highlands of Mexico and Guatemala and, in fact, is the only large-seeded, wild, annual grass in the tropical Americas. Unlike maize, teosinte lacks a cob; instead, its seeds are contained in fruitcases. At maturity, teosinte seeds are dispersed through shattering. In other respects, the annual teosinte varieties are very similar to maize and produce fully fertile offspring when interbred with the domesticated plant. Teosinte and maize have similar tassels, and similar DNA, amino acid, and nutritional compositions. Even examination with a scanning electron microscope cannot distinguish the pollen of annual types of teosinte from small-seeded varieties of corn (such as early domesticated maize).

In recent years, new botanical evidence has further clarified the ancestral role of the plant that the Aztecs called *teocentli* (God's ear of corn). Biologist John Doebley, of the University of Wisconsin, and botanist Hugh Iltis, emeritus professor at the University of Wisconsin, compared six diverse kinds of teosinte. They found that two annual teosintes were most similar in morphology and other characteristics to maize. Later studies by Doebley determined that the specific proteins from one of these annual teosinte subspecies (*Zea mays parviglumis*) were indistinguishable from those of maize. The *parviglumis* teosinte was more similar to

inflorescence The flowering part of a plant.

teosinte (Aztec, *teocentli*) A tall annual grass, native to Mexico and Central America, that is the closest relative of maize.

maize than any of the other teosintes. Doebley even demonstrated that a geographic cluster of the *parviglumis* subspecies growing at an elevation of 400–1200 m (1300–3900 ft) along the slopes of the central Balsas River drainage, 250 km (155 mi) west of the Tehuacán Valley, was more biochemically similar to maize than the other geographic subpopulations of this plant. In fact, recent genetic analysis by Doebley and his colleagues suggests that a small number of single-gene changes could account for the transformation of these annual teosintes into maize. The Balsas drainage, largely unknown archaeologically, may be a promising area for pursuing the initial domestication of maize.

To date, archaeological findings have supplemented but not resolved these debates. Archaeological deposits at Guilá Naquitz, dating to the seventh or eighth millennium B.C., contained bean and squash seeds and grains of *Zea* pollen. Yet we do not know whether the pollen came from maize or teosinte, or how the pollen was transported into the cave. Today, teosinte often grows in the same fields with beans, squash, and maize. Teosinte is a weedy pioneer that thrives in disturbed areas such as seasonally wet streambeds and abandoned campsites. Although teosinte can be neither popped nor ground into flour as easily as maize, the wild plant is occasionally eaten as a low-choice or "starvation" food in times of need. Young teosinte ears could have been eaten for their sugary taste. Seasonally, stems of the plant may have been (and are still) chewed, because the pith stores so much sugar.

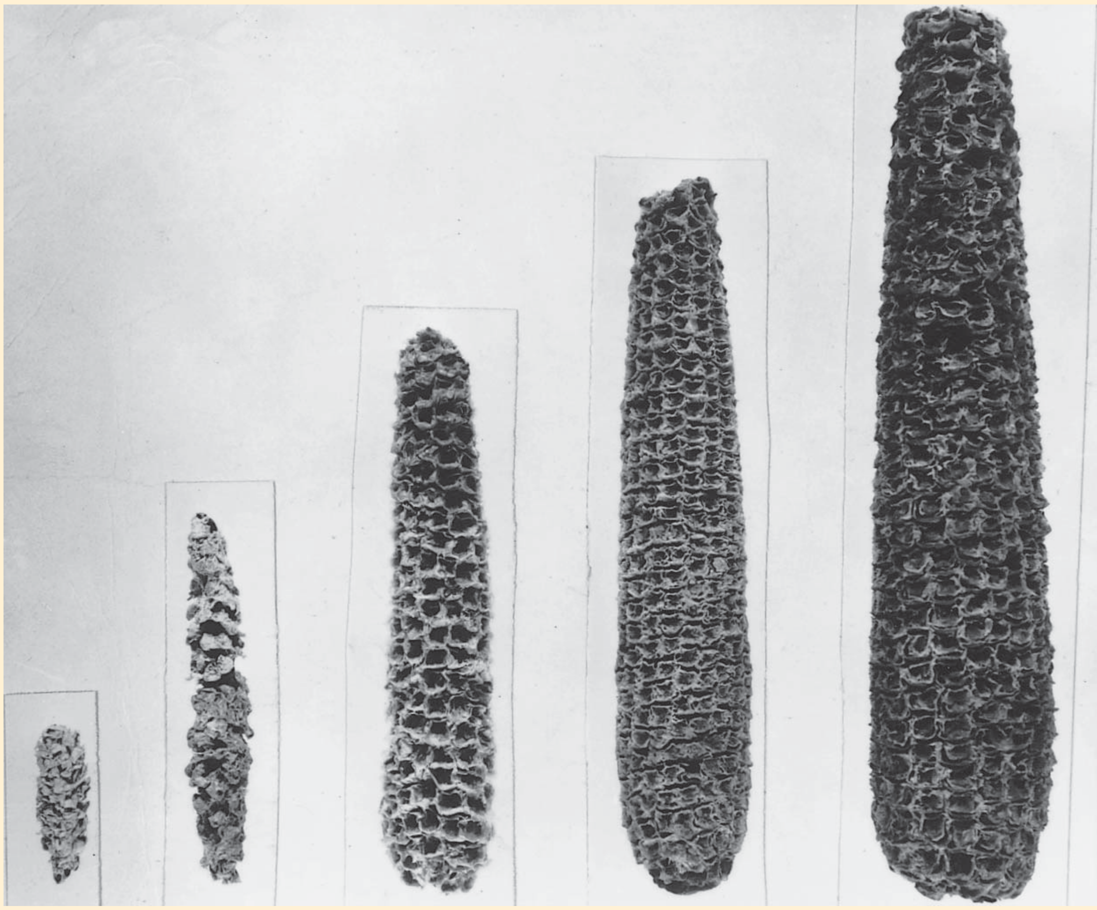


Figure 4.53 Archaeological corncobs recovered during excavations of Tehuacán cave strata document the increasing size of the maize ears through time.

According to Richard MacNeish's Tehuacán research, the earliest domesticated corn remains appear in cave deposits dating to the end of the sixth millennium B.C. The original dating of these Tehuacán cave strata was accomplished through the conventional radiocarbon analysis of charcoal samples.

Two decades ago, the early dates for Tehuacán maize were questioned, based on subsequent direct radiocarbon accelerator dating of the early maize cobs themselves. Accelerator mass spectrometry enables researchers to count individual carbon-14 atoms, rather than relying on the conventional counting of radioactive disintegrations (see "Radiocarbon Dating," Chapter 3, p. 137). As a result, they can handle much smaller samples. Recent analysis dates the early Tehuacán maize to the mid-fourth millennium B.C., several thousand years more recent than previously thought. The new AMS dates therefore provide a new date for the arrival of maize in the Tehuacán Valley. Nevertheless, at the same time, pieces of maize cob from strata at Guilá Naquitz have been dated to approximately 4200 B.C., indicating that maize domestication may well have occurred to the west of Tehuacán, possibly in the Balsas.

On the basis of these new AMS dates from the valleys of Oaxaca and Tehuacán and other innovative analysis, it is clear that the highland Mesoamerican people who adopted maize were organized in small, seasonally mobile societies. These groups added corn to their way of life, perhaps as early as 10,000 years ago, without radically changing their social or economic behavior. Not surprisingly, this relatively primitive maize does not appear to have become an immediate preceramic dietary staple. Although we cannot directly determine the role of human selection in the evolution of these early ears, later deposits and contexts from the Tehuacán Valley reveal a record of increasing cob size, from the earliest tiny cobs to the much larger and more productive ears (with bigger kernels and more seed rows) grown today (Figures 4.53 and 4.54). The important role of human selection in this latter process is evident.

Figure 4.54 The role of human selection in the domestication of corn is evident in the increasing size of the cob: (a) teosinte, (b) early maize, and (c) modern maize, all drawn to the same scale.

Site

Tehuacán

The evolution of early maize

Figure 4.55 Excavated units in Coxcatlán Cave in Tehuacán show its stratigraphy.

Mesoamerica The region consisting of central and southern Mexico, Guatemala, Belize, El Salvador, and the western parts of Honduras and Nicaragua that was the focus of complex, hierarchical states at the time of Spanish contact.

In the early 1960s, when Richard MacNeish began his fieldwork in the highland Tehuacán (tay-wa-CON) Valley in Puebla, Mexico, little was known about either the preceramic occupation of **Mesoamerica** or the beginnings of agriculture in the Americas. Before MacNeish's work, Mesoamerica was theorized to be a hearth of early agriculture. Yet no archaeological evidence existed to support that hypothesis.

MacNeish chose to search for the origins of maize (*Zea mays*) in the relatively small Tehuacán Valley for two reasons. First, because of the region's dryness, preservation was unusually good. Preliminary excavations unearthed fragments of basketry and plant materials in limestone cave deposits. Second, MacNeish already had recovered tiny 5000-year-old corncobs in caves in both the northeastern Mexican state of Tamaulipas and the southern state of Chiapas. He reasoned that the earliest domesticated *Zea* should be still older and would be found in a highland region such as Tehuacán, located between Tamaulipas and Chiapas.

MacNeish designed his Tehuacán research to examine two critical

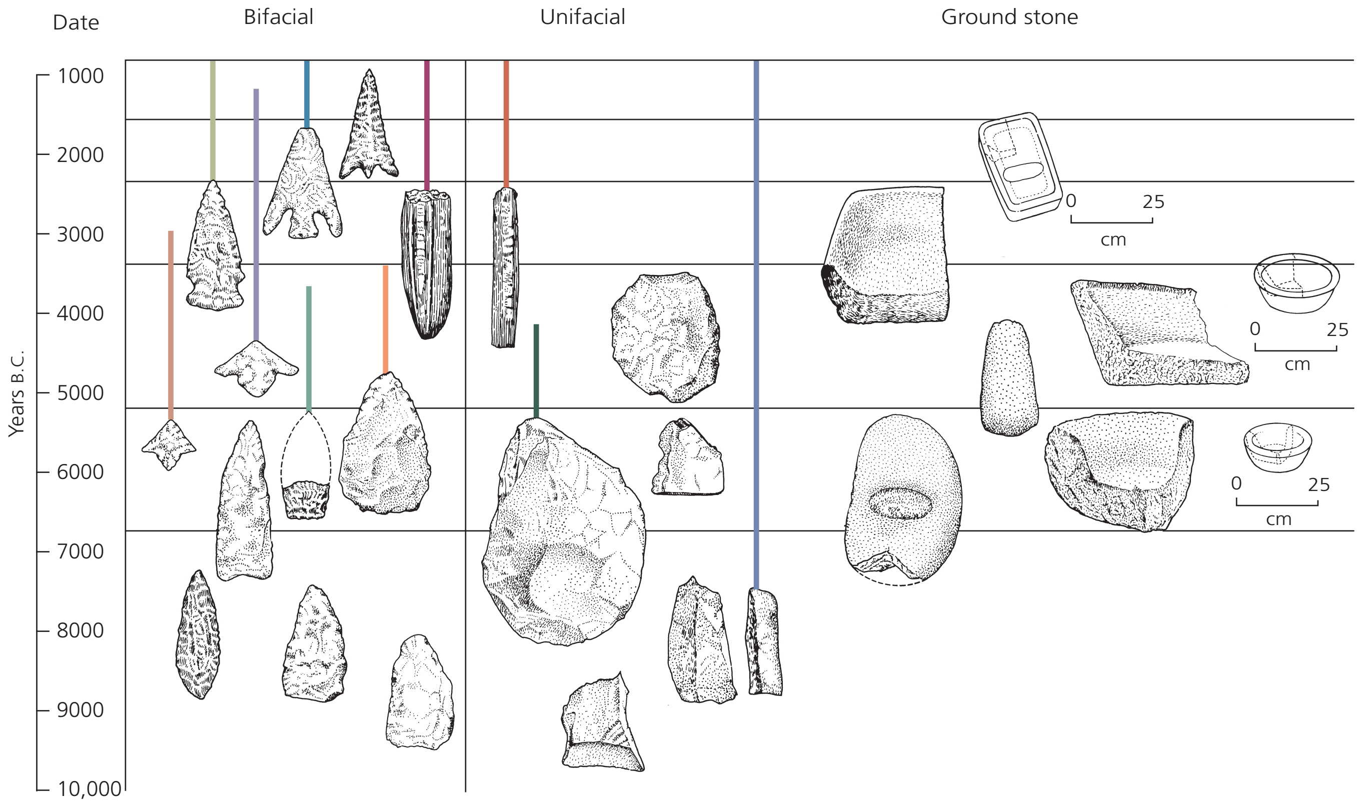


Figure 4.56 Changes in the flaked and ground stone industry in Tehuacán, 10,000–1000 B.C.

questions: (1) What led to the domestication of maize? (2) How did these changes lay the foundation for later Mesoamerican civilization? He undertook a large survey that located more than 450 prehispanic sites over the 1500 sq km (575 sq mi) of the valley and excavated at a series of 12 cave and open-air deposits, including Coxcatlán Cave (Figure 4.55). Controlled stratigraphic excavations, combined with a large number of radiocarbon dates, enabled MacNeish to reconstruct an unbroken 12,000-year sequence of occupation, at that time the longest recorded in the Americas. For the first time, a picture of early presedentary, preceramic society in Mesoamerica could be sketched, using both artifacts and the plant and animal remains preserved in dry caves of Tehuacán (Figure 4.56).

During the preceramic era, according to MacNeish, the few people of the Tehuacán Valley lived in microbands that dispersed periodically. Some camps accommodated only a single nuclear family, while others sheltered much larger groups. The plant and animal remains recovered from preceramic sites in Tehuacán's diverse topographic zones led to the recognition that the **seasonality** of resource availability and the **scheduling** of resource extraction were critically important in determining the annual regime. More specifically, the early inhabitants of Tehuacán scheduled their seasonal movements across the highland region, from the riverbanks to the foothills to the mountains, to coincide with the periodic availability of local plant and animal species.

For most of the preceramic era, such game as rabbits and deer supplemented plants in the diet. During the May–October rainy season, edible plants were more abundant, and a diversity of seeds, cactus fruits, and berries were exploited, in addition to the bountiful seedpods of the mesquite tree. Rabbits, rodents, lizards, and other small animals were consumed at this time of year, when the size of human groups

From a personal point of view, and closely connected with satisfying my innate curiosity, has been the thrill of discovery of art and artifact and the fact that these objects have remained unknown to anyone until my little trowel or paintbrush uncovered them—often after long periods of searching for these new and thrilling finds. I have been doing archaeology now for over forty years but the thrill is still there and I feel that this thrill should happen to anyone and everyone.

—Richard MacNeish (1978)

seasonality The changing availability of resources according to the different seasons of the year.

scheduling The process of arranging the extraction of resources according to their availability and the demands of competing subsistence activities.

How and why has AMS dating of archaeological samples revolutionized our perspective on early agriculture?

setaria A wild grass with edible seeds.

was generally larger. Although some fruits were still available in the early part of the dry season (November and December), cactus leaves and deer apparently were the staples during the dry spells that lasted from January to April.

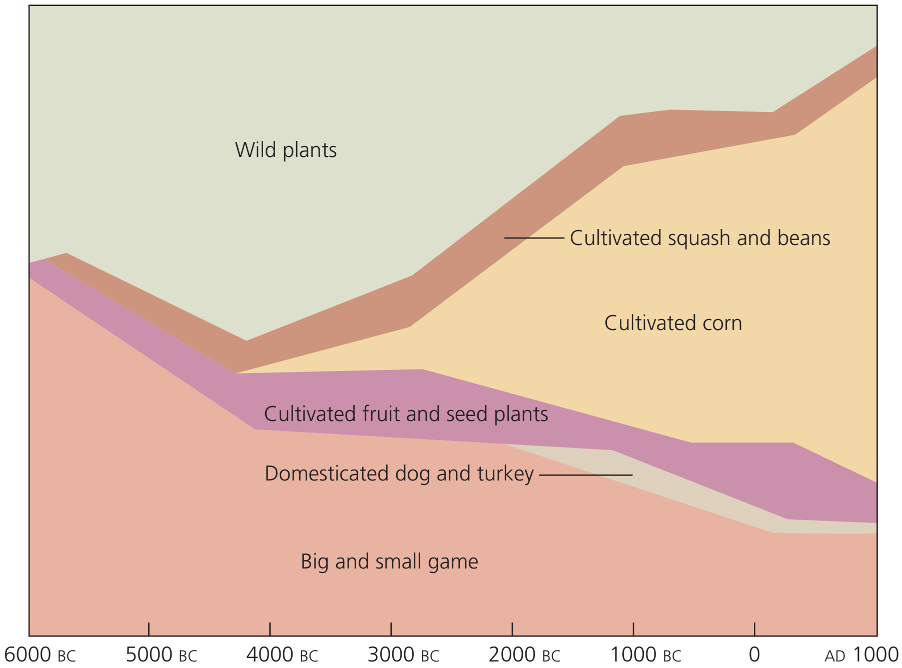
Although this way of life persisted for at least 6400 years, from about 8000 to 1600 B.C., several important dietary changes did take place. A wild ancestor of the domesticated squash was used by roughly 8000 years ago, probably as a container or for its protein-rich seeds. Thereafter during this 6400-year period, domesticated varieties of squash and maize appeared. These early maize ears were small (about the size of an index finger) and contained no more than eight rows of kernels (see Figure 4.54). These early domesticated plants did not immediately provide a large portion of the diet, which still was based primarily on wild plants and animals. Thus these initial experiments in plant domestication occurred among a population that was largely mobile and remained so for thousands of years.

Somewhat enigmatically, the bone chemistry assay of human bones from the Tehuacán excavations provides a rather different picture for the period after 5000 B.C. (see "Bone Chemistry and Prehistoric Subsistence," Chapter 3, p. 162). These studies indicate a smaller amount of meat in the diet than is seen in the archaeological deposits, as well as a greater role for either early cultigens or wild ***setaria*** grass, the seeds of which were present but not recovered in abundance in the archaeological record (Figure 4.57). Yet the relative importance of meat inferred from archaeological deposits is not very surprising, given that bone generally preserves better in ancient deposits than do smaller plant materials.

In addition to the gradual increase in the overall proportion of both wild and domesticated plant foods in the diet, the Tehuacán sequence reveals an increase in population and a decrease in residential mobility. Based on the size and number of sites known from the preceramic phases, the total population density for the Tehuacán Valley, though low, appears to have increased severalfold during this period. Although the earliest sedentary villages in Tehuacán did not occur until 4000–3000 years ago, the length of site occupation increased, and the size of sites grew during the preceding millennia. A single circular pithouse, the earliest known in Mesoamerica, was found in a 5000-year-old level at an open-air site in the region. Later preceramic occupations also tend to have more storage features.

There is little question that MacNeish's Tehuacán research has revolutionized our knowledge of early Mesoamerica, as well as our understanding of the diversity of situations in which early agriculture developed. In the Tehuacán Valley, the first experiments toward plant domestication occurred among people who remained residentially mobile for thousands of years, a sequence that is very different from what has been long known for early farming in Southwest Asia.

The wild ancestors of the major Mesoamerican cultigens—maize, beans, and squash—were all highland plants. Thus it is not surprising that the earliest archaeological evidence for Mesoamerican agriculture has been found in highland valleys such as Tehuacán and Oaxaca. The dry caves in these upland valleys are recognized for their superb archaeological preservation. Yet some of Mesoamerica's earliest sedentary villages were established in the lowlands, where the highland cultigens eventually were incorporated into a coastal subsistence economy that also included marine resources and lowland plants.



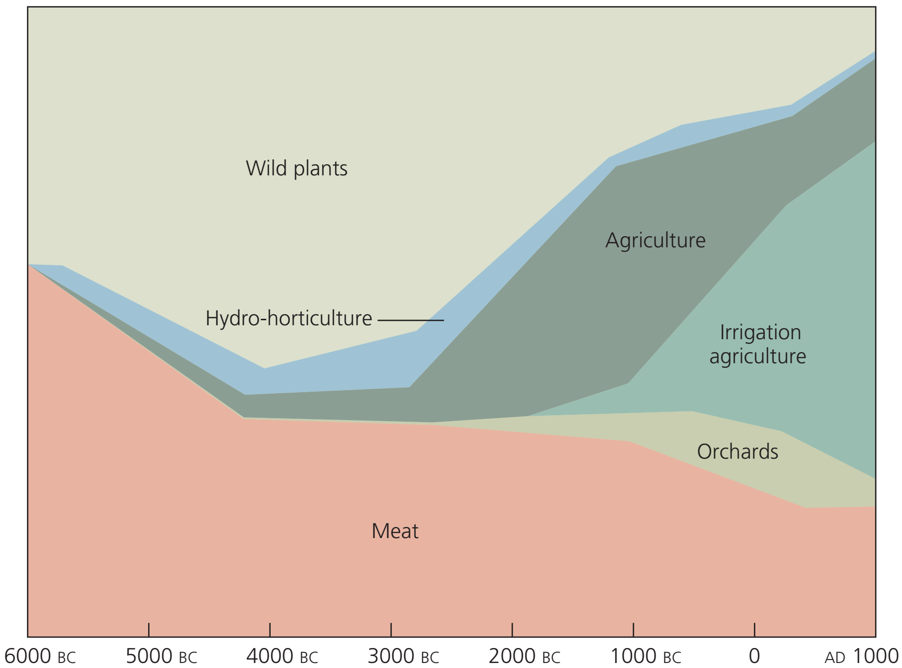


Figure 4.57 Changes in diet and farming strategies in the Tehuacán Valley, 6000 B.C.–A.D. 1000.

Site

Guitarrero Cave

The origins of domestication in the high Andes

A century before the arrival of the Spanish in the sixteenth century A.D., prehispanic America's largest empire was in place along the western side of South America (see Chapter 7). This political domain stretched from the Inca capital of Cuzco, in Peru's southern highlands, down into Chile and northwestern Argentina and up through Ecuador. It encompassed high Andean mountain slopes, Pacific coastal deserts, and the western fringes of the Amazonian tropics. The Inca established a network of roads and trails to move people and goods across these diverse topographic zones.

Thousands of years before the beginnings of Inca expansion, the earliest steps toward agriculture were taken in this part of South America, where the high Andes are sandwiched by a coastal desert and a tropical rain forest. Although roads were not yet built, communication between these environments was critical to the beginnings of Andean domestication. By 10,000–8000 years ago, Amazonian plants had been introduced into the Andes. After 6000 B.C., morphologically wild plants and animals from the rain forest and mountains were present at sites established along the Pacific. Yet the earliest indications for cultivation and domestication appear in the mountains.

As mentioned in the earlier discussion of Monte Verde, human groups first arrived in South America as mobile hunters and gatherers, using stone implements and eating a variety of foods (see "Monte Verde," Chapter 3, p. 143). They spread rapidly across the continent. Although earlier sites have been reported, archaeologists have a much more complete understanding of the past 10,000–12,000 years in the Andean highlands. One of the important sites for the early period is Guitarrero (ghee-ta-RARE-o) Cave, a large natural rockshelter at 2580 m (8500 ft) above sea level in the mountains of northern Peru (Figure 4.58). First occupied more than 10,000 years ago, Guitarrero Cave served as a campsite for thousands of years, accumulating a valuable record of the beginnings of domestication in the Andes (Figure 4.59).

Figure 4.58 The location of Guitarrero Cave in the mountains of northern Peru.

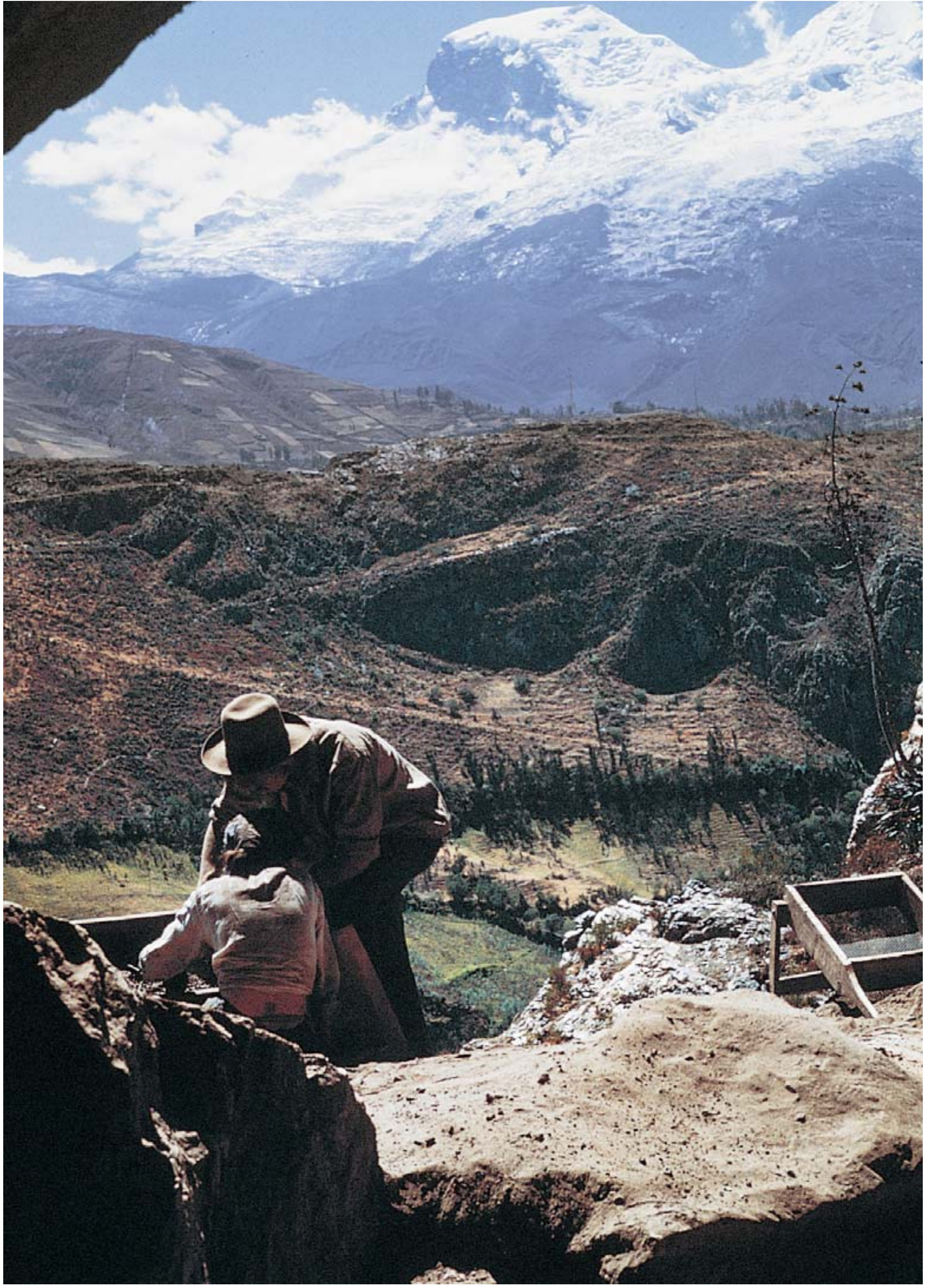


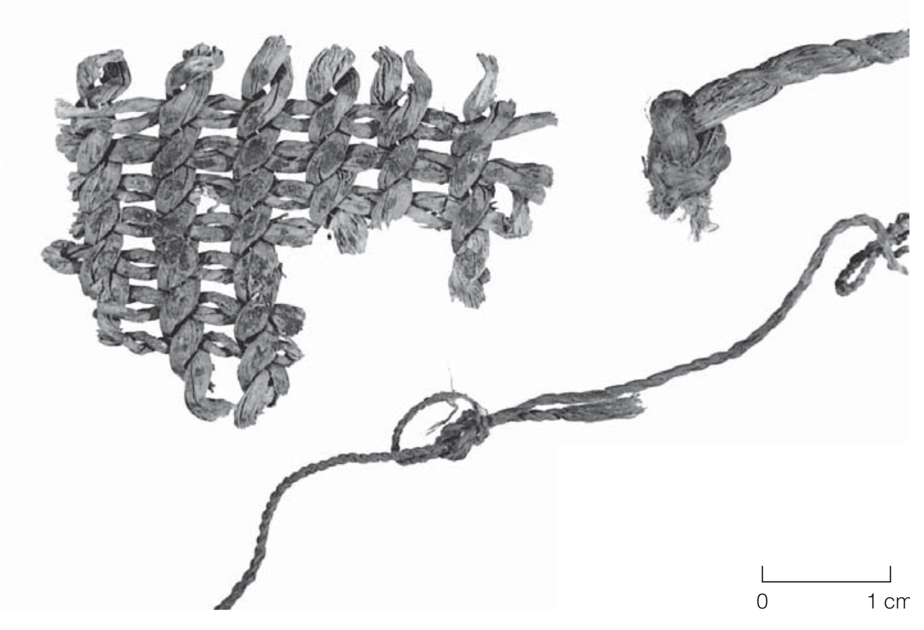
Figure 4.59 A view of the Andes from Guitarrero Cave, a large natural rockshelter situated 2.5 km above sea level in the mountains of northern Peru. The site was first used by Native Americans more than 10,000 years ago and contains a valuable record of the beginnings of domestication in the South American highlands.

Thomas F. Lynch, of Cornell University, directed excavations in the cave during the late 1960s (Figure 4.60). The dry highland cave environment preserved many organic materials, and polished bone knives, fragments of gourd bowls, cordage, basketry, and textiles were recovered (Figure 4.61). C. Earle Smith noted that the total bulk of the inedible fibrous plants was roughly equivalent to that of the food plant remains at the site, suggesting that the Andean utilization of fibers and textiles had a very early origin. The basic twining, or finger-weaving, technique, used to create many of the textiles at Guitarrero Cave, is clearly an important step toward the elaborate techniques used for later prehispanic Andean fabrics.

Organic remains also revealed continuity in another important Andean cultural pattern: communication and exchange between different environmental areas. Guitarrero Cave, on the western slope of the Andes, sits in

Figure 4.60 Excavating the early Archaic deposits at Guitarrero Cave.

Figure 4.61 Basket fragments recovered from Guitarrero Cave.



the middle of three principal environmental zones. The high-altitude shelter faces the exceedingly dry, narrow Pacific coastal zone. To the east, over the Andes, are the wetter, tropical eastern slopes, or ***montaña*** zone, which grades down to the Amazon jungle. The presence of lima beans, a plant native to the Amazon Basin, in archaeological levels dated to roughly 8000 years ago, reveals both the antiquity of pan-Andean connections, at least in an indirect, down-the-line fashion (passing from person to person, group to group over long distances), and the origins of cultivation in South America.

As with the lima bean, many wild ancestors of the major South American domesticated plants, including manioc, peanut, guava, and coca, were native to the eastern side of the Andes. Yet because of the poor archaeological preservation in the *montaña* zone, we know little about the first stages in the process of cultivation and domestication. Other root crops, such as the potato, are indigenous to the mountain zone. Unfortunately, efforts to learn the origins of root crops are hampered because these plants reproduce asexually (see "The First Farmers," p. 179). Ten thousand years ago, Andean **tubers** and **rhizomes** were prime sources of carbohydrates for the occupants of Guitarrero Cave. Yet these plants may have been wild, collected from higher elevations.

As in highland Mesoamerica, the first steps toward cultivation and domestication in the Andean highlands resulted in few immediate changes in society. In both regions, the preceramic era was characterized for thousands of years by continued mobility and a rather resilient diet. At Guitarrero Cave, the earliest inhabitants relied for generations on a variety of tubers, rhizomes, and squash for carbohydrates; several kinds of beans for plant protein; and wild fruits, along with a variety of chili peppers, for minerals and vitamins.

Analysis of the faunal remains from Guitarrero by Elizabeth Wing, emeritus curator at Florida Musuem of Natural History, indicates that deer, camelids, rabbits, and a range of small animal and bird species were hunted. Wing observed a steady decline in the number of deer bones and an increase in those of camelids through time, a pattern also seen at other Andean sites from this time and particularly at sites in the higher grassland, or ***puna,*** region. In the Andes, the increase in camelid remains is only part of the evidence for manipulation and eventual domestication (for both meat and wool) of the larger llama and the smaller alpaca. The larger llama also served as a pack animal, carrying goods across the Andes. Another Andean species, the guinea pig, also was domesticated for meat but was not abundant at Guitarrero Cave.

montaña (Spanish) Mountain, specifically referring to the wet, tropical slopes of the Amazonian Andes.

tuber A fleshy, usually oblong or rounded outgrowth (such as the potato) of a subterranean stem or root of a plant.

rhizome An edible, rootlike subterranean plant stem.

puna (Spanish) High grassland plateaus in the Peruvian Andes.

Concept

Agriculture in Native North America

Indigenous plant domestication before the spread of maize

By the time Europeans arrived in the Americas, the maize plant had spread far to the north and south. Its arrival in Central and South America followed the plant's initial domestication in highland Mesoamerica. Yet until recently, the exact timing of the plant's introduction to the south had been a matter of considerable conjecture. The recent AMS dating of maize starch grains that were extracted from charred residue on ceramic cooking vessels has now placed domesticated maize in Ecuador by around 3000 B.C. In South America, maize supplemented a range of other agricultural plants that were indigenously domesticated.

The history of maize in the Americas north of Mexico is somewhat clearer. Maize reached the Southwest by 2100 B.C., and from there it apparently was carried across the Great Plains and arrived in the Eastern Woodlands by approximately 200 B.C.–A.D. 200. Although the timing of maize's North American arrival is now better established, the role of the exotic domesticates in the beginnings of North American agriculture is still a matter of discussion. Formerly, most scholars postulated that agriculture in eastern North America began in response to the diffusion of exotic domesticated plants (specifically, squash) from the south, but that view is beginning to be challenged in the face of mounting archaeological and genetic evidence.

Based on excavations at a range of sites in eastern North America, from Ohio to Arkansas, archaeologists have found that native North American seed plants were domesticated in riverine floodplain settings as early as 2500–1500 B.C. The plants include chenopod (*Chenopodium berlandieri,* also known as goosefoot or chia), sunflower (*Helianthus annuus*), and marsh elder (*Iva annua,* var. *macrocarpa*). In each case, botanical studies have shown that the domesticated varieties have larger (Figure 4.62) and morphologically different seeds than the wild ancestors (Figure 4.63). As in Mesoamerica and South America, these domesticated seed plants were incorporated into the diet of mobile peoples, who also exploited a range of wild foods.

Although AMS dates on the maize found in eastern North American caves have consistently placed the arrival of this Mesoamerican plant well after the domestication of native North American seed plants, the picture is a bit fuzzier for squash (*Cucurbita pepo*). Small carbonized pieces of squash rind were recovered in flotation samples collected at river valley sites in Illinois

Figure 4.62 The seeds of domesticated marsh elder, sunflower, and squash (top to bottom, on the right) are larger than those of their wild ancestors (on the left). Larger seeds germinate faster and produce plants that grow more quickly, resulting in greater quantities of food. Selection in the past for larger seeds was an important part of the domestication process of these seed plants.

and Kentucky. These fragments yielded direct AMS dates of roughly 5000–3500 B.C. Although *C. pepo* does include some wild gourds, it is best known for its rich variety of domesticated squashes and pumpkins. Researchers also documented its domestication in highland Mexico around 8000–7000 B.C. The archaeological contexts that produced these early pieces of rind were outside the current range of the Texas wild gourd, another *Cucurbita* species that grows in eastern Texas. An obvious initial conclusion was that domesticated squash was introduced to eastern North America, along with the notion of agriculture, well before the cultivation of native plants.

This first scenario has been challenged by an alternative viewpoint suggesting that *C. pepo* was independently domesticated twice from different ancestral populations of wild gourds. It was domesticated in Mexico and then later in eastern North America around 2500 B.C. (around the same time the indigenous seed plants were domesticated). All the early eastern North American *Cucurbita* rind samples are thin and likely came from wild gourds. Early seeds from these plants also are small, within the range of wild gourds. The earliest morphological marker, larger seed size, of *Cucurbita* domestication in eastern North America did not appear until 2500–2300 B.C. These interpretations are supported by the findings of botanist Deena Decker-Walters. Her biochemical analyses of *C. pepo* have revealed that the species is composed of two developmental lineages, one from Mexico and the other from eastern North America. This view has recently been supported by the discovery of wild squash in the Ozarks of Missouri and Arkansas. This Ozark gourd occupies the same floodplain niche inhabited by two of the seed plants (goosefoot and marsh elder) that were indigenously domesticated in the East.

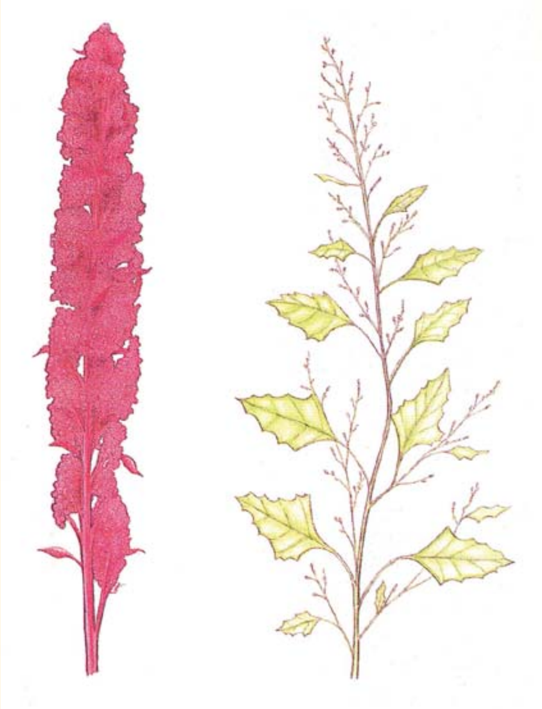


Figure 4.63 The compaction of seeds is a good indicator of domestication. In the wild *Chenopodium* plant known as lamb's-quarters, on the right, seeds are distributed in numerous small clusters. On the left, in contrast, the seeds of a domesticated *Chenopodium* plant are tightly compacted at the top of the main stem.

On the basis of these recent findings, researchers believe that the early squash rind found in eastern North America was probably from a native plant. Consequently, agriculture appears to have occurred indigenously in this North American region, well before the diffusion of the concept or any plant from Mexico.

Concept

Breast-Feeding and Birth Spacing

Ideas about post-Pleistocene demographic growth

The question must be raised. Why farm? Why give up the 20-h [hour] work week and the fun of hunting in order to toil in the sun? Why work harder for food less nutritious and a supply more capricious? Why invite famine, plague, pestilence and crowded living conditions? Why abandon the Golden Age and take up the burden?
—Jack Harlan (1992)

It is indisputable that the beginnings of farming and especially sedentary life were associated temporally with an increased rate of population growth. Because the reasons for that rapid growth are difficult to understand through the archaeological record alone, archaeologists and physical anthropologists have used demographic and physiological analyses of contemporary peoples to gain insight into factors that may have prompted that transition.

Like all significant demographic shifts, the post-Pleistocene changes theoretically could have resulted from changes in migration, mortality, or fertility. Although migration may have become an important factor in certain later agricultural regions, such as Neolithic Europe, it alone cannot account for the rapid growth evidenced in much of the world following food production and sedentism. Although post-Pleistocene mortality rates are difficult to evaluate, several conditions may have promoted increased mortality following agriculture and sedentism. In most instances, agricultural diets were less balanced than hunting-and-gathering diets. In several regions, tooth decay is found in adult burials only after the transition to agriculture. Animal domestication brought people and animals closer and may have led to the genesis of contagious human diseases, apparently beginning as animal viruses or infections. Sedentary populations and higher population densities also may have increased human susceptibility to certain contagious diseases. Thus although longer life spans may have contributed to post-Pleistocene demographic shifts, fertility changes seem to be a more likely impetus.

Demographic studies of contemporary human groups usually, though not always, indicate that settled agriculturalists have higher fertility rates than mobile hunter-gatherers. In human populations numerous factors—including age at marriage, the length of a woman's reproductive period, birth spacing, coital frequency, and the importance of contraception—can affect the number of births each female has during her lifetime. In contemporary studies of recently settled hunter-gatherers, different sets of factors seem to contribute to the frequently noted rise in fertility with the introduction of agriculture and sedentism.

Despite those differences, shortened nursing time and earlier child **weaning** often do occur among recently settled foraging populations. Shorter periods of breast-feeding prompt hormonal changes that increase the chances of conception, so spacing between births often declines when women adopt a shorter nursing period. Alternatively, nursing may stimulate a woman's hormones in a manner that suppresses ovulation and menstruation, a phenomenon known as **lactational amenorrhea.** Prolonged breast-feeding is therefore one factor associated with longer spacing between births.

The Gainj of highland Papua New Guinea, a horticultural village population, have a birth-spacing pattern, without contraception, that is more similar to that of contemporary hunter-gatherers than to that of other farmers. Gainj women breast-feed their infants for an extended period, more than 3 years on average. In part, the Gainj women breast-feed because they lack adequate weaning foods (a characteristic of many hunter-gatherers as well).

weaning The process of transferring the young from dependence on its mother's milk to other forms of nourishment.

lactational amenorrhea The suppression of ovulation and menstruation during breast-feeding.

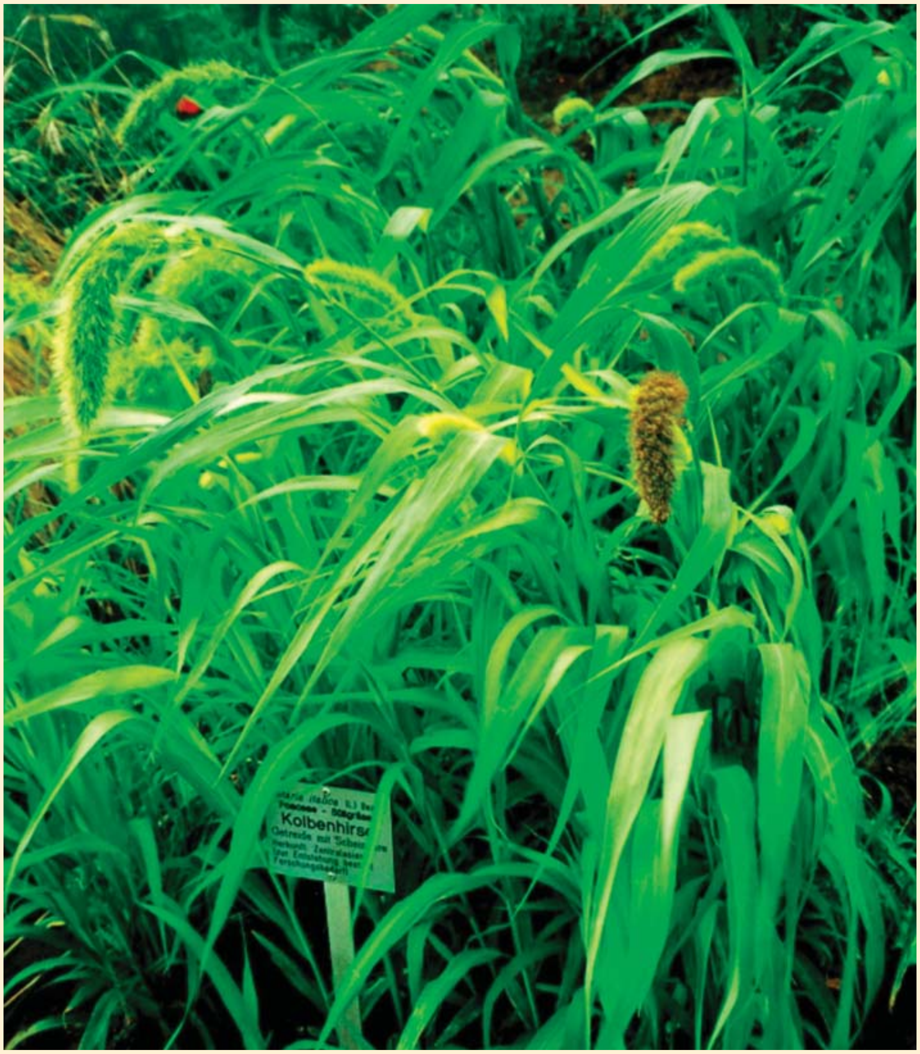


Figure 4.64 Millet was an early domesticated plant in China, and various subspecies were domesticated or used in Africa and Europe.

The Gainj agricultural staples—sweet potatoes, yams, and taro—are not easy to digest, nor are they the compact sources of nutrients required for weaning, since infants consume only small amounts of food daily.

In contrast, the Neolithic staples, which included cereal grains in most regions, of Southwest Asia provided considerably better alternatives and supplements to mother's milk than are available to the agricultural Gainj. Not only were the high carbohydrate, easy-to-digest grains (such as wheat, barley, and millet) available (Figure 4.64), but milk from sheep, goats, and cattle also could be fed to infants. The increased rate of demographic growth in post-Pleistocene Southwest Asia could have been linked to changing patterns of weaning, nursing, and hence birth spacing.

Images and Ideas

The Spread of Agriculture

The success and consequences of food production

The question "why farm?" strikes most of us modern humans as silly. Of course it is better to grow wheat and cows than to forage for roots and snails. But in reality, that perspective is flawed by hindsight.

—Jared Diamond (2002)

Different concepts and methods are used by researchers who study the Paleolithic and those who investigate agricultural societies. Paleolithic archaeologists tend to excavate in natural stratigraphic levels, often in caves, paying careful attention to the distributions of bone and stone materials. Researchers focused on later agricultural peoples concentrate more on the stratigraphic levels revealed in the architectural remains of past structures, such as temples and houses, and they must analyze pottery and metalwork as well as stone and bone. Because pre-Neolithic sites have fewer artifacts and are often deeply buried, systematic regional surveys, which find and map archaeological remains visible on the land surface, are rarely as practical or as useful for the specialist in the Pleistocene as they are for many archaeologists who study later periods.

These differences in archaeological perceptions and practices reflect real changes in the nature of the archaeological record that began 10,000–3000 years ago in many (though not all) areas of the world. In most regions, Paleolithic sites tend to be small, thin scatters of lithic materials, reflecting generally lower populations and the tendency for occupations to involve fewer people over shorter periods of time. The low artifactual densities and the general absence of substantial structures at prefarming sites also suggest greater residential mobility.

In many regions, the presence of residential and civic architecture and cemeteries at archaeological sites is unique to prehistoric farming societies. In addition, whereas the artifacts of the Paleolithic—spearpoints, knives, and scrapers—tended to be largely for capturing energy (food), "facilities"-materials (stone bowls, ceramic containers) and features (pits)-to store energy became much more important in later eras. Kent Flannery aptly noted that there are more storage facilities at 'Ain Mallaha alone than are known from all earlier Southwest Asian sites, indicating a sudden transition to residential stability, with its implied social and economic adjustments.

The archaeological record reveals that a more sedentary way of life, plant and animal domestication, and pottery were not adopted simultaneously, nor did those changes occur in a single or uniform sequence in all regions. For example, sedentary villages preceded any evidence for plant domestication in Southwest Asia, whereas the domestication of maize, beans, and squash occurred before the earliest Mesoamerican villages. Furthermore, although the Mesoamerican combination of beans and corn provides a complete protein source, as well as adequate calories, some of the other staple grains (barley and rice) are high in carbohydrates but low in protein. In addition, the domestication of animals clearly was a much more significant part of the Neolithic transition in the Old World than in the Americas. Many of the regions of early, indigenous domestication were relatively arid (Southwest Asia and highland Mexico). Yet that was not the case in either South China or the riverine settings of eastern North America.

Given the varied climatic, demographic, and cultural conditions of the early Holocene, the successful adoption and rapid spread of food production clearly was a widespread phenomenon. In regions where indigenous resources were not domesticated, exotic cultigens and animals often were quickly introduced and adopted. Once domesticated, wheat and barley were transmitted rapidly to the Nile Valley, many parts of Europe, and North China as a supplement to millet. In the river valleys of eastern North America, maize from Mexico

Figure 4.65 Some major African food crops (left to right): yam, finger millet, and sorghum.

was incorporated into local agricultural complexes that included different combinations of oily seed plants, such as marsh elder and goosefoot.

The Neolithic transition apparently was an even more complex mosaic in sub-Saharan Africa. Imported sheep and goats were introduced from Southwest Asia into diverse economies that locally domesticated more than a dozen plant species, including finger millet (Ethiopia and northern Uganda), sorghum (Lake Chad to the Nile), African rice (middle delta of the Niger), tiny-seeded teff (Ethiopia), and yams (West Africa) (Figure 4.65). Whereas domesticated sheep and goats clearly were foreign, the origins of domesticated cattle in sub-Saharan Africa are less certain; they either were exotic or were domesticated independently in northern Africa, where they were present by the fifth millennium B.C. As in Japan, where ceramics preceded food production, pottery vessels were found at sites occupied by semisedentary fisher-foragers from the fifth and sixth millennia B.C. in the Sudan, as well as along the margins of now-dry lakebeds south of the Sahara Desert.

The beginnings of cultivation also are being unraveled in the islands of the Pacific, where the transition from foraging to farming clearly was more gradual, with few stark or immediate shifts in lifeway. On the basis of recent studies by Tim Denham, of Monash University in Australia, and his colleagues at the Kuk Swamp site in the highlands of New Guinea, it appears possible that the banana may have been cultivated as early as 7000 years ago.

From a global perspective, food production emerged over the past 12,000 years, broadly coincident with major cultural changes that have shaped the course of recent human history, along with significant climatic and sea-level shifts. Just as the Neolithic creates a divide in the archaeological record and among archaeologists, the beginnings of domestication are generally (although not always) linked in time with more permanent or sedentary communities, changing social and political relationships, larger and denser populations, new technologies, and shifting networks of exchange and communication. The complexity of these relationships and their diversity from region to region make it difficult to decipher the exact causes for prehistoric changes. Yet archaeologists have developed some ideas by studying contemporary peoples, particularly those who have recently shifted from a mobile hunting-and-gathering way of life to more sedentary and agricultural pursuits.

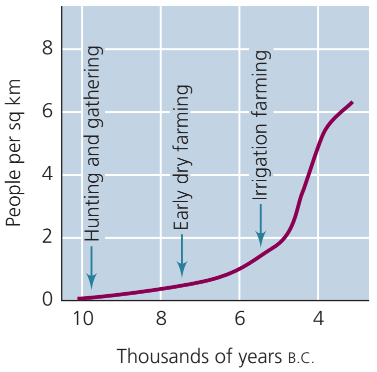
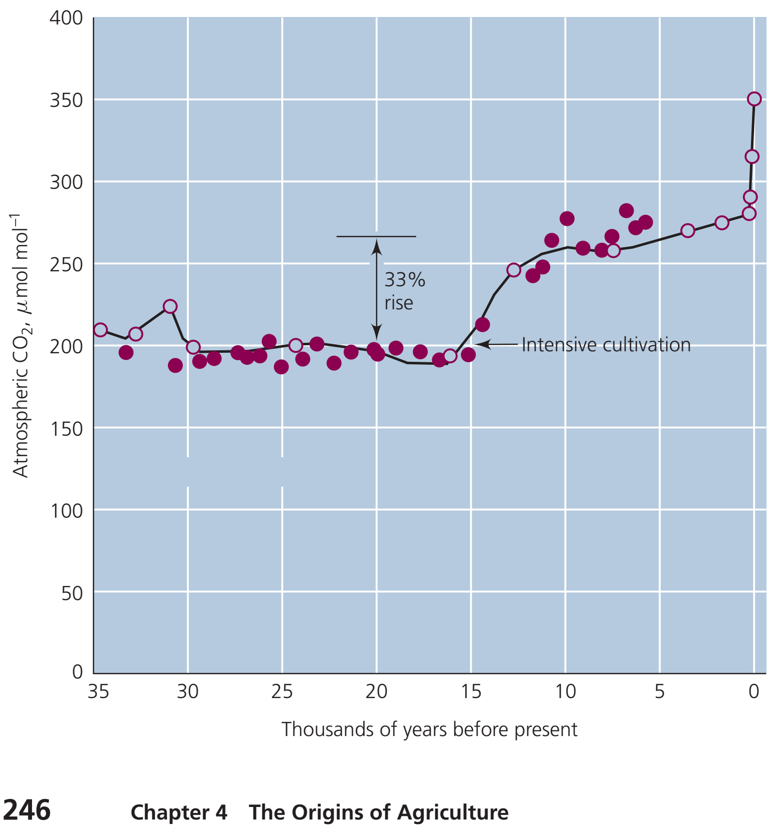


Figure 4.66 Population densities associated with different subsistence strategies.

Soil erosion, desertification, water pollution and soil degradation are intimately related to agriculture in terms of both the past and the present; they are not phenomena of the twentieth century.

—Antoinette Mannion (1999)

Figure 4.67 A graph of carbon dioxide levels in the atmosphere for the past 35,000 years. Note particularly the big increase between 15,000 and 10,000 years ago and then again in recent decades.



During the Pleistocene, human populations grew at a slow pace (Figure 4.66). If modern hunter-gatherer populations are a reliable guide, a few individuals may have separated from parent groups when resources were exhausted or when disputes became common. In larger campsites, the latter could have been a potential problem, because as the population grows, the number of interactions between individuals increases even more rapidly. By the end of the Pleistocene, with the peopling of most of the continents (albeit at low densities), fissioning would have become less of an option for many groups. This pattern may partially account for observed late Pleistocene–early Holocene increases in local population densities, residential stability, greater reliance on lower-quality foods, and decreases in social group territory sizes.

Over the past 10,000 years, the earth's population has doubled 10 times, from less than 10 million people to more than 7 billion. Following the end of the Pleistocene, the more rapid rates of demographic growth may have related in part to changing patterns of child rearing and diet. Recently settled hunter-gatherers often witness a reduction in birth spacing. A mobile way of life limits the number of infants a family group can transport and hence care for at any one time. Intensive exercise and prolonged breast-feeding have been suggested as factors that temporarily diminish a woman's fertility. With increased sedentism, storage, and domestication, both the frequency of intensive female activity and the length of the nursing cycle may have decreased. Contemporary hunter-gatherers tend to breast-feed for 2–6 years because of the frequent absence or unreliability of soft weaning foods. The storable, staple cereal grains provide such an alternative food to mother's milk. In certain regions, animal milk also could be substituted.

More productive and storable food resources may have permitted larger communities and denser populations, yet a series of organizational changes often occurred at roughly the same time. For long-term maintenance and survival, larger communities would have required new mechanisms for integration, cooperation, the resolution of disputes, and decision making. Kin relationships are severely tested when decisions must be made for groups of several hundred. Increased evidence for burials, ritual objects (e.g., figurines), nonresidential structures, more formal patterns of exchange, and in some cases more unequal access to goods and labor would seem to signal these very significant changes in social and political relationships. Some of these new organizational forms were hierarchical, with more permanent, formal leadership roles instituted above the remainder of the population. Such leaders or decision makers, in turn, may have fostered greater concentrations of resources and labor, leading to intensified production and even larger communities.

The transition to agriculture and sedentism occurred at the onset of a rapid succession of changes that have culminated in our modern world (Figure 4.67). The pace of these recent changes is truly remarkable when viewed from the perspective of all of human history. Although neither domestication nor sedentism alone is necessary and sufficient to explain the formation of early cities and ancient states, both permanent communities and food production are critical elements of those very significant, later developments.

DISCUSSION QUESTIONS

1. Where are the cradles of agriculture around the world?
2. What are the most important of the early domesticated plants and animals?
3. Discuss the different kinds of natural environments in which early domestication took place.
4. Australia is one of the few places within the limits of cultivation where agriculture did not spread. Why might that be?
5. Compare the process of change from foraging to farming in Southwest Asia and highland Mesoamerica.
6. Compare and contrast the role of social, environmental, and demographic factors in the emergence of agriculture in different areas of the world.
7. Discuss how and why human lives tended to change with the advent of sedentary settlements.
8. What are the long-term implications of the origins of agriculture in regard to contemporary concerns about the environment, natural resources, and ecological diversity?

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For more review material and study questions, see the self-quizzes on your online learning center.

SUGGESTED READINGS

For Internet links related to this chapter, please visit our Web site at www.mhhe.com/priceip7e.

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