PREFACE TO THE PAPERBACK EDITION

WHY IS WORLD HISTORY LIKE AN ONION?

THIS BOOK ATTEMPTS TO PROVIDE A SHORT HISTORY OF everybody for the last 13,000 years. The question motivating the book is: Why did history unfold differently on different continents? In case this question immediately makes you shudder at the thought that you are about to read a racist treatise, you aren't: as you will see, the answers to the question don't involve human racial differences at all. The book's emphasis is on the search for ultimate explanations, and on pushing back the chain of historical causation as far as possible.

Most books that set out to recount world history concentrate on histories of literate Eurasian and North African societies. Native societies of other parts of the world—sub-Saharan Africa, the Americas, Island Southeast Asia, Australia, New Guinea, the Pacific Islands—receive only brief treatment, mainly as concerns what happened to them very late in their history, after they were discovered and subjugated by western Europeans. Even within Eurasia, much more space gets devoted to the history of western Eurasia than of China, India, Japan, tropical Southeast Asia, and other eastern Eurasian societies. History before the emergence of writing around 3,000 B.C. also receives brief treatment, although it constitutes *99.9%* of the five-million-year history of the human species.

Such narrowly focused accounts of world history suffer from three disadvantages. First, increasing numbers of people today are, quite understandably, interested in other societies besides those of western Eurasia. After all, those "other" societies encompass most of the world's population and the vast majority of the world's ethnic, cultural, and linguistic groups. Some of them already are, and others are becoming, among the world's most powerful economies and political forces.

Second, even for people specifically interested in the shaping of the modern world, a history limited to developments since the emergence of writing cannot provide deep understanding. It is not the case that societies on the different continents were comparable to each other until 3,000 B.C., whereupon western Eurasian societies suddenly developed writing and began for the first time to pull ahead in other respects as well. Instead, already by 3,000 B.C., there were Eurasian and North African societies not only with incipient writing but also with centralized state governments, cities, widespread use of metal tools and weapons, use of domesticated animals for transport and traction and mechanical power, and reliance on agriculture and domestic animals for food. Throughout most or all parts of other continents, none of those things existed at that time; some but not all of them emerged later in parts of the Native Americas and sub-Saharan Africa, but only over the course of the next five millennia; and none of them emerged in Aboriginal Australia. That should already warn us that the roots of western Eurasian dominance in the modern world lie in the preliterate past before 3,000 B.C. (By western Eurasian dominance, I mean the dominance of western Eurasian societies themselves and of the societies that they spawned on other continents.)

Third, a history focused on western Eurasian societies completely bypasses the obvious big question. Why were those societies the ones that became disproportionately powerful and innovative? The usual answers to that question invoke proximate forces, such as the rise of capitalism, mercantilism, scientific inquiry, technology, and nasty germs that killed peoples of other continents when they came into contact with western Eurasians. But why did all those ingredients of conquest arise in western Eurasia, and arise elsewhere only to a lesser degree or not at all?

All those ingredients are just proximate factors, not ultimate explanations. Why didn't capitalism flourish in Native Mexico, mercantilism in sub-Saharan Africa, scientific inquiry in China, advanced technology in Native North America, and nasty germs in Aboriginal Australia? If one responds by invoking idiosyncratic cultural factors—e.g., scientific inquiry supposedly stifled in China by Confucianism but stimulated in western Eurasia by Greek or Judaeo-Christian traditions—then one is continuing to ignore the need for ultimate explanations: why didn't traditions like Confucianism and the Judaeo-Christian ethic instead develop in western

Eurasia and China, respectively? In addition, one is ignoring the fact that Confucian China was technologically more advanced than western Eurasia until about A.D. 1400.

It is impossible to understand even just western Eurasian societies themselves, if one focuses on them. The interesting questions concern the distinctions between them and other societies. Answering those questions requires us to understand all those other societies as well, so that western Eurasian societies can be fitted into the broader context.

Some readers may feel that I am going to the opposite extreme from conventional histories, by devoting too little space to western Eurasia at the expense of other parts of the world. I would answer that some other parts of the world are very instructive, because they encompass so many societies and such diverse societies within a small geographical area. Other readers may find themselves agreeing with one reviewer of this book. With mildly critical tongue in cheek, the reviewer wrote that I seem to view world history as an onion, of which the modern world constitutes only the surface, and whose layers are to be peeled back in the search for historical understanding. Yes, world history is indeed such an onion! But that peeling back of the onion's layers is fascinating, challenging—and of overwhelming importance to us today, as we seek to grasp our past's lessons for our future.

J.D.

CHAPTER 4

FARMER POWER

AS A TEENAGER, I SPENT THE SUMMER OF 1956 IN MONtana, working for an elderly farmer named Fred Hirschy. Born in Switzerland, Fred had come to southwestern Montana as a teenager in the 1890s and proceeded to develop one of the first farms in the area. At the time of his arrival, much of the original Native American population of hunter-gatherers was still living there.

My fellow farmhands were, for the most part, tough whites whose normal speech featured strings of curses, and who spent their weekdays working so that they could devote their weekends to squandering their week's wages in the local saloon. Among the farmhands, though, was a member of the Blackfoot Indian tribe named Levi, who behaved very differently from the coarse miners—being polite, gentle, responsible, sober, and well spoken. He was the first Indian with whom I had spent much time, and I came to admire him.

It was therefore a shocking disappointment to me when, one Sunday morning, Levi too staggered in drunk and cursing after a Saturday-night binge. Among his curses, one has stood out in my memory: "Damn you, Fred Hirschy, and damn the ship that brought you from Switzerland!" It poignantly brought home to me the Indians' perspective on what I, like other white schoolchildren, had been taught to view as the heroic conquest of the American West. Fred Hirschy's family was proud of him, as a pioneer farmer who had succeeded under difficult conditions. But Levi's tribe of hunters and famous warriors had been robbed of its lands by the immigrant white farmers. How did the farmers win out over the famous warriors?

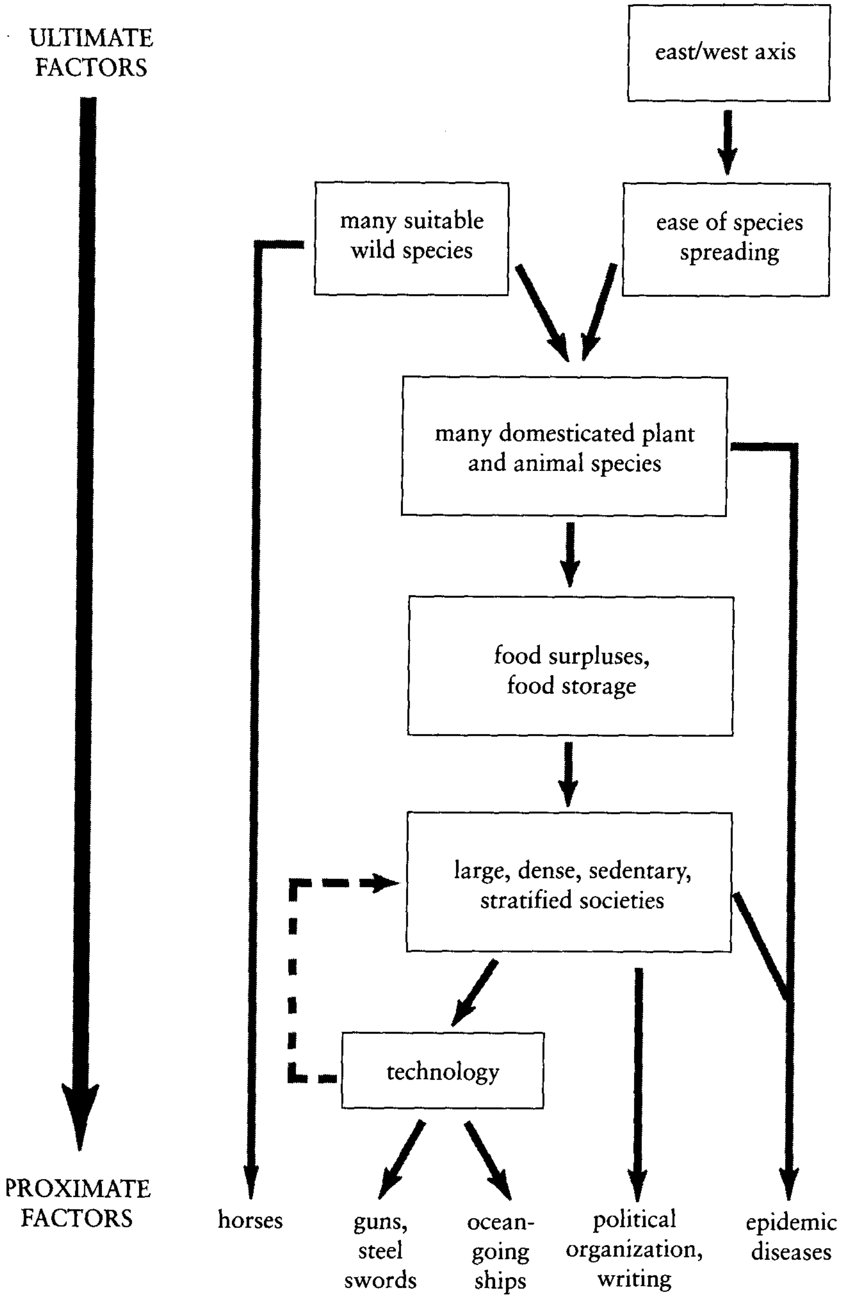
For most of the time since the ancestors of modern humans diverged from the ancestors of the living great apes, around 7 million years ago, all humans on Earth fed themselves exclusively by hunting wild animals and gathering wild plants, as the Blackfeet still did in the 19th century. It was only within the last 11,000 years that some peoples turned to what is termed food production: that is, domesticating wild animals and plants and eating the resulting livestock and crops. Today, most people on Earth consume food that they produced themselves or that someone else produced for them. At current rates of change, within the next decade the few remaining bands of hunter-gatherers will abandon their ways, disintegrate, or die out, thereby ending our millions of years of commitment to the hunter-gatherer lifestyle.

Different peoples acquired food production at different times in prehistory. Some, such as Aboriginal Australians, never acquired it at all. Of those who did, some (for example, the ancient Chinese) developed it independently by themselves, while others (including ancient Egyptians) acquired it from neighbors. But, as we'll see, food production was indirectly a prerequisite for the development of guns, germs, and steel. Hence geographic variation in whether, or when, the peoples of different continents became farmers and herders explains to a large extent their subsequent contrasting fates. Before we devote the next six chapters to understanding how geographic differences in food production arose, this chapter will trace the main connections through which food production led to all the advantages that enabled Pizarro to capture Atahuallpa, and Fred Hirschy's people to dispossess Levi's (Figure 4.1).

The first connection is the most direct one: availability of more consum-

Figure 4.1. Schematic overview of the chains of causation leading up to proximate factors (such as guns, horses, and diseases) enabling some peoples to conquer other peoples, from ultimate factors (such as the orientation of continental axes). For example, diverse epidemic diseases of humans evolved in areas with many wild plant and animal species suitable for domestication, partly because the resulting crops and livestock

Factors Underlying the Broadest Pattern of History



helped feed dense societies in which epidemics could maintain themselves, and partly because the diseases evolved from germs of the domestic animals themselves.

able calories means more people. Among wild plant and animal species, only a small minority are edible to humans or worth hunting or gathering. Most species are useless to us as food, for one or more of the following reasons: they are indigestible (like bark), poisonous (monarch butterflies and death-cap mushrooms), low in nutritional value (jellyfish), tedious to prepare (very small nuts), difficult to gather (larvae of most insects), or dangerous to hunt (rhinoceroses). Most biomass (living biological matter) on land is in the form of wood and leaves, most of which we cannot digest.

By selecting and growing those few species of plants and animals that we can eat, so that they constitute 90 percent rather than 0.1 percent of the biomass on an acre of land, we obtain far more edible calories per acre. As a result, one acre can feed many more herders and farmers—typically, 10 to 100 times more—than hunter-gatherers. That strength of brute numbers was the first of many military advantages that food-producing tribes gained over hunter-gatherer tribes.

In human societies possessing domestic animals, livestock fed more people in four distinct ways: by furnishing meat, milk, and fertilizer and by pulling plows. First and most directly, domestic animals became the societies' major source of animal protein, replacing wild game. Today, for instance, Americans tend to get most of their animal protein from cows, pigs, sheep, and chickens, with game such as venison just a rare delicacy. In addition, some big domestic mammals served as sources of milk and of milk products such as butter, cheese, and yogurt. Milked mammals include the cow, sheep, goat, horse, reindeer, water buffalo, yak, and Arabian and Bactrian camels. Those mammals thereby yield several times more calories over their lifetime than if they were just slaughtered and consumed as meat.

Big domestic mammals also interacted with domestic plants in two ways to increase crop production. First, as any modern gardener or farmer still knows by experience, crop yields can be greatly increased by manure applied as fertilizer. Even with the modern availability of synthetic fertilizers produced by chemical factories, the major source of crop fertilizer today in most societies is still animal manure—especially of cows, but also of yaks and sheep. Manure has been valuable, too, as a source of fuel for fires in traditional societies.

In addition, the largest domestic mammals interacted with domestic plants to increase food production by pulling plows and thereby making it possible for people to till land that had previously been uneconomical for farming. Those plow animals were the cow, horse, water buffalo, Bali cattle, and yak / cow hybrids. Here is one example of their value: the first prehistoric farmers of central Europe, the so-called Linearbandkeramik culture that arose slightly before 5000 B.C., were initially confined to soils light enough to be tilled by means of hand-held digging sticks. Only over a thousand years later, with the introduction of the ox-drawn plow, were those farmers able to extend cultivation to a much wider range of heavy soils and tough sods. Similarly, Native American farmers of the North American Great Plains grew crops in the river valleys, but farming of the tough sods on the extensive uplands had to await 19th-century Europeans and their animal-drawn plows.

All those are direct ways in which plant and animal domestication led to denser human populations by yielding more food than did the hunter-gatherer lifestyle. A more indirect way involved the consequences of the sedentary lifestyle enforced by food production. People of many hunter-gatherer societies move frequently in search of wild foods, but farmers must remain near their fields and orchards. The resulting fixed abode contributes to denser human populations by permitting a shortened birth interval. A hunter-gatherer mother who is shifting camp can carry only one child, along with her few possessions. She cannot afford to bear her next child until the previous toddler can walk fast enough to keep up with the tribe and not hold it back. In practice, nomadic hunter-gatherers space their children about four years apart by means of lactational amenorrhea, sexual abstinence, infanticide, and abortion. By contrast, sedentary people, unconstrained by problems of carrying young children on treks, can bear and raise as many children as they can feed. The birth interval for many farm peoples is around two years, half that of hunter-gatherers. That higher birthrate of food producers, together with their ability to feed more people per acre, lets them achieve much higher population densities than hunter-gatherers.

A separate consequence of a settled existence is that it permits one to store food surpluses, since storage would be pointless if one didn't remain nearby to guard the stored food. While some nomadic hunter-gatherers may occasionally bag more food than they can consume in a few days, such a bonanza is of little use to them because they cannot protect it. But stored food is essential for feeding non-food-producing specialists, and certainly for supporting whole towns of them. Hence nomadic hunter-gatherer societies have few or no such full-time specialists, who instead first appear in sedentary societies.

Two types of such specialists are kings and bureaucrats. Hunter-gatherer societies tend to be relatively egalitarian, to lack full-time bureaucrats and hereditary chiefs, and to have small-scale political organization at the level of the band or tribe. That's because all able-bodied hunter-gatherers are obliged to devote much of their time to acquiring food. In contrast, once food can be stockpiled, a political elite can gain control of food produced by others, assert the right of taxation, escape the need to feed itself, and engage full-time in political activities. Hence moderate-sized agricultural societies are often organized in chiefdoms, and kingdoms are confined to large agricultural societies. Those complex political units are much better able to mount a sustained war of conquest than is an egalitarian band of hunters. Some hunter-gatherers in especially rich environments, such as the Pacific Northwest coast of North America and the coast of Ecuador, also developed sedentary societies, food storage, and nascent chiefdoms, but they did not go farther on the road to kingdoms.

A stored food surplus built up by taxation can support other full-time specialists besides kings and bureaucrats. Of most direct relevance to wars of conquest, it can be used to feed professional soldiers. That was the decisive factor in the British Empire's eventual defeat of New Zealand's well-armed indigenous Maori population. While the Maori achieved some stunning temporary victories, they could not maintain an army constantly in the field and were in the end worn down by 18,000 full-time British troops. Stored food can also feed priests, who provide religious justification for wars of conquest; artisans such as metalworkers, who develop swords, guns, and other technologies; and scribes, who preserve far more information than can be remembered accurately.

So far, I've emphasized direct and indirect values of crops and livestock as food. However, they have other uses, such as keeping us warm and providing us with valuable materials. Crops and livestock yield natural fibers for making clothing, blankets, nets, and rope. Most of the major centers of plant domestication evolved not only food crops but also fiber crops—notably cotton, flax (the source of linen), and hemp. Several domestic animals yielded animal fibers—especially wool from sheep, goats, llamas, and alpacas, and silk from silkworms. Bones of domestic animals were important raw materials for artifacts of Neolithic peoples before the development of metallurgy. Cow hides were used to make leather. One of the earliest cultivated plants in many parts of the Americas was grown for nonfood purposes: the bottle gourd, used as a container.

Big domestic mammals further revolutionized human society by becoming our main means of land transport until the development of railroads in the 19th century. Before animal domestication, the sole means of transporting goods and people by land was on the backs of humans. Large mammals changed that: for the first time in human history, it became possible to move heavy goods in large quantities, as well as people, rapidly overland for long distances. The domestic animals that were ridden were the horse, donkey, yak, reindeer, and Arabian and Bactrian camels. Animals of those same five species, as well as the llama, were used to bear packs. Cows and horses were hitched to wagons, while reindeer and dogs pulled sleds in the Arctic. The horse became the chief means of long-distance transport over most of Eurasia. The three domestic camel species (Arabian camel, Bactrian camel, and llama) played a similar role in areas of North Africa and Arabia, Central Asia, and the Andes, respectively.

The most direct contribution of plant and animal domestication to wars of conquest was from Eurasia's horses, whose military role made them the jeeps and Sherman tanks of ancient warfare on that continent. As I mentioned in Chapter 3, they enabled Cortes and Pizarro, leading only small bands of adventurers, to overthrow the Aztec and Inca Empires. Even much earlier (around 4000 B.C.), at a time when horses were still ridden bareback, they may have been the essential military ingredient behind the westward expansion of speakers of Indo-European languages from the Ukraine. Those languages eventually replaced all earlier western European languages except Basque. When horses later were yoked to wagons and other vehicles, horse-drawn battle chariots (invented around 1800 B.C.) proceeded to revolutionize warfare in the Near East, the Mediterranean region, and China. For example, in 1674 B.C., horses even enabled a foreign people, the Hyksos, to conquer then horseless Egypt and to establish themselves temporarily as pharaohs.

Still later, after the invention of saddles and stirrups, horses allowed the Huns and successive waves of other peoples from the Asian steppes to terrorize the Roman Empire and its successor states, culminating in the Mongol conquests of much of Asia and Russia in the 13th and 14th centuries A.D. Only with the introduction of trucks and tanks in World War I did horses finally become supplanted as the main assault vehicle and means of fast transport in war. Arabian and Bactrian camels played a similar military role within their geographic range. In all these examples, peoples with domestic horses (or camels), or with improved means of using them, enjoyed an enormous military advantage over those without them.

Of equal importance in wars of conquest were the germs that evolved in human societies with domestic animals. Infectious diseases like smallpox, measles, and flu arose as specialized germs of humans, derived by mutations of very similar ancestral germs that had infected animals (Chapter 11). The humans who domesticated animals were the first to fall victim to the newly evolved germs, but those humans then evolved substantial resistance to the new diseases. When such partly immune people came into contact with others who had had no previous exposure to the germs, epidemics resulted in which up to *99* percent of the previously unexposed population was killed. Germs thus acquired ultimately from domestic animals played decisive roles in the European conquests of Native Americans, Australians, South Africans, and Pacific islanders.

In short, plant and animal domestication meant much more food and hence much denser human populations. The resulting food surpluses, and (in some areas) the animal-based means of transporting those surpluses, were a prerequisite for the development of settled, politically centralized, socially stratified, economically complex, technologically innovative societies. Hence the availability of domestic plants and animals ultimately explains why empires, literacy, and steel weapons developed earliest in Eurasia and later, or not at all, on other continents. The military uses of horses and camels, and the killing power of animal-derived germs, complete the list of major links between food production and conquest that we shall be exploring.

CHAPTER 5

HISTORY'S HAVES AND HAVE-NOTS

MUCH OF HUMAN HISTORY HAS CONSISTED OF UNEQUAL conflicts between the haves and the have-nots: between peoples with farmer power and those without it, or between those who acquired it at different times. It should come as no surprise that food production never arose in large areas of the globe, for ecological reasons that still make it difficult or impossible there today. For instance, neither farming nor herding developed in prehistoric times in North America's Arctic, while the sole element of food production to arise in Eurasia's Arctic was reindeer herding. Nor could food production spring up spontaneously in deserts remote from sources of water for irrigation, such as central Australia and parts of the western United States.

Instead, what cries out for explanation is the failure of food production to appear, until modern times, in some ecologically very suitable areas that are among the world's richest centers of agriculture and herding today. Foremost among these puzzling areas, where indigenous peoples were still hunter-gatherers when European colonists arrived, were California and the other Pacific states of the United States, the Argentine pampas, southwestern and southeastern Australia, and much of the Cape region of South Africa. Had we surveyed the world in 4000 B.c., thousands of years after the rise of food production in its oldest sites of origin, we would have been surprised too at several other modern breadbaskets that were still then without it—including all the rest of the United States, England and much of France, Indonesia, and all of subequatorial Africa. When we trace food production back to its beginnings, the earliest sites provide another surprise. Far from being modern breadbaskets, they include areas ranking today as somewhat dry or ecologically degraded: Iraq and Iran, Mexico, the Andes, parts of China, and Africa's Sahel zone. Why did food production develop first in these seemingly rather marginal lands, and only later in today's most fertile farmlands and pastures?

Geographic differences in the means by which food production arose are also puzzling. In a few places it developed independently, as a result of local people domesticating local plants and animals. In most other places it was instead imported, in the form of crops and livestock that had been domesticated elsewhere. Since those areas of nonindependent origins were suitable for prehistoric food production as soon as domesticates had arrived, why did the peoples of those areas not become farmers and herders without outside assistance, by domesticating local plants and animals?

Among those regions where food production did spring up independently, why did the times at which it appeared vary so greatly—for example, thousands of years earlier in eastern Asia than in the eastern United States and never in eastern Australia? Among those regions into which it was imported in the prehistoric era, why did the date of arrival also vary so greatly—for example, thousands of years earlier in southwestern Europe than in the southwestern United States? Again among those regions where it was imported, why in some areas (such as the southwestern United States) did local hunter-gatherers themselves adopt crops and livestock from neighbors and survive as farmers, while in other areas (such as Indonesia and much of subequatorial Africa) the importation of food production involved a cataclysmic replacement of the region's original hunter-gatherers by invading food producers? All these questions involve developments that determined which peoples became history's have-nots, and which became its haves.

BEFORE WE CAN hope to answer these questions, we need to figure out how to identify areas where food production originated, when it arose there, and where and when a given crop or animal was first domesticated. The most unequivocal evidence comes from identification of plant and animal remains at archaeological sites. Most domesticated plant and animal species differ morphologically from their wild ancestors: for example, in the smaller size of domestic cattle and sheep, the larger size of domestic chickens and apples, the thinner and smoother seed coats of domestic peas, and the corkscrew-twisted rather than scimitar-shaped horns of domestic goats. Hence remains of domesticated plants and animals at a dated archaeological site can be recognized and provide strong evidence of food production at that place and time, whereas finding the remains only of wild species at a site fails to provide evidence of food production and is compatible with hunting-gathering. Naturally, food producers, especially early ones, continued to gather some wild plants and hunt wild animals, so the food remains at their sites often include wild species as well as domesticated ones.

Archaeologists date food production by radiocarbon dating of carbon-containing materials at the site. This method is based on the slow decay of radioactive carbon 14, a very minor component of carbon, the ubiquitous building block of life, into the nonradioactive isotope nitrogen 14. Carbon 14 is continually being generated in the atmosphere by cosmic rays. Plants take up atmospheric carbon, which has a known and approximately constant ratio of carbon 14 to the prevalent isotope carbon 12 (a ratio of about one to a million). That plant carbon goes on to form the body of the herbivorous animals that eat the plants, and of the carnivorous animals that eat those herbivorous animals. Once the plant or animal dies, though, half of its carbon 14 content decays into carbon 12 every 5,700 years, until after about 40,000 years the carbon 14 content is very low and difficult to measure or to distinguish from contamination with small amounts of modern materials containing carbon 14. Hence the age of material from an archaeological site can be calculated from the material's carbon 14/carbon 12 ratio.

Radiocarbon is plagued by numerous technical problems, of which two deserve mention here. One is that radiocarbon dating until the 1980s required relatively large amounts of carbon (a few grams), much more than the amount in small seeds or bones. Hence scientists instead often had to resort to dating material recovered nearby at the same site and believed to be "associated with" the food remains—that is, to have been deposited simultaneously by the people who left the food. A typical choice of "associated" material is charcoal from fires.

But archaeological sites are not always neatly sealed time capsules of materials all deposited on the same day. Materials deposited at different times can get mixed together, as worms and rodents and other agents churn up the ground. Charcoal residues from a fire can thereby end up close to the remains of a plant or animal that died and was eaten thousands of years earlier or later. Increasingly today, archaeologists are circumventing this problem by a new technique termed accelerator mass spectrometry, which permits radiocarbon dating of tiny samples and thus lets one directly date a single small seed, small bone, or other food residue. In some cases big differences have been found between recent radiocarbon dates based on the direct new methods (which have their own problems) and those based on the indirect older ones. Among the resulting controversies remaining unresolved, perhaps the most important for the purposes of this book concerns the date when food production originated in the Americas: indirect methods of the 1960s and 1970s yielded dates as early as 7000 B.c., but more recent direct dating has been yielding dates no earlier than 3500 B.C.

A second problem in radiocarbon dating is that the carbon 14 / carbon 12 ratio of the atmosphere is in fact not rigidly constant but fluctuates slightly with time, so calculations of radiocarbon dates based on the assumption of a constant ratio are subject to small systematic errors. The magnitude of this error for each past date can in principle be determined with the help of long-lived trees laying down annual growth rings, since the rings can be counted up to obtain an absolute calendar date in the past for each ring, and a carbon sample of wood dated in this manner can then be analyzed for its carbon 14 / carbon 12 ratio. In this way, measured radiocarbon dates can be "calibrated" to take account of fluctuations in the atmospheric carbon ratio. The effect of this correction is that, for materials with apparent (that is, uncalibrated) dates between about 1000 and 6000 B.C., the true (calibrated) date is between a few centuries and a thousand years earlier. Somewhat older samples have more recently begun to be calibrated by an alternative method based on another radioactive decay process and yielding the conclusion that samples apparently dating to about 9000 B.C. actually date to around 11,000 B.C.

Archaeologists often distinguish calibrated from uncalibrated dates by writing the former in upper-case letters and the latter in lower-case letters (for example, 3000 B.c. vs. 3000 b.c., respectively). However, the archaeological literature can be confusing in this respect, because many books and papers report uncalibrated dates as B.C. and fail to mention that they are actually uncalibrated. The dates that I report in this book for events within the last 15,000 years are calibrated dates. That accounts for some of the discrepancies that readers may note between this book's dates and those quoted in some standard reference books on early food production.

Once one has recognized and dated ancient remains of domestic plants or animals, how does one decide whether the plant or animal was actually domesticated in the vicinity of that site itself, rather than domesticated elsewhere and then spread to the site? One method is to examine a map of the geographic distribution of the crop's or animal's wild ancestor, and to reason that domestication must have taken place in the area where the wild ancestor occurs. For example, chickpeas are widely grown by traditional farmers from the Mediterranean and Ethiopia east to India, with the latter country accounting for 80 percent of the world's chickpea production today. One might therefore have been deceived into supposing that chickpeas were domesticated in India. But it turns out that ancestral wild chickpeas occur only in southeastern Turkey. The interpretation that chickpeas were actually domesticated there is supported by the fact that the oldest finds of possibly domesticated chickpeas in Neolithic archaeological sites come from southeastern Turkey and nearby northern Syria that date to around 8000 B.C.; not until over 5,000 years later does archaeological evidence of chickpeas appear on the Indian subcontinent.

A second method for identifying a crop's or animal's site of domestication is to plot on a map the dates of the domesticated form's first appearance at each locality. The site where it appeared earliest may be its site of initial domestication—especially if the wild ancestor also occurred there, and if the dates of first appearance at other sites become progressively earlier with increasing distance from the putative site of initial domestication, suggesting spread to those other sites. For instance, the earliest known cultivated emmer wheat comes from the Fertile Crescent around •8500 B.C. Soon thereafter, the crop appears progressively farther west, reaching Greece around 6500 B.C. and Germany around 5000 B.C. Those dates suggest domestication of emmer wheat in the Fertile Crescent, a conclusion supported by the fact that ancestral wild emmer wheat is confined to the area extending from Israel to western Iran and Turkey.

However, as we shall see, complications arise in many cases where the Same plant or animal was domesticated independently at several different Sites. Such cases can often be detected by analyzing the resulting morphological, genetic, or chromosomal differences between specimens of the same crop or domestic animal in different areas. For instance, India's zebu breeds of domestic cattle possess humps lacking in western Eurasian cattle breeds, and genetic analyses show that the ancestors of modern Indian and western Eurasian cattle breeds diverged from each other hundreds of thousands of years ago, long before any animals were domesticated anywhere. That is, cattle were domesticated independently in India and western Eurasia, within the last 10,000 years, starting with wild Indian and western Eurasian cattle subspecies that had diverged hundreds of thousands of years earlier.

LET'S NOW RETURN to our earlier questions about the rise of food production. Where, when, and how did food production develop in different parts of the globe?

At one extreme are areas in which food production arose altogether independently, with the domestication of many indigenous crops (and, in some cases, animals) before the arrival of any crops or animals from other areas. There are only five such areas for which the evidence is at present detailed and compelling: Southwest Asia, also known as the Near East or Fertile Crescent; China; Mesoamerica (the term applied to central and southern Mexico and adjacent areas of Central America); the Andes of South America, and possibly the adjacent Amazon Basin as well; and the eastern United States (Figure 5.1). Some or all of these centers may actually comprise several nearby centers where food production arose more or less independently, such as North China's Yellow River valley and South China's Yangtze River valley.

In addition to these five areas where food production definitely arose de novo, four others—Africa's Sahel zone, tropical West Africa, Ethiopia, and New Guinea—are candidates for that distinction. However, there is some uncertainty in each case. Although indigenous wild plants were undoubtedly domesticated in Africa's Sahel zone just south of the Sahara, cattle herding may have preceded agriculture there, and it is not yet certain whether those were independently domesticated Sahel cattle or, instead, domestic cattle of Fertile Crescent origin whose arrival triggered local plant domestication. It remains similarly uncertain whether the arrival of those Sahel crops then triggered the undoubted local domestication of indigenous wild plants in tropical West Africa, and whether the arrival of Southwest Asian crops is what triggered the local domestication of indige-

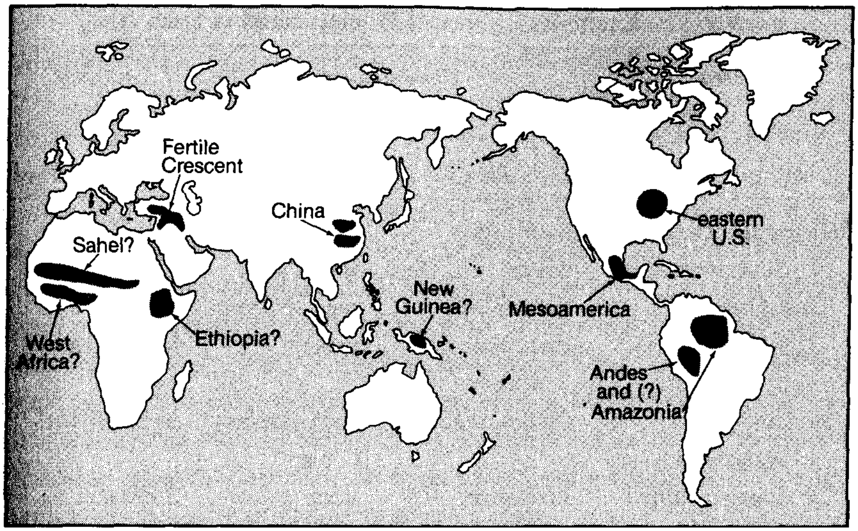


Figure 5.1. Centers of origin of food production. A question mark indicates some uncertainty whether the rise of food production at that center was really uninfluenced by the spread of food production from other centers, or (in the case of New Guinea) what the earliest crops were.

nous wild plants in Ethiopia. As for New Guinea, archaeological studies there have provided evidence of early agriculture well before food production in any adjacent areas, but the crops grown have not been definitely identified.

Table 5.1 summarizes, for these and other areas of local domestication, some of the best-known crops and animals and the earliest known dates of domestication. Among these nine candidate areas for the independent evolution of food production, Southwest Asia has the earliest definite dates for both plant domestication (around 8500 B.C.) and animal domestication (around 8000 B.c.); it also has by far the largest number of accurate radiocarbon dates for early food production. Dates for China are nearly as early, while dates for the eastern United States are clearly about 6,000 years later. For the other six candidate areas, the earliest well-established dates do not rival those for Southwest Asia, but too few early sites have been securely dated in those six other areas for us to be certain that they really lagged behind Southwest Asia and (if so) by how much.

The next group of areas consists of ones that did domesticate at least a

TABLE 5.1 **Examples of Species Domesticated in Each Area**

Area	*Domesticated*		*Earliest Attested Date of Domestication*
	Plants	*Animals*	
Independent Origins of Domestication			
1. Southwest Asia	wheat, pea, olive	sheep, goat	8500 B.C.
2. China	rice, millet	pig, silkworm	by 7500 B.C.
3. Mesoamerica	corn, beans, squash	turkey	by 3500 B.C.
4. Andes and Amazonia	potato, manioc	llama, guinea pig	by 3500 B.C.
5. Eastern United States	sunflower, goosefoot	none	2500 B.C.
? 6. Sahel	sorghum, African rice	guinea fowl	by 5000 B.C.
? 7. Tropical West Africa	African yams, oil palm	none	by 3000 B.C.
? 8. Ethiopia	coffee, teff	none	?
? 9. New Guinea	sugar cane, banana	none	7000 B.C.?
Local Domestication Following Arrival of Founder Crops from Elsewhere			
10. Western Europe	poppy, oat	none	6000–3500 B.C.
11. Indus Valley	sesame, eggplant	humped cattle	7000 B.C.
12. Egypt	sycamore fig, chufa	donkey, cat	6000 B.C.

couple of local plants or animals, but where food production depended mainly on crops and animals that were domesticated elsewhere. Those imported domesticates may be thought of as "founder" crops and animals, because they founded local food production. The arrival of founder domesticates enabled local people to become sedentary, and thereby increased the likelihood of local crops' evolving from wild plants that were gathered, brought home and planted accidentally, and later planted intentionally.

In three or four such areas, the arriving founder package came from Southwest Asia. One of them is western and central Europe, where food production arose with the arrival of Southwest Asian crops and animals between 6000 and 3500 B.C., but at least one plant (the poppy, and probably oats and some others) was then domesticated locally. Wild poppies are confined to coastal areas of the western Mediterranean. Poppy seeds are absent from excavated sites of the earliest farming communities in eastern Europe and Southwest Asia; they first appear in early farming sites in western Europe. In contrast, the wild ancestors of most Southwest Asian crops and animals were absent from western Europe. Thus, it seems clear that food production did not evolve independently in western Europe. Instead, it was triggered there by the arrival of Southwest Asian domesticates. The resulting western European farming societies domesticated the poppy, which subsequently spread eastward as a crop.

Another area where local domestication appears to have followed the arrival of Southwest Asian founder crops is the Indus Valley region of the Indian subcontinent. The earliest farming communities there in the seventh millennium B.C. utilized wheat, barley, and other crops that had been previously domesticated in the Fertile Crescent and that evidently spread to the Indus Valley through Iran. Only later did domesticates derived from indigenous species of the Indian subcontinent, such as humped cattle and sesame, appear in Indus Valley farming communities. In Egypt as well, food production began in the sixth millennium B.C. with the arrival of Southwest Asian crops. Egyptians then domesticated the sycamore fig and a local vegetable called chufa.

The same pattern perhaps applies to Ethiopia, where wheat, barley, and other Southwest Asian crops have been cultivated for a long time. Ethiopians also domesticated many locally available wild species to obtain crops most of which are still confined to Ethiopia, but one of them (the coffee bean) has now spread around the world. However, it is not yet known whether Ethiopians were cultivating these local plants before or only after the arrival of the Southwest Asian package.

In these and other areas where food production depended on the arrival of founder crops from elsewhere, did local hunter-gatherers themselves adopt those founder crops from neighboring farming peoples and thereby become farmers themselves? Or was the founder package instead brought by invading farmers, who were thereby enabled to outbreed the local hunters and to kill, displace, or outnumber them?

CHAPTER 10

SPACIOUS SKIES AND TILTED AXES

ON THE MAP OF THE WORLD ON PAGE 177 (FIGURE 10.1), compare the shapes and orientations of the continents. You'll be struck by an obvious difference. The Americas span a much greater distance north-south (9,000 miles) than east-west: only 3,000 miles at the widest, narrowing to a mere 40 miles at the Isthmus of Panama. That is, the major axis of the Americas is north-south. The same is also true, though to a less extreme degree, for Africa. In contrast, the major axis of Eurasia is east-west. What effect, if any, did those differences in the orientation of the continents' axes have on human history?

This chapter will be about what I see as their enormous, sometimes tragic, consequences. Axis orientations affected the rate of spread of crops and livestock, and possibly also of writing, wheels, and other inventions. That basic feature of geography thereby contributed heavily to the very different experiences of Native Americans, Africans, and Eurasians in the last 500 years.

FOOD PRODUCTION'S SPREAD proves as crucial to understanding geographic differences in the rise of guns, germs, and steel as did its origins, which we considered in the preceding chapters. That's because, as we

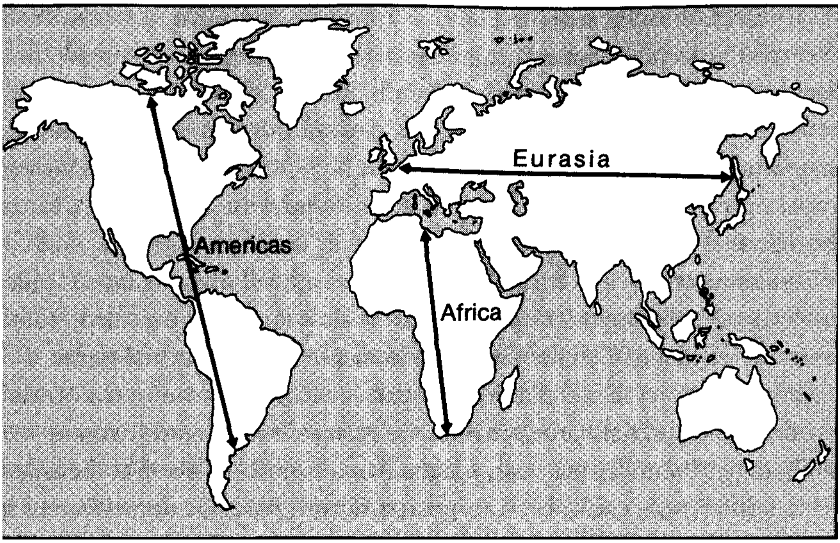


Figure 10.1. Major axes of the continents.

saw in Chapter 5, there were no more than nine areas of the globe, perhaps as few as five, where food production arose independently. Yet, already in prehistoric times, food production became established in many other regions besides those few areas of origins. All those other areas became food producing as a result of the spread of crops, livestock, and knowledge of how to grow them and, in some cases, as a result of migrations of farmers and herders themselves.

The main such spreads of food production were from Southwest Asia to Europe, Egypt and North Africa, Ethiopia, Central Asia, and the Indus Valley; from the Sahel and West Africa to East and South Africa; from China to tropical Southeast Asia, the Philippines, Indonesia, Korea, and Japan; and from Mesoamerica to North America. Moreover, food production even in its areas of origin became enriched by the addition of crops, livestock, and techniques from other areas of origin.

Just as some regions proved much more suitable than others for the origins of food production, the ease of its spread also varied greatly around the world. Some areas that are ecologically very suitable for food production never acquired it in prehistoric times at all, even though areas of prehistoric food production existed nearby. The most conspicuous such examples are the failure of both farming and herding to reach Native

American California from the U.S. Southwest or to reach Australia from New Guinea and Indonesia, and the failure of farming to spread from South Africa's Natal Province to South Africa's Cape. Even among all those areas where food production did spread in the prehistoric era, the rates and dates of spread varied considerably. At the one extreme was its rapid spread along east-west axes: from Southwest Asia both west to Europe and Egypt and east to the Indus Valley (at an average rate of about 0.7 miles per year); and from the Philippines east to Polynesia (at 3.2 miles per year). At the opposite extreme was its slow spread along north-south axes: at less than 0.5 miles per year, from Mexico northward to the U.S. Southwest; at less than 0.3 miles per year, for corn and beans from Mexico northward to become productive in the eastern United States around A.D. 900; and at 0.2 miles per year, for the llama from Peru north to Ecuador. These differences could be even greater if corn was not domesticated in Mexico as late as 3500 B.C., as I assumed conservatively for these calculations, and as some archaeologists now assume, but if it was instead domesticated considerably earlier, as most archaeologists used to assume (and many still do).

There were also great differences in the completeness with which suites of crops and livestock spread, again implying stronger or weaker barriers to their spreading. For instance, while most of Southwest Asia's founder crops and livestock did spread west to Europe and east to the Indus Valley, neither of the Andes' domestic mammals (the llama / alpaca and the guinea pig) ever reached Mesoamerica in pre-Columbian times. That astonishing failure cries out for explanation. After all, Mesoamerica did develop dense farming populations and complex societies, so there can be no doubt that Andean domestic animals (if they had been available) would have been valuable for food, transport, and wool. Except for dogs, Mesoamerica was utterly without indigenous mammals to fill those needs. Some South American crops nevertheless did succeed in reaching Mesoamerica, such as manioc, sweet potatoes, and peanuts. What selective barrier let those crops through but screened out llamas and guinea pigs?

A subtler expression of this geographically varying ease of spread is the phenomenon termed preemptive domestication. Most of the wild plant species from which our crops were derived vary genetically from area to area, because alternative mutations had become established among the wild ancestral populations of different areas. Similarly, the changes required to transform wild plants into crops can in principle be brought about by alternative new mutations or alternative courses of selection to yield equivalent results. In this light, one can examine a crop widespread in prehistoric times and ask whether all of its varieties show the same wild mutation or same transforming mutation. The purpose of this examination is to try to figure out whether the crop was developed in just one area or else independently in several areas.

If one carries out such a genetic analysis for major ancient New World crops, many of them prove to include two or more of those alternative wild variants, or two or more of those alternative transforming mutations. This suggests that the crop was domesticated independently in at least two different areas, and that some varieties of the crop inherited the particular mutation of one area while other varieties of the same crop inherited the mutation of another area. On this basis, botanists conclude that lima beans *(Phaseolus lunatus),* common beans *(Phaseolus vulgaris),* and chili peppers of the *Capsicum annuutn I chinense* group were all domesticated on at least two separate occasions, once in Mesoamerica and once in South America; and that the squash *Cucurbita pepo* and the seed plant goosefoot were also domesticated independently at least twice, once in Mesoamerica and once in the eastern United States. In contrast, most ancient Southwest Asian crops exhibit just one of the alternative wild variants or alternative transforming mutations, suggesting that all modern varieties of that particular crop stem from only a single domestication.

What does it imply if the same crop has been repeatedly and independently domesticated in several different parts of its wild range, and not just once and in a single area? We have already seen that plant domestication involves the modification of wild plants so that they become more useful to humans by virtue of larger seeds, a less bitter taste, or other qualities. Hence if a productive crop is already available, incipient farmers will surely proceed to grow it rather than start all over again by gathering its not yet so useful wild relative and redomesticating it. Evidence for just a single domestication thus suggests that, once a wild plant had been domesticated, the crop spread quickly to other areas throughout the wild plant's range, preempting the need for other independent domestications of the same plant. However, when we find evidence that the same wild ancestor was domesticated independently in different areas, we infer that the crop spread too slowly to preempt its domestication elsewhere. The evidence for predominantly single domestications in Southwest Asia, but frequent multiple domestications in the Americas, might thus provide more subtle evidence that crops spread more easily out of Southwest Asia than in the Americas.

Rapid spread of a crop may preempt domestication not only of the same wild ancestral species somewhere else but also of related wild species. If you're already growing good peas, it's of course pointless to start from scratch to domesticate the same wild ancestral pea again, but it's also pointless to domesticate closely related wild pea species that for farmers are virtually equivalent to the already domesticated pea species. All of Southwest Asia's founder crops preempted domestication of any of their close relatives throughout the whole expanse of western Eurasia. In contrast, the New World presents many cases of equivalent and closely related, but nevertheless distinct, species having been domesticated in Mesoamerica and South America. For instance, 95 percent of the cotton grown in the world today belongs to the cotton species *Gossypium hirsutum,* which was domesticated in prehistoric times in Mesoamerica. However, prehistoric South American farmers instead grew the related cotton *Gossypium barbadense.* Evidently, Mesoamerican cotton had such difficulty reaching South America that it failed in the prehistoric era to preempt the domestication of a different cotton species there (and vice versa). Chili peppers, squashes, amaranths, and chenopods are other crops of which different but related species were domesticated in Mesoamerica and South America, since no species was able to spread fast enough to preempt the others.

We thus have many different phenomena converging on the same conclusion: that food production spread more readily out of Southwest Asia than in the Americas, and possibly also than in sub-Saharan Africa. Those phenomena include food production's complete failure to reach some ecologically suitable areas; the differences in its rate and selectivity of spread; and the differences in whether the earliest domesticated crops preempted redomestications of the same species or domestications of close relatives. What was it about the Americas and Africa that made the spread of food production more difficult there than in Eurasia?

To ANSWER THIS question, let's begin by examining the rapid spread of food production out of Southwest Asia (the Fertile Crescent). Soon after food production arose there, somewhat before 8000 B.C., a centrifugal wave of it appeared in other parts of western Eurasia and North Africa farther and farther removed from the Fertile Crescent, to the west and east. On this page I have redrawn the striking map (Figure 10.2) assembled by the geneticist Daniel Zohary and botanist Maria Hopf, in which they illustrate how the wave had reached Greece and Cyprus and the Indian subcontinent by 6500 B.C., Egypt soon after 6000 B.C., central Europe by 5400 B.c., southern Spain by 5200 B.C., and Britain around 3500 B.c. In each of those areas, food production was initiated by some of the same suite of domestic plants and animals that launched it in the Fertile Crescent. In addition, the Fertile Crescent package penetrated Africa southward to Ethiopia at some still-uncertain date. However, Ethiopia also developed many indigenous crops, and we do not yet know whether it was these crops or the arriving Fertile Crescent crops that launched Ethiopian food production.

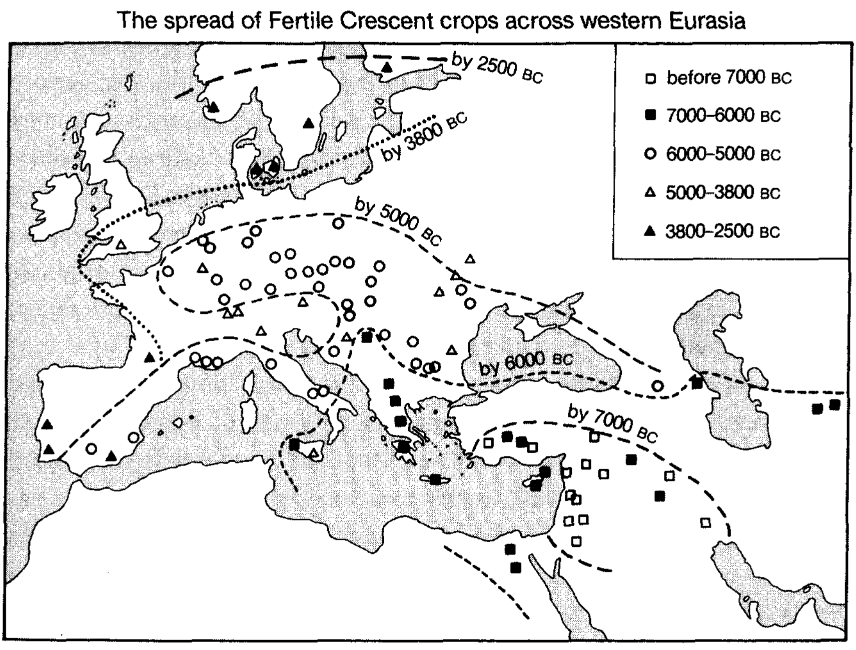


Figure 10.2. The symbols show early radiocarbon-dated sites where remains of Fertile Crescent crops have been found. • = the Fertile Crescent itself (sites before 7000 B.C.). Note that dates become progressively later as one gets farther from the Fertile Crescent. This map is based on Map 20 of Zohary and Hopf's Domestication of Plants in the Old World *but substitutes calibrated radiocarbon dates for their uncalibrated dates.*

Of course, not all pieces of the package spread to all those outlying areas: for example, Egypt was too warm for einkorn wheat to become established. In some outlying areas, elements of the package arrived at different times: for instance, sheep preceded cereals in southwestern Europe. Some outlying areas went on to domesticate a few local crops of their own, such as poppies in western Europe and watermelons possibly in Egypt. But most food production in outlying areas depended initially on Fertile Crescent domesticates. Their spread was soon followed by that of other innovations originating in or near the Fertile Crescent, including the wheel, writing, metalworking techniques, milking, fruit trees, and beer and wine production.

Why did the same plant package launch food production throughout western Eurasia? Was it because the same set of plants occurred in the wild in many areas, were found useful there just as in the Fertile Crescent, and were independently domesticated? No, that's not the reason. First, many of the Fertile Crescent's founder crops don't even occur in the wild outside Southwest Asia. For instance, none of the eight main founder crops except barley grows wild in Egypt. Egypt's Nile Valley provides an environment similar to the Fertile Crescent's Tigris and Euphrates Valleys. Hence the package that worked well in the latter valleys also worked well enough in the Nile Valley to trigger the spectacular rise of indigenous Egyptian civilization. But the foods to fuel that spectacular rise were originally absent in Egypt. The sphinx and pyramids were built by people fed on crops originally native to the Fertile Crescent, not to Egypt.

Second, even for those crops whose wild ancestor does occur outside of Southwest Asia, we can be confident that the crops of Europe and India were mostly obtained from Southwest Asia and were not local domesticates. For example, wild flax occurs west to Britain and Algeria and east to the Caspian Sea, while wild barley occurs east even to Tibet. However, for most of the Fertile Crescent's founding crops, all cultivated varieties in the world today share only one arrangement of chromosomes out of the multiple arrangements found in the wild ancestor; or else they share only a single mutation (out of many possible mutations) by which the cultivated varieties differ from the wild ancestor in characteristics desirable to humans. For instance, all cultivated peas share the same recessive gene that prevents ripe pods of cultivated peas from spontaneously popping open and spilling their peas, as wild pea pods do.

Evidently, most of the Fertile Crescent's founder crops were never domesticated again elsewhere after their initial domestication in the Fertile Crescent. Had they been repeatedly domesticated independently, they would exhibit legacies of those multiple origins in the form of varied chromosomal arrangements or varied mutations. Hence these are typical examples of the phenomenon of preemptive domestication that we discussed above. The quick spread of the Fertile Crescent package preempted any possible other attempts, within the Fertile Crescent or elsewhere, to domesticate the same wild ancestors. Once the crop had become available, there was no further need to gather it from the wild and thereby set it on the path to domestication again.

The ancestors of most of the founder crops have wild relatives, in the Fertile Crescent and elsewhere, that would also have been suitable for domestication. For example, peas belong to the genus *Pisum,* which consists of two wild species: *Pisum sativum,* the one that became domesticated to yield our garden peas, and *Pisum fulvum,* which was never domesticated. Yet wild peas of *Pisum fulvum* taste good, either fresh or dried, and are common in the wild. Similarly, wheats, barley, lentil, chickpea, beans, and flax all have numerous wild relatives besides the ones that became domesticated. Some of those related beans and barleys were indeed domesticated independently in the Americas or China, far from the early site of domestication in the Fertile Crescent. But in western Eurasia only one of several potentially useful wild species was domesticated—probably because that one spread so quickly that people soon stopped gathering the other wild relatives and ate only the crop. Again as we discussed above, the crop's rapid spread preempted any possible further attempts to domesticate its relatives, as well as to redomesticate its ancestor.

WHY WAS THE spread of crops from the Fertile Crescent so rapid? The answer depends partly on that east-west axis of Eurasia with which I opened this chapter. Localities distributed east and west of each other at the same latitude share exactly the same day length and its seasonal variations. To a lesser degree, they also tend to share similar diseases, regimes of temperature and rainfall, and habitats or biomes (types of vegetation). For example, Portugal, northern Iran, and Japan, all located at about the same latitude but lying successively 4,000 miles east or west of each other, are more similar to each other in climate than each is to a location lying even a mere 1,000 miles due south. On all the continents the habitat type known as tropical rain forest is confined to within about 10 degrees latitude of the equator, while Mediterranean scrub habitats (such as California's chaparral and Europe's maquis) lie between about 30 and 40 degrees of latitude.

But the germination, growth, and disease resistance of plants are adapted to precisely those features of climate. Seasonal changes of day length, temperature, and rainfall constitute signals that stimulate seeds to germinate, seedlings to grow, and mature plants to develop flowers, seeds, and fruit. Each plant population becomes genetically programmed, through natural selection, to respond appropriately to signals of the seasonal regime under which it has evolved. Those regimes vary greatly with latitude. For example, day length is constant throughout the year at the equator, but at temperate latitudes it increases as the months advance from the winter solstice to the summer solstice, and it then declines again through the next half of the year. The growing season—that is, the months with temperatures and day lengths suitable for plant growth—is shortest at high latitudes and longest toward the equator. Plants are also adapted to the diseases prevalent at their latitude.

Woe betide the plant whose genetic program is mismatched to the latitude of the field in which it is planted! Imagine a Canadian farmer foolish enough to plant a race of corn adapted to growing farther south, in Mexico. The unfortunate corn plant, following its Mexico-adapted genetic program, would prepare to thrust up its shoots in March, only to find itself still buried under 10 feet of snow. Should the plant become genetically reprogrammed so as to germinate at a time more appropriate to Canada—say, late June—the plant would still be in trouble for other reasons. Its genes would be telling it to grow at a leisurely rate, sufficient only to bring it to maturity in five months. That's a perfectly safe strategy in Mexico's mild climate, but in Canada a disastrous one that would guarantee the plant's being killed by autumn frosts before it had produced any mature corn cobs. The plant would also lack genes for resistance to diseases of northern climates, while uselessly carrying genes for resistance to diseases of southern climates. All those features make low-latitude plants poorly adapted to high-latitude conditions, and vice versa. As a consequence, most Fertile Crescent crops grow well in France and Japan but poorly at the equator.

Animals too are adapted to latitude-related features of climate. In that respect we are typical animals, as we know by introspection. Some of us can't stand cold northern winters with their short days and characteristic germs, while others of us can't stand hot tropical climates with their own characteristic diseases. In recent centuries overseas colonists from cool northern Europe have preferred to emigrate to the similarly cool climates of North America, Australia, and South Africa, and to settle in the cool highlands within equatorial Kenya and New Guinea. Northern Europeans who were sent out to hot tropical lowland areas used to die in droves of diseases such as malaria, to which tropical peoples had evolved some genetic resistance.

That's part of the reason why Fertile Crescent domesticates spread west and east so rapidly: they were already well adapted to the climates of the regions to which they were spreading. For instance, once farming crossed from the plains of Hungary into central Europe around 5400 B.c., it spread so quickly that the sites of the first farmers in the vast area from Poland west to Holland (marked by their characteristic pottery with linear decorations) were nearly contemporaneous. By the time of Christ, cereals of Fertile Crescent origin were growing over the 8,000-mile expanse from the Atlantic coast of Ireland to the Pacific coast of Japan. That west-east expanse of Eurasia is the largest land distance on Earth.

Thus, Eurasia's west-east axis allowed Fertile Crescent crops quickly to launch agriculture over the band of temperate latitudes from Ireland to the Indus Valley, and to enrich the agriculture that arose independently in eastern Asia. Conversely, Eurasian crops that were first domesticated far from the Fertile Crescent but at the same latitudes were able to diffuse back to the Fertile Crescent. Today, when seeds are transported over the whole globe by ship and plane, we take it for granted that our meals are a geographic mishmash. A typical American fast-food restaurant meal would include chicken (first domesticated in China) and potatoes (from the Andes) or corn (from Mexico), seasoned with black pepper (from India) and washed down with a cup of coffee (of Ethiopian origin). Already, though, by 2,000 years ago, Romans were also nourishing themselves with their own hodgepodge of foods that mostly originated elsewhere. Of Roman crops, only oats and poppies were native to Italy. Roman staples were the Fertile Crescent founder package, supplemented by quince (originating in the Caucasus); millet and cumin (domesticated in Central Asia); cucumber, sesame, and citrus fruit (from India); and chicken, rice, apricots, peaches, and foxtail millet (originally from China). Even though Rome's apples were at least native to western Eurasia, they were grown by means of grafting techniques that had developed in China and spread westward from there.

While Eurasia provides the world's widest band of land at the same latitude, and hence the most dramatic example of rapid spread of domesticates, there are other examples as well. Rivaling in speed the spread of the Fertile Crescent package was the eastward spread of a subtropical package that was initially assembled in South China and that received additions on reaching tropical Southeast Asia, the Philippines, Indonesia, and New Guinea. Within 1,600 years that resulting package of crops (including bananas, taro, and yams) and domestic animals (chickens, pigs, and dogs) had spread more than 5,000 miles eastward into the tropical Pacific to reach the islands of Polynesia. A further likely example is the east-west spread of crops within Africa's wide Sahel zone, but paleobotanists have yet to work out the details.

CONTRAST THE EASE of east-west diffusion in Eurasia with the difficulties of diffusion along Africa's north-south axis. Most of the Fertile Crescent founder crops reached Egypt very quickly and then spread as far south as the cool highlands of Ethiopia, beyond which they didn't spread. South Africa's Mediterranean climate would have been ideal for them, but the 2,000 miles of tropical conditions between Ethiopia and South Africa posed an insuperable barrier. Instead, African agriculture south of the Sahara was launched by the domestication of wild plants (such as sorghum and African yams) indigenous to the Sahel zone and to tropical West Africa, and adapted to the warm temperatures, summer rains, and relatively constant day lengths of those low latitudes.

Similarly, the spread southward of Fertile Crescent domestic animals through Africa was stopped or slowed by climate and disease, especially by trypanosome diseases carried by tsetse flies. The horse never became established farther south than West Africa's kingdoms north of the equator. The advance of cattle, sheep, and goats halted for 2,000 years at the northern edge of the Serengeti Plains, while new types of human economies and livestock breeds were being developed. Not until the period A.D. 1-200, some 8,000 years after livestock were domesticated in the Fertile Crescent, did cattle, sheep, and goats finally reach South Africa. Tropical African crops had their own difficulties spreading south in Africa, arriving in South Africa with black African farmers (the Bantu) just after those

Fertile Crescent livestock did. However, those tropical African crops could never be transmitted across South Africa's Fish River, beyond which they were stopped by Mediterranean conditions to which they were not adapted.

The result was the all-too-familiar course of the last two millennia of South African history. Some of South Africa's indigenous Khoisan peoples (otherwise known as Hottentots and Bushmen) acquired livestock but remained without agriculture. They became outnumbered and were replaced northeast of the Fish River by black African farmers, whose southward spread halted at that river. Only when European settlers arrived by sea in 1652, bringing with them their Fertile Crescent crop package, could agriculture thrive in South Africa's Mediterranean zone. The collisions of all those peoples produced the tragedies of modern South Africa: the quick decimation of the Khoisan by European germs and guns; a century of wars between Europeans and blacks; another century of racial oppression; and now, efforts by Europeans and blacks to seek a new mode of coexistence in the former Khoisan lands.

CONTRAST ALSO THE ease of diffusion in Eurasia with its difficulties along the Americas' north-south axis. The distance between Mesoamerica and South America—say, between Mexico's highlands and Ecuador's—is only 1,200 miles, approximately the same as the distance in Eurasia separating the Balkans from Mesopotamia. The Balkans provided ideal growing conditions for most Mesopotamian crops and livestock, and received those domesticates as a package within 2,000 years of its assembly in the Fertile Crescent. That rapid spread preempted opportunities for domesticating those and related species in the Balkans. Highland Mexico and the Andes would similarly have been suitable for many of each other's crops and domestic animals. A few crops, notably Mexican corn, did indeed spread to the other region in the pre-Columbian era.

But other crops and domestic animals failed to spread between Mesoamerica and South America. The cool highlands of Mexico would have provided ideal conditions for raising llamas, guinea pigs, and potatoes, all domesticated in the cool highlands of the South American Andes. Yet the northward spread of those Andean specialties was stopped completely by the hot intervening lowlands of Central America. Five thousand years after llamas had been domesticated in the Andes, the Olmecs, Maya, Aztecs, and all other native societies of Mexico remained without pack animals and without any edible domestic mammals except for dogs.

Conversely, domestic turkeys of Mexico and domestic sunflowers of the eastern United States might have thrived in the Andes, but their southward spread was stopped by the intervening tropical climates. The mere 700 miles of north-south distance prevented Mexican corn, squash, and beans from reaching the U.S. Southwest for several thousand years after their domestication in Mexico, and Mexican chili peppers and chenopods never did reach it in prehistoric times. For thousands of years after corn was domesticated in Mexico, it failed to spread northward into eastern North America, because of the cooler climates and shorter growing season prevailing there. At some time between A.D. 1 and A.D. 200, corn finally appeared in the eastern United States but only as a very minor crop. Not until around A.D. 900, after hardy varieties of corn adapted to northern climates had been developed, could corn-based agriculture contribute to the flowering of the most complex Native American society of North America, the Mississippian culture—a brief flowering ended by European-introduced germs arriving with and after Columbus.

Recall that most Fertile Crescent crops prove, upon genetic study, to derive from only a single domestication process, whose resulting crop spread so quickly that it preempted any other incipient domestications of the same or related species. In contrast, many apparently widespread Native American crops prove to consist of related species or even of genetically distinct varieties of the same species, independently domesticated in Mesoamerica, South America, and the eastern United States. Closely related species replace each other geographically among the amaranths, beans, chenopods, chili peppers, cottons, squashes, and tobaccos. Different varieties of the same species replace each other among the kidney beans, lima beans, the chili pepper *Capsicum annuum I chinense,* and the squash *Cucurbita pepo.* Those legacies of multiple independent domestications may provide further testimony to the slow diffusion of crops along the Americas' north-south axis.

Africa and the Americas are thus the two largest landmasses with a predominantly north-south axis and resulting slow diffusion. In certain other parts of the world, slow north-south diffusion was important on a smaller scale. These other examples include the snail's pace of crop exchange between Pakistan's Indus Valley and South India, the slow **spread of South** Chinese food production into Peninsular Malaysia, and the failure of tropical Indonesian and New Guinean food production to arrive in prehistoric times in the modern farmlands of southwestern and southeastern Australia, respectively. Those two corners of Australia are now the continent's breadbaskets, but they lie more than 2,000 miles south of the equator. Farming there had to await the arrival from faraway Europe, on European ships, of crops adapted to Europe's cool climate and short growing season.

1 HAVE BEEN dwelling on latitude, readily assessed by a glance at a map, because it is a major determinant of climate, growing conditions, and ease of spread of food production. However, latitude is of course not the only such determinant, and it is not always true that adjacent places at the same latitude have the same climate (though they do necessarily have the same day length). Topographic and ecological barriers, much more pronounced on some continents than on others, were locally important obstacles to diffusion.

For instance, crop diffusion between the U.S. Southeast and Southwest was very slow and selective although these two regions are at the same latitude. That's because much of the intervening area of Texas and the southern Great Plains was dry and unsuitable for agriculture. A corresponding example within Eurasia involved the eastern limit of Fertile Crescent crops, which spread rapidly westward to the Atlantic Ocean and eastward to the Indus Valley without encountering a major barrier. However, farther eastward in India the shift from predominantly winter rainfall to predominantly summer rainfall contributed to a much more delayed extension of agriculture, involving different crops and farming techniques, into the Ganges plain of northeastern India. Still farther east, temperate areas of China were isolated from western Eurasian areas with similar climates by the combination of the Central Asian desert, Tibetan plateau, and Himalayas. The initial development of food production in China was therefore independent of that at the same latitude in the Fertile Crescent, and gave rise to entirely different crops. However, even those barriers between China and western Eurasia were at least partly overcome during the second millennium B.C., when West Asian wheat, barley, and horses reached China.

By the same token, the potency of a 2,000-mile north-south shift as a barrier also varies with local conditions. Fertile Crescent food production spread southward over that distance to Ethiopia, and Bantu food production spread quickly from Africa's Great Lakes region south to Natal, because in both cases the intervening areas had similar rainfall regimes and were suitable for agriculture. In contrast, crop diffusion from Indonesia south to southwestern Australia was completely impossible, and diffusion over the much shorter distance from Mexico to the U.S. Southwest and Southeast was slow, because the intervening areas were deserts hostile to agriculture. The lack of a high-elevation plateau in Mesoamerica south of Guatemala, and Mesoamerica's extreme narrowness south of Mexico and especially in Panama, were at least as important as the latitudinal gradient in throttling crop and livestock exchanges between the highlands of Mexico and the Andes.

Continental differences in axis orientation affected the diffusion not only of food production but also of other technologies and inventions. For example, around 3,000 B.C. the invention of the wheel in or near Southwest Asia spread rapidly west and east across much of Eurasia within a few centuries, whereas the wheels invented independently in prehistoric Mexico never spread south to the Andes. Similarly, the principle of alphabetic writing, developed in the western part of the Fertile Crescent by 1500 B.C., spread west to Carthage and east to the Indian subcontinent within about a thousand years, but the Mesoamerican writing systems that flourished in prehistoric times for at least 2,000 years never reached the Andes.

Naturally, wheels and writing aren't directly linked to latitude and day length in the way crops are. Instead, the links are indirect, especially via food production systems and their consequences. The earliest wheels were parts of ox-drawn carts used to transport agricultural produce. Early writing was restricted to elites supported by food-producing peasants, and it served purposes of economically and socially complex food-producing societies (such as royal propaganda, goods inventories, and bureaucratic record keeping). In general, societies that engaged in intense exchanges of crops, livestock, and technologies related to food production were more likely to become involved in other exchanges as well.

America's patriotic song "America the Beautiful" invokes our spacious skies, our amber waves of grain, from sea to shining sea. Actually, that song reverses geographic realities. As in Africa, in the Americas the spread of native crops and domestic animals was slowed by constricted skies and environmental barriers. No waves of native grain ever stretched from the **Atlantic to** the Pacific coast of North America, **from** Canada to Patagonia, or from Egypt to South Africa, while amber waves of wheat and barley came to stretch from the Atlantic to the Pacific across the spacious skies of Eurasia. That faster spread of Eurasian agriculture, compared with that of Native American and sub-Saharan African agriculture, played a role (as the next part of this book will show) in the more rapid diffusion of Eurasian writing, metallurgy, technology, and empires.

To bring up all those differences isn't to claim that widely distributed crops are admirable, or that they testify to the superior ingenuity of early Eurasian farmers. They reflect, instead, the orientation of Eurasia's axis compared with that of the Americas or Africa. Around those axes turned the fortunes of history.