Chapter 25. ORIGIN OF FOOD PRODUCTION

> "While observing the barbarous inhabitants of Tierra del Fuego, it struck me that the possession of some property, a fixed abode, and the union of many families under a chief, were the indispensable requisites for civilization. Such habits almost necessitate the cultivation of the ground; and the first steps would probably result… from some such accident as the seeds of a fruit tree falling on a heap of refuse, and producing some unusually fine variety. The problem, however, of the first advance of savages toward civilization is at present much too difficult to be solved."
>
> C. Darwin, *Descent of Man* (1874)

I. Introduction

This change in subsistence patterns from hunting and gathering to agriculture was the first unambiguously CULTURAL "revolution" in human technology and ecology. It constitutes an interesting and important macro-evolutionary phenomenon. All previous changes, as we saw in the last chapter, entailed genetic changes insofar as modifications in morphology were involved. Humans seem to have become biologically modern in Southern Africa by perhaps 100,000 years ago, and fully modern people had replaced Neanderthals by ca 40,000 bp in the remote outpost of glacial Europe. The agricultural revolution, by contrast, was primarily technological, behavioral and social. Any associated genetic changes are likely to have been an insignificant part of the food production revolution.

T*he changes in the culture core occasioned by the development of a subsistence based on plant and animal domestication was in some ways as dramatic as any of the biocultural transformations of the deeper past (see Chapters 4 and 6)*. A full-blown agrarian society of millions of people is in some ways a big or bigger step in terms of social organization as the step from a weakly cooperative primate troop of 60 animals to the cooperative hunting band of the same size[1]. The food production revolution greatly impressed earlier scholars because it was the economic basis of "civilization"—literacy, mathematics, state political organization, and the like. There is no doubt that this complex of traits deriving indirectly from agriculture represent impressive changes from hunting and gathering. In industrial societies today we are still dealing with the ramifications of the food production revolution that began 10,000 years ago.

---

1. Although recall that the hunting band is really part of a larger society of some hundreds to thousands of individuals of the same linguistic/cultural group, a unit with no real parallel in the animal case.

The evolution of food production has been intensively studied since the early 1950s and thus the development of societies dependent on food production is also much better known than any earlier transformation of human ecological patterns. The sites for studying this development are numerous because they are relatively recent and the food foragers who gave rise to them were populous. Several major archeological teams, beginning in the 1950s, conducted a number of quite sophisticated studies designed explicitly to test earlier hypotheses about agricultural origins. Archeologists of an earlier generation working in the regions of the first civilizations—V. Gordon Childe is the best known name—had made interesting speculations about this subject.

The most important early projects were led by Robert and Linda Braidwood (in the Near East) and Richard MacNeish (in Mesoamerica and the Andes). These investigators led multidisciplinary teams of archeologists, botanists, zoologists, radiocarbon daters, ecologists, and geomorphologists to study in areas carefully selected to be in the likeliest areas for the transformation from hunting and gathering to agricultural subsistence. They deliberately looked for evidence of plant and animal domesticates and other aspects of the ecological relations of the succession of societies across the transition. The result of these and similar investigations gives a fairly clear picture of the events of the revolution, although the processes involved are less clear. A large literature interpreting the events in terms of processes has grown up in the period since these investigations began. Prominent names associated with process hypotheses to explain agricultural origins include Kent Flannery and Lewis Binford. A number of botanists were also attracted to work on the evolution of plant domesticates from their wild ancestors. The work of Paul Manglesdorf and George Beadle on maize is especially noteworthy. The climate record over the relevant interval is recent enough to be comparatively easy to study, and is consequently fairly well understood.

II. The Evidence

A. The "Agricultural" or "Neolithic" Revolution

There are three non-controversial "centers" of crop domestication for which the archeological data are good and which are known to represent independent developments. These are listed below:

1. Near East—beginning about 9,500 bp.

2. Meso-America—beginning about 7,200 bp.

3. Peruvian highlands—beginning about 6,500 bp.

Evidence for the cultivation of rice in the Far East (Thailand), beginning about 8,500 BPis more controversial, as is the evidence for tropical root crop agriculture in West Africa. Figure 25-1 shows the centers of plant and animal domestication. The main crop plants to be first domesticated were large-seeded grasses and other annuals, maize, wheat, rice, beans, and many others. Highland Peru and the lowland tropics differed in the kinds of plants used--there the emphasis was on root crops (MacNeish, 1977).

A little after 10,000 years bp, agriculture "broke out all over the world, like measles." The several centers of domestication are almost contemporaneous and developments are very rapid (relative to a geological time scale or the time scale of human evolution at any earlier time). Indeed, although the agricultural "revolution" took an average of about 4,000 years to go from food foraging to complete dependence on domesticated products, on an evolutionary time scale this was a sudden, rapid event. *This* was a punctuational event if ever there was such, though it was still well within the scope of ordinary microevolutionary processes to accomplish.

Figure 26-1. Centers of plant and animal domestication. Copied from *The Times Concise Atlas of World History* (1982:7).

There were similar stages in each regional case. Table 25-1 illustrates with the Meso-American example.

Table 25-1. Outline of the basic archeological data recovered by Richard MacNeish in the Techuacan Valley, Southern Mexican Highlands. This is one of the classical examples of origin-of-agriculture excavation studies (adapted from MacNeish, 1964).

Phase	Dates bp	Estimated Population (in 2,400km^2 valley)	Culture Core	% Animals in Diet	% Deomesticated Plants in Diet
Ajuereado	>9,200	10-20	*Big game hunting*, including now extinct horses, antelopes and mammoths, but small game more important. *No special tools to process plant food.* Small bands, highly mobile.	>50(?)	0
El Riego	9,200-7,200	50-70	Broader spectrum of plant foods used *including protocultivars* of squash, chili, & avocado. *Seed-grinding tools. Macroband* camps in wet season. Shamans, ceremonial burials.	54	0-5
Coxcatlan	7,200-5,400	150-180	Still more specialized plant collectors with *a bit of plant cultivation.* Acquired gourds, beans, used wild corn. Larger wet season camps, but *still microbands in dry season*. Incipient agriculturalists.	34	14
Abejas & Purron	5,400-3,500	350-700	More sedentary, less use of microband camps. *Used domesticated corn. Pottery* developed in Purron.	30	20-30
Axxxxxn & Santa Maria	3,500-2,200	1,000-4,000	Almost completely sedentary, with *mud houses. Mainly domesticated plants*. Fancy pottery, ceremonial centers (temples). Possible start of irrigation.	30	40-45
Palo Blanco	2,200-1,300	18,000-26,000	Full-time agriculture, *irrigation heavily used.* New domesticates include tomatoes & turkeys. Large ceremonial centers, pyramids, etc. *Kings & bureaucrats.*	18	65
Venta	1,300-450	80,000-90,000	Commerce becomes important. *Large* residential towns *as well as ceremonial centers.*	17	75
Salada Spanish Conquest	~450		Domesticated animals and metallurgy introduced.		

Pleistocene big game hunters give way to specialized food foragers a few thousand years as a consequence of the "broad spectrum revolution". The classic big game hunting people of the Pleistocene showed little signs of using much plant matter, or even small animals and fish. However, over time these specialized food foragers built up larger populations per unit of land area and were forced to begin exploiting lower quality resources. They developed seed grinding equipment, digging tools, etc., preadapted to plant production. This event is known by the archeologists' term "**the broad spectrum revolution**". In addition to greater use of plants, it includes a tendency toward settled villages in favored areas, use of fish, shellfish, and small animals in much greater numbers than in the Pleistocene. For example, in the Highland Andes, deer bones declined sharply in middens[2], and guinea pig bones became very common, as a part of the broad spectrum revolution. Another good example is the shift in California from Folsom type peoples with a toolkit adapted for hunting big game to the acorn grinding, salmon drying people of the contact period. Some of these societies began to use the wild progenitors of what eventually became crop plants. In general, these post-broad spectrum systems were more locally specialized than big game/rich plant collecting subsistence systems were during the Pleistocene. Then the same basic animals and plants were exploited with the same basic technology over wide areas.

As these specialized food foragers began using species which ultimately become domesticates, incipient agriculture grew imperceptibly and slowly from specialized foraging (on a generation to generation time scale). At first, people may have merely protected and weeded naturally occurring stands of desirable plants and engaged in other management strategies short of actual cultivation. Later, seed might have been gathered, and the genetic changes leading to domestic races of crops initiated. Archeologists recognize domesticated crops mostly by key anatomical changes for which humans (perhaps inadvertently) select as they come to dominate the species' demography. In wild grasses, for example, seed heads break apart ("shatter") at maturity in order to scatter the seed. Domesticated varieties are non-shattering; this enables efficient harvesting. In legumes, the pods split explosively at maturity in order to scatter seed. Domesticated bean and pea pods remain closed until we shuck out the seeds. Zohary and Hopf (1988) provide a good discussion of the history and biology of all the important Old World crops. At first the proportionate dependence on domesticates was low, and a near complete loss of hunting and gathering strategies took considerable time.

2. refuse heaps which are great sources of information for archaeologists

B. The Relative Nature of Time Scales

Notice that, on a conventional time scale[3]*, this "revolution" actually occurred slowly and gradually*. It took roughly 3,000 years for the transition from the barest beginnings of plant domestication to almost full dependence on domesticated foodstuffs in the Near East[4]. Compared to the Industrial Revolution, with which we are more familiar, the agricultural revolution was slow! It took a similar length of time for horticulture to spread from the Near East to far-Western Europe. From a macro-evolutionary perspective, however, the rates of cultural evolution achieved during the agricultural revolution occurred in the blink of an eyelid. Nevertheless let us think of it from the point of view of an individual living 8,000 bp. Agricultural change would have probably been imperceptible, with the acquisition of a new innovation only every few generations or so. It is doubtful that individuals ever felt part of a progressive, developing trajectory the way we do. At each point in time, lifeways probably seem like static traditions. Making allowance for large differences in time scales in different kinds of evolutionary and ecological processes and events requires some careful thinking. Our intuitions, developed in a world of incredibly rapid progress (well, change at any rate), are not necessarily very trustworthy.

C. Differences and Similarities between Centers

There were some striking environmental similarities between the main centers of plant domestication. Meso-America and the Fertile Crescent (the hilly uplands in the headwaters of the Tigris and Euphrates rivers, and adjacent regions) are particular similar. They are hilly, diverse, subtropical regions. Both regions were host to large-seeded grasses and a large flora of annual vegetation. Even today, most of our key plant domesticates were developed from natives of these two regions: The list includes maize, wheat, barley, various legumes, etc. Highland Peru differs somewhat in being tropical, although the extreme elevation and aridity give it more of a resemblance to Mexico and the Fertile Crescent than one might at first suppose. Also, the classically important domesticate of Peru is the white potato which is a root crop, not a grass seed domesticate.

There were also some interesting differences between Centers, for example the Americas were late and slow. Meso-American societies began the development of horticulture perhaps 2,000 years later than in the Near East. The pace of developments was also somewhat slower in the New World after the initial moves toward cultivation. Thus, the early city-states and initial empires that developed in Mesopotamia ca 5,000BP resembled the political structure of the most advanced American societies at contact ~500BP. Amer-

3. i.e. the way we modern humans like to think about things.
4. Note that 3,000 years is roughly 120 human generations.

ica, especially Meso-America, lacked the variety of domesticated animals found in Eurasia. Probably because the Pleistocene mega-faunal extinctions were more severe in the new world, there was a lack of pre-adapted animals that could be domesticated to provide the level of transport and traction needed for agrarian subsistence modes. Perhaps the role of horses and other domestic livestock in promoting labor efficiency and extending the reach of tradesmen and soldiers accounts for the quicker rate of evolution in the Old World.

There were also probably major evolutionary differences between the seed-agriculture of subtropical and temperate regions and the vegeculture of the tropics, the latter of which was late and diffuse. Tropical cultivators tend to use more vegetatively propagated[5] plants like sweet potatoes, taro, and bananas. Temperate and subtropical cultivators tend to use more seed crops like maize, wheat and rice. The archeological record in the tropics is very poor, but there is an indication that the development of tropical vegeculture was slow er, later, and less concentrated in "centers" (the restricted regions of innovation from which seed agriculture appears to have diffused).

D. The Importance of Climate Change[6]

The beginning of the broad-spectrum revolution and of the later shift to food production is roughly correlated with the end of the Pleistocene. The world became warmer and perhaps generally wetter beginning about 14,000bp. By about 10,000bp, climates were essentially modern. Notice in the many records shown in Appendix 24-A how high-frequency climatic variations suddenly became much less important across the Pleistocene-Holocene transition[7]. While the Pleistocene had strong climate fluctuations on time scales of 1,000 years or less, these fluctuations have been substantially muted in more recent times.

III. Hypotheses Attempting to Explain the Origin of Food Production

A. Inventor-Genius Hypotheses

According to Carter (1977), agriculture is an inherently better way to make a living—but it takes the rare genius to see it. Under this hypothesis there is extreme innovation limitation on the evolution of the culture core. We can categorize this as an extreme type internalist hypothesis of the "random trigger and breakthrough" type. It also has that strong flavor of "onward and upward" progressivism that we must beware of.

---

5. Vegetative propagation involves planting a piece cut from a plant rather than seeds. For example, one propagates potatoes by planting pieces of potato with 'eyes' or root starts on them. One plants bananas by digging up a small offshoot from the base of a mature plant and planting it elsewhere in fertile soil.
6. Refer to Appendix 24-A.
7. approximately 10,000bp

B. "Settling In" Hypothesis

According to Braidwood (1967), food foragers gradually learn agriculture after they became more familiar with lower ranked resources during the "broad spectrum" revolution. This is very similar to Carter's hypothesis, except that the inventor is not a "rare genius" but a careful observer of the habits of animals and plants. This hypothesis is also largely internalist and progressive.

C. Population Pressure Hypothesis

According to Mark Cohen (1977), agriculture was born of necessity when population density reached some critical threshold. Slow population increases in the late Pleistocene gradually caused people to adopt more and more "technology-intensive" means of production. Once this threshold favoring the adoption of agriculture was passed, cultural evolution took off at a great rate as population growth rates accelerated[8]. This is a punctuational hypothesis based upon environmental deterioration under which human competition for resources eventually causes the adoption of agriculture. In this sense it is also internalist.

This is a popular hypothesis but reflects a confusion about time scales. Population "pressure" builds very rapidly because of Malthus' "law." Over the course of 10s of thousands of years, there must have been many episodes of population "pressure," even assuming that there were many density *independent* mortality episodes[9]. Even on the time scale of the development of food production, population pressure is liable to be more or less constant, not something that can explain a macroevolutionary event. That is, populations are not limited by resources can easily double in a century (or even a generation). As we saw in the case of pre-industrial population and technical improvement in England, population growth can easily keep up with fairly rapid technical improvement. On the several thousand year time scale of changes involved in the broad spectrum and agricultural revolutions, population increase could surely have kept up with technological improvement. Thus the driving variables must be related to controls of technical improvement (the rate of innovation), not to the rate of increase of population.

D. Ecological Hypothesis

Harris (1977) proposed a more sophisticated hypothesis based upon positive feedback and environmental deterioration that unlike Cohen's identified the specific conditions

8. This type of hypothesis is also typical of earlier social sciences human ecologists such as Amos Hawley (1986).
9. For density independently regulated populations, consult Chapter 16. It is also reminiscent of Boserup (Chapter 16)

in which a hunter-gatherer population would benefit from adopting agriculture. This idea is best viewed as an explanation for why the adaptive topography might have a decided valley between hunting and gathering and agriculture, and how special circumstances might allow particular hunting and gathering societies to cross the valley. Although this hypothesis' focus is local in time and space, it is an important component of the best story we can currently tell about the origins of agriculture.

According to Harris, ordinary food foragers normally will not develop agriculture because there is stabilizing selection on the food foraging adaptation. As data on diets and effort expenditure show, many food foragers are not particularly stressed by a lack of food. There is therefore no obvious incentive for them to develop agriculture. Moreover, food production would conflict with the need of foragers to move frequently. This is important because of the importance of hunting as a status activity that requires participants to follow highly mobile game animals. Sedentary life therefore conflicts with food forager prestige systems. It also conflicts with immediate needs to move because local supplies of plant foods are rapidly exhausted. Two unusual factors must therefore converge before the shift to horticulture can emerge: a) a very rich environment, and b) the availability of food plants that are easy to domesticate.

According to this view, only rare combinations of circumstances will cause food foragers to adopt agriculture. Essentially, the argument is that a few particularly provident environments permit semi-sedentary life, such as those in which Native Americans in the Pacific Northwest coast and California Central Valley lived. However, some sort of social preadaptation appears to be necessary—it is hard to imagine that hunters would take naturally to planting crops because prestige norms are so involved with hunting prowess, and settled living conflicts with hunting. (As generations of missionaries and Indian agents discovered, it was very hard to turn Native American hunters into farmers.) The settled life that evolved in a few especially resource-rich areas under hunting conditions was perhaps a social precondition to agricultural developments.

Once life becomes relatively sedentary, the reliance on storable food products leads to using materialism (goods) for status competition. Such goods provide a motive for increasing work effort, leading to a sort of social feedback. Certain kinds of luxury goods, become "necessities" in status competitions, and old status "necessities" associated with hunting become less important. All of a sudden, hard work in the hot sun tilling a field can be turned into wealth and status. This work competes with roving long distances to acquire game. Even in the sedentary food foragers like the Northwest Coastal Indians, we saw status based on ownership of large quantities of heavy, non-portable goods. Materialism easily arises in settled folk, and will tend to turn them away from hunting and toward farming. Once there is enough farming to produce settled life, incipient agriculturalists are likely to get addicted to the easy life.

Sedentary farming communities can probably outcompete hunters and gatherers. Once farming becomes well established in any one locality, it will tend to spread. Farmers maintain dense populations relative to hunters, and were probably militarily dominant in habitats reasonably favorable for farming. Farmers also don't stop hunting. Rather dense agricultural populations probably reduce game to the point where hunters and gatherers cannot persist near their villages. Farming communities will expand, and hunting and gathering populations will normally have to give way. Many frontiers between hunting and gathering peoples and farmers are known ethnographically and archeologically, and the farmers usually expand at the expense of the hunters. There are exceptions. The Anasazi[10] culture spread into the Colorado River Basin country from Arizona and New Mexico, and then retreated, for example. Often, farming communities probably absorbed hunting and gathering societies. In Africa today, both Bushman and Pygmy societies tend to lose women especially to their horticultural and pastoral neighbors. The agricultural peoples are richer and life is a little easier on a farm or in a cattle camp. Horticultural and pastoral societies are often polygynous, and taking second and third wives from poorer folk is a normal thing. Thus people, especially women, flow into the farming communities, providing a demographic plus for farming and a negative for hunting and gathering.

A final ironical twist to the ecological hypothesis lies in Flannery's argument that some crops, such as corn, domesticated humans! A few kinds of plants will respond to human collecting with co-evolutionary adjustments that increase production. When certain crops are harvested, they may respond with genetic changes that improve yields. Humans then specialize on these plants, population densities rise, and a return to hunting becomes impossible. Competition between people favors improvements in cultivation techniques. Corn can be viewed as having "tricked" humans into growing it, spreading its seeds to new areas, fighting its competitors through weeding, etc. This hypothesis is based on biological positive feedback, plus environmental deterioration via population increase. People of California and the Northwestern American coast did not develop food production because oaks and salmon did not respond positively to exploitation.

E. Climatic Hypotheses

There are a suite of hypotheses which speculate that agriculture is an inherently su-

10. The Anasazi were a group of Native American Indian cliff dwellers in what is now the Southwestern U.S. who were horticulturalists.

perior mode of subsistence, but that some sort of climate change trigger is required to get it going. V. Gordon Childe (1951) expressed the idea that desiccation caused people to invent agriculture in order to escape famine as they collected around a few desert oases in the Middle East. Binford(1968) proposed that population pressure increased when a climate-induced rising sea level forced coastal peoples inland. However, many researchers are skeptical of this claim. They argue that local population pressure must have been common throughout the Pleistocene climate changes. These changes would cause population regulation, but no evolution occurred during those incidents. This is similar to objections to Cohen; essentially, the time scale seems wrong. Populations grow up to exert pressure or collapse under the impact of adverse environments on a short time scale (one or two centuries) relative to the millennium-scale of most major cultural evolutionary events. Climate change, especially in the Pleistocene, must often have subjected people to demographic crunches, but only the last big change led to agriculture.

Charles Reed (1977) and H.E. Wright (1977) argue that climate change brought pre-adapted people and plants together in the Middle East ~10,000 bp. The problem with this hypothesis is that people around the world domesticated many crop plants in many different environments. Even if there are some commonalities in the "Center" environments, it is hard to imagine that there were not many combinations of people and plants—including the species that eventually became domesticated—during the Pleistocene. Thus again the specific factors responsible for the Neolithic revolution are not well identified by this hypothesis.

Climate hypotheses can be given a more externalist flavor. The Holocene[11] has been unusually quiet climatically, as you can see in the climate records (Flohn, 1979). Could it be that this was the first climatic regime for at least 75,000 years that is suitable for agriculture? Present droughts, floods, and longer-term climatic fluctuations like the "little ice age" from 1430-1850 AD cause substantial problems for agriculture (Lamb, 1977). There is reasonable evidence that climate changes in the Pleistocene completely rearranged biotic communities. Plant and animal communities did not shift intact north and south as the glaciers came and went. Instead communities were torn apart and reassembled as the climate changed. With fluctuations in climate it is difficult for farmers to cope.

The rapid fluctuations of the Pleistocene may have disrupted plant communities on a time scale so short that agricultural adaptations could never arise. It seems to take on the order of a 1000 years or more for a complex plant exploiting adaptation to arise, with its

11. last 10,000 years

complex processing adaptations (e.g. acorn leaching and storage), and a careful balancing of the diet to avoid poisoning by secondary plant compounds and nutritional deficiencies[12]. Pleistocene climates appear to have been changing too rapidly for these kinds of adaptations to be reached. Rather the strongly fluctuating climate of the Pleistocene would have required a mobile hunting population to follow migrating herds of big game. Perhaps any form of sedentary or semi-sedentary life, much less agriculture, was impossible under such a climatic regime.

This is a fairly radically externalist hypothesis insofar as it lays much explanatory power in the hands of the changing climate. To some extent the data support it, although one should certainly keep in mind the present quality of both the archeological and climatic records. As we pointed out in Chapter 24 new climate data (and archaeological data) should help us refine these ideas. The archeological record suggests that Pleistocene hunters were doing very different things than recent hunters and gatherers of the broad spectrum sort, much less the agricultural societies that immediately followed the broad spectrum revolution in a few places (Price and Brown, 1985).

F. Most Plausible Current Hypotheses

The best hypotheses combine elements of an externalist hypotheses for the long time scale with internalist elements on the shorter time scale[13]. Let us combine the climate with the ecological hypothesis. This would allow us to predict just which people would first adopt food production, and how fast developments would proceed. Essentially, reduction in climatic variation made agriculture possible, and expanding populations of broad-spectrum foragers and incipient agriculturalists generated the *competition* that drove evolution "forward" to agriculture in the quiet Holocene environment. (Think of this as the externalist postulate.) The ecological feedback hypothesis accounts for *which* food foragers initiated food production. There was innovation limitation on the short- to intermediate-time-scale that caused that some societies to evolve domestication before others. The "genius" model has difficulty with the near-simultaneous, independent "invention" of food production in so many places. Braidwood's "settling in" has similar problems; i.e., why wasn't there very different timing in different places? It is also vague about exact mechanisms. The "quiet climate" part of our hypothesis solves this problem.

---

12. Recall the maize/lysine/alkali story from the second Chapter .

13. This is Peter Richerson's present opinion, notice the change from the review he wrote for Agricultural History in 1979. Remember, we are on the frontier and things can change quite rapidly.

IV. Conclusion

The agricultural "revolution" is a good laboratory problem with which to investigate the connection between macro- and microevolutionary processes as they apply to cultural evolution. Different processes have different time scales, and each process plays a role according to its natural time scale. We have exposed you to an array of hypotheses (or tools) for thinking about the problem. The implications of the revolution for cultural evolution have been enormous. In a sense, all the increases of cultural sophistication since 10,000 years ago depend upon increasing the efficiency of resource utilization to support denser populations with more division of labor. On this view, we can say that an internalist hypothesis for the increased sophistication of culture is appropriate. A test of the externalist hypothesis regarding the role of climate is likely to come[14]. The Pleistocene has really not ended, and it is probable that a new glacial period will eventually occur, or that the more variable climates of the typical Pleistocene will recur. The climatologist Flohn (1979) thinks that the last 10,000 years have just been a lucky break, perhaps because volcanic activity has been unusually low. He worries about how we would cope with a renewed episode of strongly fluctuating climates. Is there a good chance we'd have to go back to being big game hunters. If we don't leave any big game to hunt, well….

Among other things, we hope to have conveyed the concept of time scales here. Thus, we've criticized a certain kind of population pressure hypothesis because it seems to imply that population growth has a natural time scale of hundreds of generations instead of tens of generations. Populations, as we saw in the demography chapter, tend to approach carrying capacities quite rapidly. Evolutionary time scales, even the comparatively rapid time scale of cultural evolution, are usually longer.

Only since the industrial revolution have these two time scales converged (thus, we have at least temporarily escaped Malthus' and Ricardo's dilemma). We've argued that when the time scale of climatic fluctuation coincides roughly with the cultural evolutionary time scale (as it did during the Pleistocene) we should expect a very different set of adaptations than when the time scale is longer. When the environment fluctuates rapidly, societies could not reach an adaptive equilibrium with the conditions of the moment; they were changing too rapidly. Rather, people would likely have had to have adapted to the variance itself with strategies that were more generalized and independent of local environmental details.

---

14. Indeed, it has! See H.E. Wright (1993). Environmental determinism in Near Eastern History. Current Anthropology 34:458-469.

V. Bibliographic Notes

References:

Ammerman, A.J. and L.L. Cavalli-Sforza. 1985. *The Neolithic Transition and the Genetics of Populations in Europe*. Princeton: Princeton Univ. Press. (Documents the diffusion of agriculture into Europe, and tries to deduce the genetic consequences of this event.)

Barraclough, Geoffrey, ed. 1982. *The Times Concise Atlas of World Histor*y. Maplewood, NJ: Hammond.

Beadle, G.W. 1977. The origins of *Zea mays*. Pp. 615-36 in Reed, C. A. *Origins of Agriculture.* The Hague: Mouton.

Binford, L.R. 1968. Post-Pleistocene adaptations. Pp. 131-41 in New Perspectives in *Archeology*, S.R and L.R. Binford (eds.). Chicago: Aldine.

Braidwood, R.J. 1967. *Prehistoric Men.* Glenview, IL: Scott, Forman.

Carter, G. F. 1977. A hypothesis suggesting a single origin of agriculture. Pp. 89-134 in Reed, C. A. *Origins of Agriculture.* The Hague: Mouton.

Childe, V. G. 1951. *Man Makes Himself.* New York: Mentor.

Cohen, M. N. 1977. *The Food Crisis in Prehistory. Overpopulation and the Origins of Agriculture*. New Haven: Yale Univ Press.

Coope, G. R. 1979. Late Cenozoic fossil coleoptera: evolution, biogeography, and ecology. *Ann. Rev. Ecol. Syst.* 10: 247-268. (The beetles tell all!)

Flannery, K. 1973. The Origins of Agriculture. *The Ann. Rev. of Anthropology* 2:271-310.

Flohn, H. 1979. On the time scales and causes of abrupt paleoclimatic events. *Quaternary Research* 12: 135-49.

Harland, J. R. 1971. Agricultural origins: centers and noncenters. *Science* 174:468-474

Harris, D. R. 1977. Alternative pathways toward agriculture. pp. 179-244 in Reed, C. A. *Origins of Agriculture.* The Hague: Mouton.

Hawley, Amos H. 1986. *Human Ecology: A Theoretical Essay*. Chicago: University of Chicago Press.

Lamb, H. H. 1977. *Climate: Present, Past and Future*. Vol. II. London: Methuen. (This is a classic, includes a lot of information on the effects of historical climate variation on human societies. Recently reprinted by in paper by Princeton.)

MacNeish, R.S. 1964. Ancient Mesoamerican civilization. *Science* 143: 531-7.

MacNeish, R.S. 1977. The beginning of agriculture in Central Peru. Pp. 753-802 in Reed, C. A. *Origins of Agriculture.* The Hague: Mouton.

Mangelsdorf, P. C., R.S. MacNeish, and W.C. Galinat. 1964. Domestication of corn. *Science* 143:538-544

McIntosh, S.K. and R.J. McIntosh. 1981. West African prehistory. *Amer. Scientist* 69: 602-13.

Meyer, J.T. 1971. The Origins of Agriculture: An Evaluation of Three Hypotheses. Pp. 101-121 in Streuver S., ed. 1971 *Prehistoric Agriculture*. Natural History Press, Garden City, N.Y.

Reed, C. A. (ed.). 1977. *Origins of Agriculture*. The Hague: Mouton. (This is an excellent collection. Reed's own discussion and conclusions are an especially good synthesis.)

Streuver S., ed. 1971 *Prehistoric Agriculture*. Natural History Press, Garden City, N.Y. (This is a nice collection of classics)

Wright, H.E. Jr. 1977. Environmental change and the origin of agriculture in the Old and New Worlds. Pp. 281-320 in Reed, C. A. *Origins of Agriculture.* The Hague: Mouton.

Zohary, D. and M. Hopf. 1988. *Domestication of Plants in the Old World*. Oxford: Oxford University Press.