Environmental Studies 30 -- The Global Ecosystem
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LECTURE 4. Human Adaptations

Purpose

Humans and our domesticated plants and animals face the same problems of adaptation to environments that ordinary organisms do. However, it is not clear whether the mechanisms of human adaptation are the same as those which affect other populations; the subject is one of great current controversy. In any case, each biome presents its own problems and potentials for human use. The result is a familial similarity between them that we want to uncover in this course. A little terminology and some basic concepts, the subject of this lecture, will be useful later on.

The Processes of Human Adaptation

I. Biological Adaptation

A. The Basic Adaptations, Culture and Tool Making.

Humans adapt to environmental circumstances mainly through the medium of technology. Although the very earliest humans, the Australopithecines, appear not to have made elaborate use of tools, tool making has been a human specialty for about 2 million years. The cultural adaptation was very likely a response to the climatic deterioration of the Pleistocene, which put a premium on adaptive speed and flexibility. The information necessary to make tools is based on our capacity for culture. This capacity is a genetic adaptation of a rather peculiar sort, allowing humans to transmit and accumulate knowledge about how to make the tools appropriate to local circumstances. By contrast, other animals code their adaptive information primarily on genes, and the learned adjustments to particular situations are not passed on to offspring. Only a few animals have more than rudimentary capacity for culture.

It does not appear that modern humans differ much, if at all, in their capacities for culture, but the kinds of tools people use and the kinds of societies that they organized to use them differ dramatically from place to place. Humans have undergone dramatic biological evolution in the recent past. Biologically modern humans only appeared about 30,000 years ago; the people of the early and middle Pleistocene were different, perhaps dramatically different in their capacities for culture.

B. Local Biological Adaptations

A few important human adaptations to local circumstances are still made via the processes of genes and natural selection. The best documented examples are inherited resistances to locally prevalent diseases. The sickle cell trait and related hemoglobin characters, which confer resistance to malaria in heterozygotes, are the best known examples.

Such differential adaptations to disease have played a prominent role in human history. For example, European colonization of Africa was greatly inhibited by the presence of tropical diseases to which Europeans had no resistance, while the colonization of the Americas was aided by the spread of European diseases among the Native Americans who had carried few Old World diseases with them.

Whether or not the more conspicuous differences between human populations, skin color, body form and facial features have any adaptive significance is controversial. Dark skin may be an adaptation to sunburn, a protection from Vitamin D poisoning or an advantage in gaining heat when the sun shines. On the other hand, many such characters may be the result of sexual selection, a favorite hypothesis of Darwin. In other words, such traits may be a result of fad and fashion defining what handsome men and women look like.

II. Cultural Adaptation

There is no widespread agreement among social scientists about the processes by which cultural adaptations occur. Nevertheless, people's tools and techniques are always elaborately specialized for local conditions, often in ways that are closely parallel to biological adaptations. Three major schools of thought exist on the matter.

A. The sociobiologist's Hypothesis

Cultural variation may be controlled or guided indirectly by genes. We may select those cultural behaviors from among the alternatives we know about that feel best. The culture that, in a given environment, produces the most food, the most comfortable houses, satisfies our desires for sex and so forth for the least effort, may be chosen above other ways of doing things. If the feelings that guide us are genetic, we have the sociobiological hypothesis.

B. The Cultural Ecologist's Hypothesis

Cultural behaviors may evolve to adapt people to environments, but not necessarily in the sense of making them genetically fit. It is possible that culture exists to promote its own survival, rather than that of genes. Cultural ecologists often assume that cultural adaptations evolve to perpetuate society rather than an individual's genes.

C. The Symbolic Anthropologist's Hypothesis

Many anthropologists think that most human behavior is not adaptive at all. Their argument is that many forms of behavior are highly variable without any obvious adaptive basis, for example, religious practice, art, and language. Perhaps culture generates its own meanings and objectives that have nothing to do with survival. These scholars will admit that survival is a prerequisite for a culture, so adaptive significance can be attached to some portion of cultural behavior.

Most of the time, the differences between these schools are less significant in practice than they are in theory. The cultural adaptations we will be most concerned with -- what kinds of crops and animals people use in which kinds of biomes, for example, can equally well be viewed as helping people pass on their genes or their culture or as serving as a material base for the higher achievements of cultures. A very loose notion of cultural adaptation will serve our purposes well enough.

D. The Role of History

Historical differences play a much larger role in culture than in biology. Perhaps this is simply a result of modern humans being such a recently evolved species. To some approximation, we can treat biological adaptations in most organisms as existing in equilibrium with existing environments. This is not the case with humans. Our cultures are evolving very rapidly (and have evolved rapidly for the last 30,000 years, ever since Homo sapiens appeared).

Depending on the accidents of history, the same biomes on different continents, or even in different countries or localities on the same continent, may have a rather unique set of adaptations. Conquest, emigration, and cultural diffusion play prominent roles in explaining why people in a given place behave as they do. In addition, humans profoundly alter the ecosystems they use, which induce further, time dependent, changes by feedback. Perhaps these complexities are one reason why social scientists disagree more over basic processes than natural scientists.

Types of Human Adaptations

Human societies can be divided into several types and sub-types. The conventional classification is based on technology. Each technological type interacts with the environment in a

characteristic way and imposes a fairly narrow range of options for the organization of society on the other. Each of the general types is in turn composed of individual societies which are more or less closely tuned to local environmental circumstances. The classification by technology is a mixed one, reflecting both history and existing differences between biomes. That is, over human history, the level of technology has tended to rise, but at different rates. Some of the differences in rate are affected by environment and even today examples of "primitive" types tend to occur in certain kinds of environments.

I. Hunting and Gathering

Before plant and animal domestication, all humans used relatively simple stone, bone and wood tools to glean a living from wild plant and animal resources. To judge from the stone tools people left behind, there was not much regional variation or local sophistication in human adaptations during much of the last two million years. Early hominids became fairly widespread in the Old World in the tropical and subtropical latitudes, but may have occupied similar niches in local environments, probably hunting, scavenging and collecting plants in fairly open country.

During the last 150,000 years or so, food foraging adaptations rapidly became much more sophisticated. Humans penetrated less hospitable environments such as northern temperate climates and eventually the Arctic. Especially during the last few thousand years of hunting and gathering, technical specialization increased. Adaptations to local circumstances became more sophisticated, and the use of plant foods increased at the expense of animal products. The human penetration of the American continents dates from this late phase of food foraging evolution; the best evidence suggests the peopling of the Americas only about 12,000 years ago. Some students of these late hunter-gathers think that they were responsible for the destruction of the diverse Pleistocene fauna of large mammals in the Americas and Australia. These animals, including such spectacular species as the Woolly Mammoths, Mastodons, Glyptodonts, and Ground Sloths disappeared just after humans arrived on these continents. Of all the continents only Africa retained a big mammal fauna more or less intact. Perhaps survival was due to a longer period of time to adapt to increasingly sophisticated human predators. In any case, it is interesting to try to imagine California and Kansas with big mammals more spectacular than East Africa, almost yesterday in geological terms.

Today, hunter-gatherer populations are relicts, restricted to a few areas so unfavorable for other activities that more powerful peoples have not evicted them. The Bushmen and Pygmy hunters of Africa, the deep forest hunters of Amazonia and some Australian Aborigines are examples. The hunting and gathering adaptation is an extremely extensive one. Populations are small, and political organization weak, so that agriculturally based peoples can ordinarily evict hunters from more desirable land areas.

II. Agricultural Adaptations

A. Horticulture

Plant and animal domestication began about 10,000 years ago, just after the end of the last major glacial episodes of the Pleistocene. Apparently several centers of food production arose independently and more or less simultaneously in several areas of the world, including the Near East and the Far East in the Old World and in Mexico and Peru in the New World. The early food producers used a rather extensive system of production, technically termed horticulture. The absence of the animal drawn plow is the usual criterion used to distinguish horticulture from agriculture proper.

Horticultural societies can be further subdivided into those who primarily depend on seed crops, as in Mexico where corn was the basic staple, and those who depend primarily on root crops like yams and casaba. Another division is those people who cultivate permanent fields and those who practice swidden (shifting field or slash-and-burn cultivation).

Horticulture is still very common in the tropical and subtropical countries of the Third World. Perhaps 200 million people still practice swidden, which is well adapted to the wet tropics so long as population pressure allows sufficiently long rotations. In many environments, and in the less technically developed cases, horticulture is less productive per acre than agriculture. The societies supported by it are generally much larger than in hunting and gathering societies, but smaller and less well organized politically than societies based on agriculture. The classic horticultural society is politically organized at the tribal level, a few thousand to a few hundred thousand people ruled by chiefs, often but not always hereditary. Exceptions include the great pre-Columbian States of the Americas and some of the rice growing areas of South Asia.

B. Agriculture

The use of animals for pulling plows, in transportation, and in warfare greatly increased the work power available to individual farmers, traders, and warriors. The agricultural adaptation grew out of its horticultural predecessors first in the Near East about 5,000 years ago.

Agricultural societies typically have larger, denser populations and more elaborate political organization than horticultural societies. The peasant-state style of social organization is usually associated with agriculture, including the classical states and empires of antiquity (Assyria, Egypt, Rome) and many modern Third World countries (India, Indonesia, China). Such states consist of a large mass of small-scale farmers, a modest class of artisans and other specialists and a small ruling elite. Such states have been the predominant adaptation in the more favorable parts of the world for the last 2 or 3 thousand years.

C. Pastoralism

Pastoralists are specialists at herding animals. This adaptation arose many times as a variant on the more common mixed farming of agriculturalists in which animals are important to subsistence but in which plant crops predominate. Examples include the horse herding people of Central Asia (e.g. Mongols), the camel herders (e.g. Bedouin) of Arabia, and the cattle herders of Africa (e.g Masai).

Mostly pastoralism is an adaptation to semi-arid and arid areas where agriculture is difficult but sufficient pasture exists to support nomadic herds and flocks. Also, however, pastoralism seems to have been encouraged by the rise of states and empires in agriculturally favorable areas. Pastoralists are traders and raiders. Usually they must trade livestock to settled agriculturalists in order to obtain enough food to survive.

However, the animal-based mobility of pastoralists lends itself to warfare and pastoralists usually get lots of fighting practice quarreling among themselves. You all know the story of the Plains Indians and their horse thievery. The political organization of pastoralists is ordinarily fairly small-scale, much like that of horticulturalists. As a consequence, agricultural states usually control or restrict pastoralists.

Nevertheless, Central and Southwest Asia once supported rather large numbers of pastoralists and occasionally tribal leaders would succeed in organizing a consortium of tribes for raiding and conquest. Attila, Genghis Khan, Tamerlane and other leaders of pastoralists conquered the most powerful states of the time. The advent of firearms tipped the military balance against pastoralists, and their political independence has virtually ended in the last few centuries. The Saudi state in Arabia, begun with Lawrence's and Faisal's adventures against the Turks in WWI, is the only remaining political unit derived from pastoralist conquest.

D. Some Common Elements in the Food Production Adaptations

All of these adaptations require the creation of elaborate agro-ecosystems. Crop plants and animal systems have to be adapted to both the physical environment and human use by artificial selection. As a consequence, agricultural systems are highly specialized, and different biomes have their own characteristic suite of domesticates and cultivation practices.

The worldwide interchange of domesticates during the last 500 years has tended to increase the resemblance between biomes. The widespread crop plants like corn, wheat and rice have thousands of varieties adapted for local conditions. At the same time, there has been a coevolution of crop systems and the societies that use them. As we have seen, horticulture, agriculture and pastoralism tend to imply a certain kind of social and political organization.

Because food production is a more or less intensive human adaptation, its impact on natural environments is extreme. At the least, natural communities are replaced or dramatically modified on a very large scale. In places like Europe, with a long history of intense cultivation in a favorable environment, there are simply no completely natural ecosystems left. At the worst, the large human populations supported by agriculture greatly degrade the environment, even for food production itself. Deforestation, soil erosion (by wind and water), overgrazing and soil salinization (from improper irrigation practices) have more or less destroyed large areas of the earth in the last 3 or 4 thousand years.

III. Commercial and Industrial Adaptations

Commerce and small scale manufacturing are the province of the artisan class of agricultural states, but seldom make up more than a small minority of the population or make more than a modest contribution to the economy. During the last 500 years, improvements in the use of inanimate energy (e.g. from fossil fuels) have transformed human society. The development of open ocean sailing (and cannons) led to the worldwide trading empires of Europe and their associated population migrations. More recently, the development of engines and mass production has revolutionized human adaptations. A convenient, if artificial, dividing line between agricultural and commercial-industrial ones is when more than 50% of the population is engaged in nonagricultural pursuits. By this standard, perhaps 25% of contemporary societies are industrialized.

Commercial-industrial societies have a much different, but still strong, relationship to the environment than agricultural ones. The importance of mineral resources and trade routes reduces the impact of climate and soils on settlement patterns and population size. Agriculture remains important, but it is transformed by the application of industrial methods (tractors, fertilizers) and by commercialization (most peasants consume most of what they produce, and sell only a small fraction).

Social organization and politics are transformed by the growth and rationalization of bureaucracies, and the development of organized interest groups on a national scale. Large scale, hierarchically organized corporations and government agencies employ most of the population; autonomous agriculturalists and artisans become a minority.

By supporting large populations at a lavish level, industrial societies have severe impacts on natural communities. The potential for damage by the direct use of renewable resources is increased; the classical environmental problems of agricultural societies are exacerbated. At the same time, the use of inanimate energy and minerals in manufacturing adds a qualitatively new dimension to environmental impacts in the form of industrial pollution. Perhaps the increased managerial sophistication of such societies will prove capable of mitigating these impacts or perhaps not.

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Lecture 4: Discussion questions

1. Why are human cultural adaptations somewhat different from genetic adaptations? Do you understand the differences between the sociobiological, cultural ecological and symbolic hypotheses?

2. Why is the historical hypothesis more likely to be important in humans as compared to plant and animal geography?

3. Why is technology the key element in understanding human interactions with environment?