Environmental Archaeology

Principles and Practice

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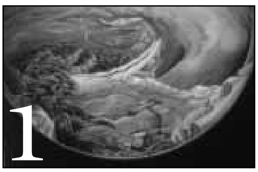

ENVIRONMENTAL ARCHAEOLOGY AND HUMAN ECOLOGY

Ecology, a word so much in vogue in recent years that it has lost much of its original meaning, may be defined as "that branch of science concerned with [the study of] the relationships between organisms and their environment" (Hardesty 1977: 290). **Environment**, which is often confused with ecology, encompasses all the physical and biological elements and relationships that impinge upon a living being. Specification of an organism's environment emphasizes those variables relevant to the life of that organism – ideally, almost every aspect of its surroundings.

Advances in instrumentation for the observation and measurement of biological, planetary, and astronomical environmental phenomena have driven unprecedented recent growth in the historical geo- and biosciences. The maturing geosciences acknowledge unexpected complexity, diversity, and dynamism in the natural world, now slowly seeping into study of the social sciences as well. The biosciences have powerful new techniques for examining life at small scales, notably the molecular scale. The growth in these ancillary disciplines has opened opportunities for advances in archaeology on the basis of new data sources and richer understanding of processes and mechanisms in all historical sciences.

Archaeologists have embraced the novel results, and built on some of the new data, not always understanding the theoretical and methodological bases on which those results were founded; some of those foundations have since been shown to be unsteady. Premature adoption of poorly evaluated analytical techniques and their preliminary results has given archaeology a decade or more of spectacular claims and attendant rebuttals, creating an uneasy atmosphere.

In this atmosphere and by such means, environmental archaeology has gained a reputation as being driven by method at the expense of sound practice and genuinely useful results. Some excellent, even extraordinary, work has been done in the environmental archaeology mode using the powerful new techniques and revised theories, most of it, however, applying one or at most two disciplinary data sets. Single data sets, utilized in isolation, have proven very vulnerable to rebuttal from other directions. Along with impressive improvements of field work and analysis, a chorus of dissatisfaction swelled as very few large, well-financed and staffed research projects achieved significant coordination and integration across the several disciplines which contribute to the practice of environmental archaeology.

This present exploration of human ecology emphasizes excellence in the methods and practice of environmental archaeology, worldwide. It begins with a brief review of the physical and cultural evolution of our species, identifying aspects of environment that have impinged most significantly upon human populations at various stages in prehistory. The argument emphasizes archaeologically recoverable information that enhances understanding of the human condition from an ecologically informed perspective.

ORGANIZATION OF THIS VOLUME

Archaeology has long been perceived as a borrower discipline, taking techniques and data from other sciences to help it meet its own goals, but giving back little. As I hope to show in the pages that follow, a mature archaeology can return to all the historical disciplines studying the last 3 million years a finer time scale, an enhanced database that integrates information from many disciplines, and a deeper understanding of the contributions, both positive and negative, of human lives in the evolution of the world we know today. As electronic communication expands and information flows more freely globally, it will be crucial for researchers to command the basic theory and assumptions of other special fields and disciplines, in order to evaluate claims for new methods, applications, and results.

The several parts of the volume group chapters related in terms of the data sets used in building interpretations of aspects of paleoenvironments. Thus, Part I presents the argument for multidisciplinary inclusiveness, which is developed further in each part that follows. Part II presents approaches to the construction of chronological frameworks, which are essential to the integration of data sets that cross disciplinary borders. It argues for active evaluation of methods used for chronology building, and for informed awareness of their limitations and best applications. Part III presents paleoclimatology in a framework of its relevance to archaeological data and problems. The concept of scales of data and interpretation is elaborated in Part III, and threads its way through all the later chapters.

Part IV presents structural geomorphology in paleoenvironments, again emphasizing the importance of appropriate scales of analysis for different kinds of human experience. Part V introduces sedimentology as a fundamental aspect of archaeological context and of paleoenvironmental analysis. Soils science is given importance equal to sedimentology, while its special applications and rewards are argued, emphasizing soils as archaeological matrices holding paleoenvironmental information and affecting relative preservation. Part VI presents paleobotany in its various manifestations, introducing its several scales of inquiry with the data and methods appropriate for each. Part VII brings in animals, not only as objects of inquiry for zooarchaeology, but more centrally as aspects of human environments informative in themselves and biologically significant. Because the subjects of archaeology, people, are members of the world's Animal Kingdom, Part VII has three chapters instead of the two assigned to most of the other parts. Part VIII attempts to be both retrospective and forward-looking, discussing the enterprise of environmental archaeology in the context of the concepts presented throughout the volume, and attempting to evaluate its prospects for future success as a central element in the study of past human experience and human influences on many processes that define the home planet.

INTERDEPENDENCE

The Red Queen beyond Alice's Looking Glass huffed that the world and events were moving so fast that "it takes all the running you can do, to keep in the same place" (Gardner 1960: 210). Her plight has become the "Red Queen hypothesis" of ecology and evolution (Foley 1984; van Valen 1973): environments are constantly changing (at one scale or another) as climate varies, populations fluctuate, species' distributions change, or behavior is modified. Each such change may entail behavioral, distributional, or biological changes as species respond to the new conditions. The responses themselves in turn modify the environments of the target species and to some extent of all others sharing the same space. Thus, living things must continually monitor and respond to changing environments, even as their responses stimulate further change. Change presents problems and opportunities to all organisms; those that successfully solve the problems may be said to have adapted – ultimately, to survive. The emergence of the human species, within the last 2 million years or so, has complicated ecological relationships in ways that seem both to result from and to inspire the peculiarly human characteristic of high intelligence.

In traditional Western culture, human beings are conceived as separable from their environment, so that everything that is not human (and even some humans if sufficiently unfamiliar) is defined as "other" and considered to be subordinate and potentially exploitable. Ecology shows us that our very humanness is defined not by our separateness from the rest of the world, but by our unique but interdependent relationships to all those "others."

Homo sapiens is a creature of the Earth; humans would be different in fundamental ways if they had developed on any other planet, in any other solar system, at any other time. The elemental matter that comprises our planet condensed out of the primeval gases of the proto-Universe. Earth continuously receives bits of matter in the form of star dust that gravitates to it out of space: atoms of nitrogen, carbon, and other elements rain down on its surface, and are ultimately incorporated into organic and inorganic compounds (Morowitz 1983; Ponnamperuma and Friebele 1982). Humans ingest those compounds into our living substance from the foods we eat. Our genetic codes, partly inherited from ancestors millions of years remote from us, reflect the environments and selection pressures of marine and terrestrial habitats of a younger Earth. We move through, and breathe in, the Earth's unique gaseous atmosphere. Basic body rhythms, reset daily by sunlight, are in phase with the day lengths defined by planetary rotation; some appear to be responsive to the Moon's gravity. Our populations display biological characteristics that are responses to specific latitudinal and altitudinal stresses: biological adaptations to severe cold or heat, thin air, filtered sunlight, or high insolation. Our species is among many that emerged during the Quaternary ice ages, a prolonged period of unusually cool planetary climates. As we explore out into space, we cannot expect to find other creatures like ourselves.

We take our form of existence so thoroughly for granted that it appears inevitable. We cannot even imagine creatures fundamentally different from ourselves, and so we imagine them as distorted versions of ourselves – the anthropomorphized denizens of science fiction and fable. Perhaps if we can learn to know and understand the contexts that produced modern humans, we can better prepare ourselves for the future when our historically conditioned fitness will be put to harsh new tests (Potts 1996).

The human animal shares the basic needs common to all earthly life: food, shelter, and reproduction. We are born knowing something about supplying those needs, but from the first moment of life, we require other humans to help us satisfy them. We do not hatch out of an egg and begin to forage for ourselves. Society is a requirement of all contemporary human life. We can take that for granted throughout the human past, and perhaps should acknowledge it as a fourth basic need.

Becoming human

Human prehistory begins with relatively large-brained, bipedal, social omnivores in Africa. The original **habitats** (typical environments) seem to have been gallery forests and savanna edges, only a little cooler and drier than the Miocene home country of the immediately ancestral large primates. The climate was apparently equable, the terrain diverse and in many places actively volcanic. The vegetal environments were **patchy** (spatially heterogeneous) and linear, following river courses and lake shores. Early humans met some of the challenges of such environments by developing hand and eye coordination to new heights, building upon the alertness, curiosity, and manipulative skills characteristic of all primates. Enlargement of the brain went along with these adaptive developments. Throughout this volume there are passing references to biological/genetic change in humans; however, human evolutionary biology is not a central issue in this presentation of human ecology, which focuses on environments, not genotypes. Readers interested in current thinking and data on evolutionary physiology should seek primary sources on that topic.

Within this habitat, early humans made a **niche** (a species' role in a biological community) for themselves as social omnivores, foraging and scavenging a wide variety of foods on and under the surface of the land. The ability to acquire, consume, and digest almost anything not positively poisonous gave humans a special role and some advantages within their environment. Their broad niche made it possible for them to expand into habitats not closely similar to their original homes, and thus to proliferate. Human physiology is highly dependent on water; people cannot live long without replenishing body fluids. Where surface water was unavailable, they substituted liquids stored in the bodies of plants and other animals. The need for water imposed limitations on the locations of home bases and on effective travel distances.

The elaborated brain that distinguishes our species from all others extracted a price in extended gestation and lengthened periods of childhood dependency. Both constrained the mobility of women with young children and thus, probably, that of the residential group, placing a further premium upon generalizing behavior and diet breadth rather than specialization, which requires mobility. The development of the human brain apparently exceeded the requirements of natural selection in any conceivable environment. Evolutionary physiologists explain it by positing crucial feedback from social, cultural, and linguistic developments that synergistically improved the fitness of large-brained individuals (Tattersal 1998).

The emergence of language is not specifically revealed in archaeological data. Its origins and early development are matters of speculation (Mellars and Gibson 1996). However, even a rudimentary language that could allow foresight and planning (discussing what is not present or has not happened) would stimulate cultural elaboration and confer survival benefits upon its speakers. With elaboration came more effective communication, ritual and magic, and enhanced social cohesiveness. Language that allowed consideration of options and planning for contingencies would have been beneficial, if not essential, to the human groups that slowly moved out of familiar landscapes into new and challenging others.

Homo erectus, an intercontinental traveler, colonized well beyond the semitropical homelands (Fig. 1.1) into temperate zones of Europe and Asia (Tattersal 1998). Once fire could be controlled, expansion into higher altitudes and latitudes became possible and worthwhile. Using fire to drive game and clear underbrush could have been learned from observation of natural fires, but its use as a campfire opened unprecedented possibilities. Fires keep people warm, soften food, and push back the night. Fires kept prowling carnivores away from human groups, even those who took up residence in the carnivore lairs. In all these ways, fire enhanced the comfort and safety of the home base, contributing to the self-domestication of the human family.

Accumulations of trash in late Lower Paleolithic sites support the notion that home bases with fire were occupied for longer periods of time than earlier habitation and sleeping sites (Turner 1984). Home bases may also support larger interdependent groups, making accommodative social skills more important to survival. By keeping people together in one place home bases may have intensified the sharing and spread not only of food and cultural behavior but also of parasites and some communicable diseases. Thus, the institution of home bases had implications for both biological and social evolution.

ELABORATING CULTURE

Given that humans are primates, an order of mammals most of whose members are plant-eaters, major questions in human evolution involve when and how **hominids** (Hominidae: the human branch of the primates) began to eat significant amounts of meat, and when and how they began the purposeful killing of large mammals (Bunn 1981; Isaac and Crader 1981; Potts 1984). Chimpanzees and baboons kill and eat small creatures: predatory behavior is within the primate spectrum. In human prehistory, stone tools create an archaeological record more than 2 million years in duration, but we know very little about how those early tools were used in food-getting. In the archaeological record, scavenging as a means of meat acquisition is very difficult to distinguish from hunting, since both activities produce associations of broken bones and rough tools. Confidence in previous interpretations of purposeful hunting by early hominids has given way to cautious skepticism about the appropriateness of modern analogies (Binford 1981; Nitecki and Nitecki 1987; Potts 1984). Within the last million years or so, *Homo erectus* or early *H. sapiens* began to hunt large mammals, becoming the first hominids to share niche space with those powerful social hunters, the large cats and canids.

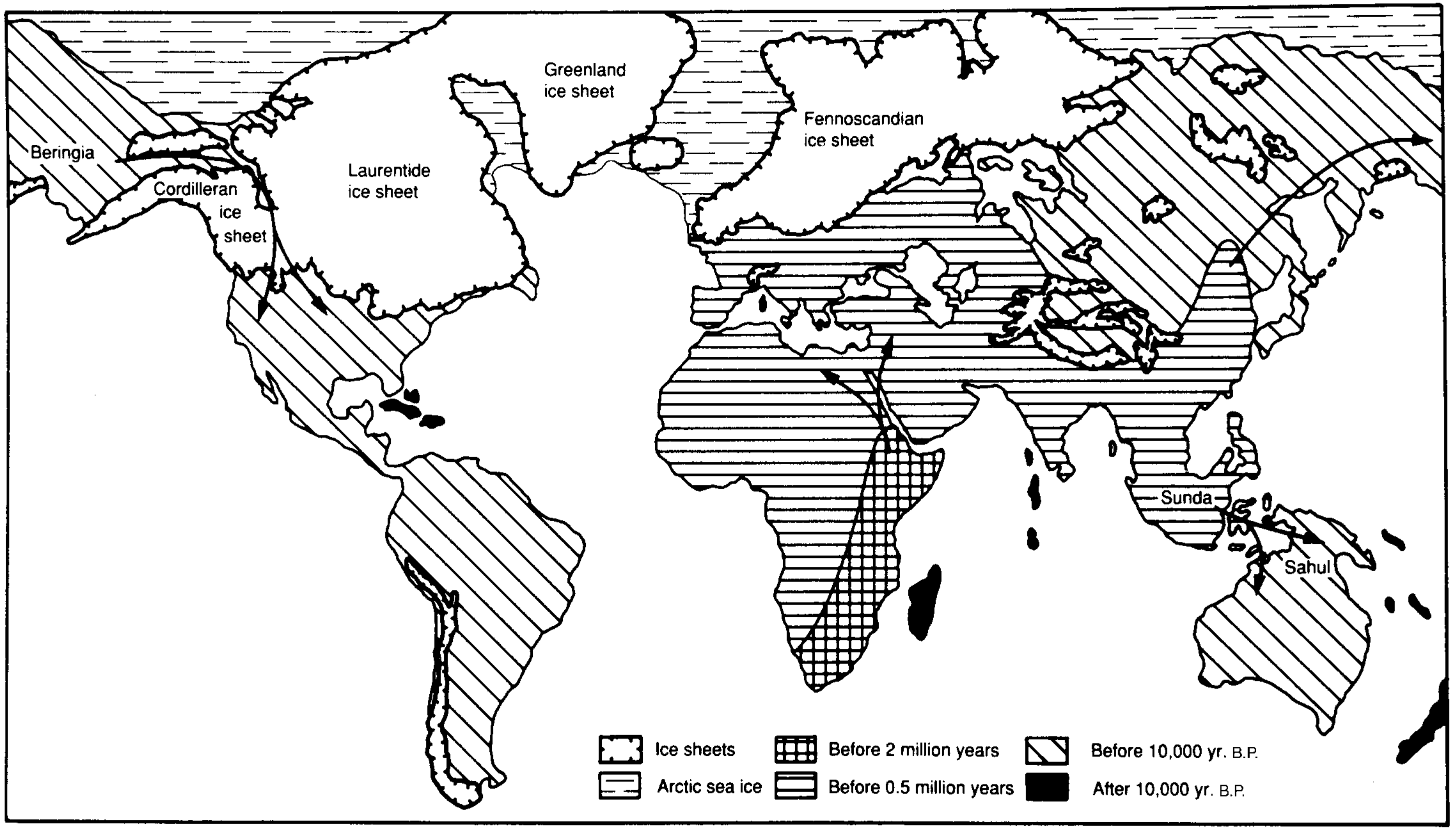

Figure 1.1 Hominid expansion across the continents, during the Pleistocene (hatchured and cross-hatched) and Holocene (solid) epochs. Entry routes into the Americas probably included water travel down the west coast. (Reproduced from Roberts 1989: Fig. 3.7, by permission of Blackwell Publishers.)

Gatherers and hunters

Meat is a high-quality food, offering maximal energetic nutrition per unit of bulk or weight. Its consumption on a regular basis opened a new niche at the top of the food pyramid for hominids. However, hunting large game involves considerable risk of failure if pursued more than opportunistically; some alternative food-getting strategies are essential for buffering risk. Cooperative behaviors are institutionalized in the hunt: in the reliance on others to provide alternative foods, in the necessity for trust and sharing of whatever food is acquired. When hunters range widely, base camps must provide safety for infants and their caretakers, as well as secure places in which to consume large amounts of perishable food which is likely to attract the interest of other potential consumers.

There is a romantic fiction that people who live by gathering and hunting exist in a state of blessed nature, in benign harmony with the world around them. This idea has triumphed over earlier perspectives of gatherer-hunters living lives that were "nasty, brutish, and short." The purported harmony is evoked as the opposite of modern conditions where people clearly threaten the tenuous balances of the biological world. On the contrary, human beings have long been the world's great destabilizers, leaving almost nothing strictly as they find it (Goudie 1993). Long before bulldozers and dams, people were remaking the world to suit their visions, and before that, they were changing things by inadvertence if not always by volition. Gatherer-hunters, simply by being rather large and very clever animals, affect the world in which other species live. Where groups of them gather together and stay for any length of time, the local vegetation is trampled or removed. Their food and body wastes change the local soil chemistry. Their campfires ignite prairie and forest fires, establishing or maintaining fire-successional communities. In hard times they impose significant additional stress on prey species and on species with whom they compete for prey. Their game drives and fish weirs impose heavy predation burdens on local populations of game and fish. They move plants and plant parts around and may introduce species into new habitats. By changing the distribution and densities of flora and fauna, humans have always lived in a world partly of their own making (Dincauze 1993a). The physical remains of such behavior and its consequences make possible an archaeology of paleoenvironments and paleoecology.

By the Middle Pleistocene (Table 1.1), early humans expanded their ranges out of subtropical Africa into the Near East and Europe. In latitudes where they faced winter low temperatures, shelter became an imperative. Caves and small cave-like houses kept wind and rain outside; ultimately, clothing made the artificial "indoor"

Table 1.1 Geological epochs and Paleolithic stages, with ages

Time (millions of years)	Geological epochs	Paleolithic stages
0.01	HOLOCENE	
0.05	LATE PLEISTOCENE	UPPER PALEOLITHIC
0.1		
		MIDDLE PALEOLITHIC
0.5		
0.7	MIDDLE PLEISTOCENE	LOWER PALEOLITHIC
1.0		
	EARLY PLEISTOCENE	
1.5		
2.0	PLIOCENE	

climates portable for mobile hunters and foragers. The artificial microclimates of housing and clothing provide relatively benign conditions not only for people but for lice, fleas, and other insects. Small mammalian scavengers hiding in the dark corners of houses gain access to food. Houses create dead-air spaces, and smoky fires pollute that air. People relying upon houses and clothing are stressed by more and different diseases than are tropical people living mobile existences in the open air. Both genetic and behavioral selection is imposed by such novel stressors, including the social and psychological requirements for tolerating the close presence of others in winter quarters. Contemporary people, after thousands of generations of selection, still suffer from cabin fever or seasonal depression in long, dark winters. For all its benefits, environmental innovation entails major consequences.

Nevertheless, gatherer-hunters were phenomenally successful among the animals of the world. The environmental problems that constrained the ranges of the earliest hominids – inability to prepare portable high-energy foods, reliance on equable climates, and limited defense from predators – were solved well enough before 50,000 years ago to make life possible in all continents that were accessible by foot. Subsequently, by boat across the Pacific and Arctic Oceans and by foot into the last deglaciated terrains, they reached almost all habitable lands, mainly before cities rose anywhere. People learned to live successfully gathering and hunting the diverse plant and animal life of the planet from the high Arctic to the tropical forests, along the seacoasts, and in the mountains.

Domesticators

People first domesticated themselves, learning to live in social communities of their own invention. They then brought animals and plants into their communities and their houses, creating innovative social and economic relationships.

Dogs were apparently the first animals to be domesticated. The process of that achievement is unknown, but dogs genetically modified in the direction of modern domesticates appear in the archaeological record of Eurasia and North America by the end of the ice age (Davis and Valla 1978). Dogs accept food that they have not killed, and it may have been as scavengers that canids first came into close association with humans, joining human communities as secondary self-domesticators (Serpell 1995). Speculation has long centered on the usefulness of dogs to human hunters; their use prehistorically in hunting remains undemonstrated but possible. As pets, their intelligence and loyalty recommend them immediately; as alarm-givers, protectors, warmers, and comforters, and even as a convenient emergency meat supply, they offer appreciable benefits to humans who feed them. Dogs are good value: only in cities are their costs likely to exceed their contributions to group life.

There is no way of knowing how many other species humans might have tamed as pets; the keeping of individual animals rarely shows in the archaeological record. Nor do we expect to know how many species were experimented with as domesticates. We count the successes, and those were the small ungulates of the highlands fringing Mesopotamia. Sheep and goats were manageable; gazelles were not. On that difference hangs much of history and unmeasured ecological effects. The benefits of domesticating herbivores appear obvious in hindsight – a food supply conveniently close by, a ready source of milk, hair, fur, and other animal products, some control over the numbers of economically useful animals. In fact, some of the benefits could not have been immediately realized (sheep's woolly coats, for example, appeared later in domesticated flocks). We do not know what the impetus was for early efforts at domestication; more evidence of the context is required. In several parts of the world, people managed vegetation to increase the density of wild herbivores, achieving some of the benefits of domestication without the heavy costs.

Keeping domestic herds establishes unprecedented relationships between people and animals. While the seasonal **transhumance** of herders may seem not very different from the mobility of hunters, there are additional considerations. Herd animals, once captured, must be restrained, protected, fed, bred, and actively managed. The selection of the more docile for breeding, whether intentional or not, eventually produced animals ill adapted to fend for themselves. Successful maintenance or expansion of herds requires that the herders eliminate competitors and predators, and seek or supply essential food and water. All of these tasks entail human labor, requiring daily and seasonal scheduling. Later, when the original domesticates were augmented by cattle and when husbandry was expanded beyond the original homelands into the forests of Anatolia and Europe, labor requirements were increased by the construction and maintenance of facilities such as corrals and shelters. In Europe, early farmers kept their animals within their houses, presumably at night, thereby intensifying their own exposure to a range of contagious or vector-borne diseases. Close relationships with farm and herd animals directly affected human group size, territoriality, division of labor, niche breadth, diet breadth, mobility, and health, in both beneficial and deleterious ways. The changed conditions of life entailed genetic and social adaptations. With the invention of harness, humans were able to use large animals for traction, adding significantly to the benefits of animal domestication by increasing the energy and muscle power available to them.

Plant domestication emerged from foraging economies in many parts of the world during the early **Holocene** (between 12,000 and 10,000 years ago). In southwestern and southeastern Asia, Mesoamerica, and South America, seed-producing and starchy root plants were brought under human care and propagation by 10,000 to 8000 years ago. Because the archaeological record for leafy vegetables and fruits is impoverished by preservation problems, the chronology and location of domestication for some of our favorite modern foods is still unknown (Harris and Hillman 1989).

Competent gatherers of wild plant foods know well when the edible portions of various species are at their best, and they know where to find them in economic quantities. The easiest way to utilize plants in season is to go where they grow, gather and consume them until there are insufficient quantities left, then move on to other places. Population numbers, distance, or seasonality may encourage gathering more food than can be immediately consumed, with additional labor invested in preparing the surplus for later use. Such "harvesting" strategies bridge much of the conceptual distance between gathering wild plants and tending crops. The global warming that accompanied and followed the shrinkage of the ice sheets certainly brought climatic changes that in turn entailed changes in the compositions and distributions of plant and animal communities. Behavioral adaptations by human foragers followed; repeatedly, these involved deliberate manipulation of economically important plants. Plants colonizing new or disturbed surfaces, wild plants responding to drought, the sequential recovery of plant communities following fires, must all have been familiar to gatherers and understood well enough to permit human manipulation of the distribution or densities of favored species. Intentionally or inadvertently spreading seeds, as well as transplanting and weeding desirable plants and diverting or carrying small amounts of water for simple irrigation, are well within the technological competence of foragers. Small changes in human behavior, bringing minor, short-term benefits, do not show well in the archaeological record (chapters in Harris and Hillman [1989]; Watson and Kennedy 1991). Early experiments in plant management are even more elusive than the early successes at domesticating animals that seem to have been going on at about the same time in the Near East, at least.

The Farmer Trap was sprung later. The labor increase associated with early plant domestication must have been perceived as either a reasonable or necessary cost for a realized benefit. The varied diets of hunter-gatherers provide qualitatively better nutrition than do the simpler, more consistent, diets of subsistence farmers. Eventually, many foragers relinquished some freedom and mobility in exchange for a predictable sufficiency of a simpler and ultimately poorer diet. Crop-raising supports increased population and family size, typically at the cost of lowered nutritional status and diminished body size (Cohen and Armelagos 1984). Labor invested in the land requires a more sedentary life, which brings its own benefits and costs such as improved shelter, technology and its material products, labor requirements for the construction and maintenance of facilities and tools, and increases in density-dependent diseases. Lost mobility options make possible more intensive social control over individuals, beginning social stratification. The short-term predictability of domesticated crops is countered by the ecological fragility of specialization on only a few plants, which are subject to losses from diseases, unfavorable weather, insects, and animal predators.

The domestication of the landscape followed shortly on the establishment of subsistence agriculture. In Mesopotamia and the eastern Mediterranean lands its effects have been well documented archaeologically. "In their efforts to control the environment in the interest of reducing risk and increasing productivity, people unwittingly imposed a Near Eastern subsistence landscape on new and frequently unsuitable environments" (Butzer 1982: 310).

Landscape modifiers

The development of technology for landscape modification usually increases the **carrying capacity** of habitats for our unique species, making possible higher human population densities. With farming, land becomes valuable; land rights set up the conditions for social inequality and territorial conflicts at many scales. The discontents of civilization, as well as its material benefits, seem to be legacies from the same source.

Human effects on the biological landscape are inseparable from those on its physical aspects. Soils (Chapter 11) articulate the two very closely, so that what affects soils changes the **biota** (all living things in a defined place), and vice versa. Landform modification, of course, affects both. Even very simple plows, breaking the soil and exposing it to wind and water erosion, initiate significant changes in the distribution of soil types and superficial sediment bodies (e.g., Starkel 1987). Irrigation reorganizes surficial water flow and changes local water tables. New communities of plants and animals line up along irrigation canals. Pastured animals and manured cultivated fields further change soil characteristics. Soil depletion and erosion, progressive salinization of irrigated fields, deforestation to create fields and pastures and to obtain wood for buildings and fuel, siltation of lakes and rivers by agricultural runoff – these are ancient side effects of farming that change the natural landscape. As towns grew into cities, roads facilitated the movement of people carrying information, other organisms, and commodities. Urban populations, building anew on their own ruins, heaped cities into artificial hills.

Climate also is influenced by changes in biota and landforms. Deforestation and seasonally bare soils change the reflectivity of the Earth's surface, modifying air currents and thus weather patterns. When fragile plant communities are damaged, desertification can result – an expression of changed local climate, and in turn a cause of it.

City-dwellers

People hold strongly divergent opinions about cities as places to live; they feel ambivalent about these population concentrations that offer cultural richness and sybaritic comforts for some, with stressful social, economic, and biological challenges for the many. High population densities at a regional scale entail territorial and social circumscription. Sedentary communities are dependent upon outsiders to supply commodities not locally available, and importation of goods requires economic management. Managerial hierarchies everywhere bring taxes to pay for them, priests to justify the resultant inequality, chiefs to enforce it, and soldiers to protect it. High urban population densities amplify the benefits and costs of coresidence: houses and neighborhoods are more permanent, less clean. Urban conditions breed diseases; with cities came epidemics.

Cities not only concentrate population and energy, they consume them. Unlike rural hamlets and towns, cities rarely replenish themselves; they are instead replenished from their hinterlands, from which come commodities, energy, and population. The rate of population increase in cities tends to be orders of magnitude higher than biological potential; they are population sinks, and may always have been so (Barney 1980: 60–64; Watt 1973: 141).

Urban societies, concentrating power and wealth, support craftspeople and artisans whose products are not merely luxury goods but symbols of privilege and social power. Full-time craft specialists bring technology to new heights of achievement and complexity. The transformation of minerals by pyrotechnology that began in the work of potters and metallurgists is the foundation of all modern industry. Ore extraction and metallurgy began about the same time as cities in Asia Minor, although they involved also non-urbanized societies in the hinterlands.

The special needs of urban societies, and the wealth and power at their command, led to public works such as large temples, pyramids, palaces, and city walls. Beyond the walls were built canals, roads, and reservoirs to serve the inhabitants. Later swamp draining and land leveling expanded the food-producing potential. Irrigation, short-fallow regimes, and erosion eventually depleted the soils whose crops supplied the early cities. Native biota were displaced as the landscape was urbanized. Citizens kept pets, farm animals, and work animals. In shops, warehouses, and homes where food was stored, vermin such as rats and weevils proliferated.

Urban environments have their own distinct climates. Cities are notorious "heat islands," generating and retaining temperatures higher than the adjacent countryside. Rising air currents deflect local rainfall. Roofs and pavements shed water much as bedrock does, with the result that the local water table is lowered as water drains off outside the city center.

Urban environments have biological effects upon the residents. Privilege, poverty, stress, and density-dependent diseases all affect the quality and length of urban lives. We may expect, therefore, some selective effects on the gene pools in cities. However, these effects do not seem to have led to biological adaptation at the population scale. Cities, after all, are very recent phenomena in human environments, only about 5000 years old at the maximum. Because city populations rarely replace themselves, succeeding generations bring new genetic material from outside. Genetic adaptations to urban life remain for the future to observe and evaluate.

Cities raise to new heights human potential in the arts and in the art of living. At the same time, these special environments are transitory in the global scale of phenomena. The archaeological ruins of romance and fantasy are mainly those of dead cities. Where the early civilizations rose, the ancient centers stand abandoned in devastated landscapes. Over a hundred years ago, George Perkins Marsh urged his contemporaries to ponder the death of cities, that they might take some interest in the deaths of organisms around them in time to avoid a like fate (Marsh 1965 [1864]).

This rapid review of human environments in evolutionary perspective demonstrates that the human environment has become more complex through time – slowly at first, then at increasing rates, to arrive at today's startling pace of change and diversification. Today, worldwide, the sociocultural environment dominates individual lives, the fates of nations, and the destiny of other species coresident on the planet.

GOALS OF PALEOENVIRONMENTAL STUDIES

The global scale of human habitat is unique among creatures, most of which have environmental tolerances that limit their ranges. Humans invented personal and social environments that they carry about with them, permitting today almost any style of life to be lived anywhere on the globe. We bipedal omnivores with our powerful technologies modify the quality and distribution of climate, soils, water, vegetation, animals, and landforms. Paleoenvironmental studies, by no means esoteric historical exercises, are essential for elucidating the process by which this came about. Because of the interrelationships of organisms and their environments, past conditions continue to shape the present and future. Paleoenvironmental studies in archaeology have three kinds of goals: historical, philosophical, and policy-making goals.

Historical goals

The first task of paleoenvironmental study is the description and understanding of environments in the human past. As has been shown above, the traditional contrast between natural and social environments is no longer analytically acceptable; the two are mutually dependent and inseparable. The hypothetical question, "Are the modern densities of the human species attributes of its 'natural' or its 'social' environments?" defies analysis. Population density is central to the conditions of existence for any community, and begs to be understood on its own terms. Any adequate understanding must acknowledge the polydimensional character of environment, its physical, biological, and social aspects. Historical research can reveal how these characteristics developed and interacted to define our species as we find ourselves today.

Theoretical and philosophical goals

More abstractly, but not less significantly, we seek knowledge of the nature of *Homo sapiens* – the inherent potentials and limitations of the species. Significant issues include the uniqueness among mammals of our bipedal big-brained species, the interdependence of individuals and societies, the biological distinctions among populations, the social equivalence of our diverse societies, the problem of free will, the definition of "progress," and the ultimate questions of being and behaving. Paleoenvironmental data and insights will not resolve these issues, but it is unlikely that genuine understanding of them can be gained without a perspective on environmental contexts and the evolutionary processes that defined them.

The following chapters will amply demonstrate that an ecological perspective on human physical and social history and evolution is by no means determinative. People are the proximate causes of change in their societies; their environments reflect, amplify, or dampen change, and return changed conditions to the instigators of change, requiring new adaptations.

Policy goals

Insights and understanding gained during pursuit of the first two goals contribute to intelligent planning for the future. It is widely acknowledged that present generations must take action to assure a survivable world for ourselves, and we see that we cannot live in isolation from the worlds around us. The reciprocity between any creature and its environment is an inescapable fact of existence. Human ecology is not a simple phenomenon. Complex problems cannot be alleviated by simplification; what is needed is the understanding that permits creative insight and appropriate action. Ecology shows that static assumptions – the expectation that things will, or ought to, stay the same – are maladaptive. We need to build into the fabric of our daily lives an awareness of the global consequences of our activities. Human societies today, and for a long time, have found adaptation to each other both the immediate and the ultimate challenge. The threats we pose to each other, to all other living things, and to the physical world around us, are the adaptive challenges of today. Adaptation, fundamentally, is survival and reproduction. That always entails costs to individuals and communities.

Knowledge of past lifeways and foodways can illuminate dysfunctional aspects of contemporary lives, directly in the case of traditional people whose ancestry can be traced to archaeological sites, and indirectly in the case of urban and ghettoized populations. Significant policy implications can be developed from paleoenvironmental and paleonutritional research, to support improved living conditions for contemporary people (e.g., Brenton 1994).

Environmental studies in archaeology are not undertaken in expectation that descriptions of past environments will directly explain human actions, cultural developments, or change of any kind. The chapters that follow should make clear why such expectations are futile. The complexity of the natural world and, especially, of potential human responses within and to that world, defeats any hopes for easy, direct, causal connections between forms of human society or existence and the non-human world. However, no understanding of human conditions in the past can be achieved without some grasp of physical and biological contexts. The better we can know and evaluate the context of daily lives at any time in the past, the better to evaluate and understand the challenges faced, the choices made, and the changes engendered by human thought and actions. For archaeology, alone among the paleoenvironmental disciplines represented in this book, the human thinkers and actors retain primacy of place. Even though we can rarely identify individuals in the past, we cannot for a moment forget that it is the human beings whom we seek to understand, not simply the frequency of rains in past summers. As we learn more about both, the more likely it seems that the two phenomena are related.