Medical Anthropology

Contemporary Theory and Method

Revised Edition

edited by

Carolyn F. Sargent and Thomas M. Johnson

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Disease, Ecology, and Human Behavior

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Disease is an inevitable part of life, and coping with disease is a universal aspect of the human experience. All humans, during the course of their lives, harbor infections by disease organisms and suffer the consequences of those infections. The experience of disease, by individuals or whole populations, is as inescapable as death itself. Yet the particular diseases that afflict people, as well as the way in which symptoms are interpreted and acted upon, vary greatly by culture. Understanding the nature of interactions between disease and culture can be a productive way of understanding humanity and is therefore an important topic in medical anthropology. Because of its biocultural, evolutionary, and cross-cultural perspectives, anthropology has much to offer to the understanding of the causes and consequences of disease. From an anthropological perspective, diseases cannot be explained as purely "things in themselves"; they must be analyzed and understood within a human context—that is, in relation to ecology and culture.

The distribution of disease in a population is neither constant nor random. The diseases that characteristically afflict members of a population vary significantly among societies because of differences in culture, ecological setting, and historical period. More important, within a single society, there may be striking variations in the kind and severity of diseases that afflict individuals of different ages, sexes, social classes, and ethnic groups. Understanding the descriptive epidemiological distribution of disease morbidity and mortality is important to medical anthropologists particularly because the social patterning of disease distribution often reflects the cultural coding of behaviors. Understanding the role of culture in disease distribution is also necessary for the implementation of successful disease control programs

Culture plays a major role in determining the patterns of disease and death in a population for two reasons. First, culture may shape important behaviors (with respect to diet, activity patterns, water use, sexual practices, etc.) that predispose individuals to acquire certain diseases. Second, through culture, people actively change the nature of their environment, often in ways that affect their health. The archaeological and historical record clearly demonstrates that the environmental changes caused by humans can have profound effects, both positive and negative, on disease rates. Although humans have a dual system of inheritance through both genes and culture, culture is the primary mechanism for survival. Culture is a mechanism of adaptation to environmental threats, such as diseases, which act as agents of natural selection in the evolution of both human biology and culture. Cultural practices, however, can also be maladaptive when they exacerbate health problems.

Ecology is the study of the relationship of organisms in an environment. Human societies coinhabit their environment with many other organisms, including those producing disease. An ecological approach to human health and illness emphasizes the fact that the environment and its health risks are, to a significant extent, created by the culture. In many cultures, people think of themselves as masters of their environment, because they exploit so many plants and animals within the food chain as sources of energy and nutrients. Yet at the same time, humans are being exploited by microorganisms, including those that cause disease, as a source of food and shelter. Disease ecology primarily focuses on the multiplex interactions of the pathogen, the environment, and the human host. The nutritional, physiological, genetic, and mental condition of the human individual host all play significant, if still incompletely understood, roles in both infectious and noninfectious disease states. The current international health problems called "emerging infections" provide a good example of the mutability of these ecologic interactions.

The study of disease and human behavior in an ecological setting is a fundamental task for medical anthropology. The approach contributes to basic and applied research in the field by providing a strategy for answering some of the major questions raised by both general anthropology and epidemiology. For example, it can be applied to anthropological questions concerning the interaction of biology and culture in human evolution or to questions of why particular cultural behaviors may "make sense" and be retained in an ecological setting. This type of research strategy is truly biocultural and can therefore help to bridge the gap between biological and cultural anthropology. In epidemiology, the contribution of an anthropological focus on human behavioral patterns can help unravel fundamental questions of disease causality. The study of disease, ecology, and behavior also has important implications for public health programs. Through the study of behavioral patterns related to the social epidemiology of disease, it is possible to design health programs that are both effective and culturally acceptable. Moreover, the ecological approach can help to anticipate the health implications of technological change or new political-economic policies.

This chapter discusses basic concepts and methods in the study of disease, ecology, and behavior; it is not an exhaustive review of the literature. Instead, we summarize many illustrative examples of research that focuses on particular diseases in particular cultural settings. These examples emphasize infectious diseases for several reasons: first, the etiology (causation) of these diseases is the best understood; second, the ecological approach described here is most applicable to this category of disease, (although it is also applicable to the study of chronic diseases with complex etiologies, which are characteristic of industrialized societies, as well as nutritional deficiency diseases, which are characteristic of the poor in economically developing societies); and, finally, infectious diseases still represent the major cause of morbidity and mortality in nonindustrialized societies, which anthropologists have traditionally studied.

THE THEORETICAL ORIENTATION OF DISEASE ECOLOGY

What Is Disease?

In the enormous literature of biomedicine, there is no universally accepted definition of disease. Like many theoretically important concepts, "disease" is essentially left undefined and is used in ambiguous ways. For example, it is often defined by what it is not. Disease is generally seen as a failure of normal physiological activities and a departure from a state of health. But such a definition is uninformative. The problem is that within this definition is a concept of "normal." Yet it is clear that normality must be considered as culturally constructed; for example, conditions that have been considered as normal in particular populations include persistent diarrhea (Desowitz 1981), malaria (Ackerknecht 1945), the bloody urine of schistosomiasis (Heyneman 1979), and the skin discolorations of pinta (Ackerknecht 1943). "Health," of course, is so notoriously difficult to define that the World Health Organization's (WHO) utopian phrase, "a state of complete physical, mental, and social well-being," has little use for those who wish to measure health.

Medical social scientists have often made the distinction between disease and illness. In this case, disease refers to a set of objective, clinically identifiable symptoms, while illness refers to an individual's perception of those symptoms. This perception is what motivates the individual to seek medical care or to assume the sick role (Mechanic 1968). A persistent paradox in modern medical systems is the fact that many patients seeking medical care (i.e., who have an illness) do not have any identifiable disease, while at the same time, many people with disease do not define themselves as ill and thus do not seek medical help (Zola 1972). Although the distinction between disease and illness is useful, it assumes that the biomedical definition of disease is objective and culture free. But this is clearly not the case. Biomedicine is a cultural system in which certain kinds of information are privileged and certain cultural values are used to interpret symptoms (Hahn 1995).

When defining disease, it is useful to compare the conceptions of the layperson, the biomedical specialist, and the disease ecologist. Most people, even in complex societies, conceive of diseases as invisible entities "out there," that can attack victims and cause sickness, pain, loss of vitality, and even death. Although diseases are usually named, they generally cannot be controlled by ordinary individuals. From the emic perspective of the lay patient, there is little difference between a disease caused by a "germ" and one caused by evil spirits or other supernatural agents. In either case, the sick person may be a completely innocent victim of the disease (as in most pediatric cases) or may have partly encouraged it to attack by way of irresponsible behavior (e.g., breaking postpartum taboos, smoking cigarettes). For most people, the large number of unknown diseases "out there" makes the world a dangerous place. People can attempt to prevent "catching" a disease by avoiding contexts where they are exposed to pathogenic agents or by avoiding conditions where they might be more likely to have diseases "sent" to them.

For the practitioner of biomedicine, disease is the expression of pathology alone. One textbook begins, "Pathology is the study of disease by scientific methods. Disease may, in turn, be defined as an abnormal variation in the structure or function of any part of the body" (Anderson 1985:1). Diseases can be identified by discrete sets of signs and symptoms or by diagnostic tests. Diseases can be categorized, within the taxonomy of biomedicine, primarily in terms of the biological characteristics of the etiological agents. The standard categorization system is the *International Classification of Disease* (ICD), currently in its ninth edition and the analogous system for psychiatric disorders is the *Diagnostic and Statistical Manual,* currently in its fourth edition. These listings form an authoritative text linking diagnostic labels, clinical findings, and patients' symptoms, and therefore they suggest a uniformity of biomedical practice that only theoretically exists. In reality, both the taxonomic and diagnostic systems of biomedicine, however, are based on certain cultural assumptions about causality and normality; the practice of biomedicine varies according to local traditions. The use of particular diagnostic categories or the prescription of particular therapies or procedures also varies significantly according to cultural geography (Payer 1988; Konner 1993). Furthermore, it has been argued that in clinical settings the disease is treated rather than the patient; from the viewpoint of the practitioner, the disease often takes on an existence quite apart from the patient. A more patient-centered approach focusing on the experience of "sickness" has recently been advocated by Hahn (1995). The idea that biomedicine is itself a cultural construction is a basic insight of critical medical anthropology. Nevertheless, the ICD classification system remains useful for organizing encyclopedic volumes like the invaluable *Cambridge World History of Infectious Disease* (Kiple 1993).

In contrast, from an ecological perspective, disease does not exist as a thing in and of itself. Disease is a process triggered by an interaction between a host and an environmental insult, often a pathogenic organism or "germ." Disease is one possible outcome of the relationship between the host and the potential pathogen. Since the advent of bacteriology and germ theory, it has been recognized that infection is a necessary but not sufficient condition for disease to occur. For tuberculosis, for example, this principle has been recognized since the work of the turn-of-the-century bacteriologist, Koch.[1] Normal, healthy individuals typically harbor many different colonies of viruses and bacteria that are not pathogenic (i.e., disease producing), primarily because these agents are held in check by the human immune system. Indeed, individuals are constantly being challenged by microorganisms in their environment (Burnet and White 1978). Disease occurs only when the host's immunological system is unable to keep pace with the reproduction of the pathogen, a process that is affected by age and can be accelerated through malnutrition, coinfection, or immunosuppression (Scrimshaw, Taylot, and Gordon 1976).

According to Jacques May in his classic volume, *The Ecology of Human Disease,* disease is "very simply that alteration of living tissues that jeopardizes their survival in their environment" (1958:1). This means that disease is the temporary expression of maladjustment of an individual trying to cope with the challenges of his or her environment. In this model the most common eventual outcome of this maladjustment is, on the level of the population, a mutual accommodation between host and pathogen. This is most often a relationship of dynamic tension, wherein a change in the host (e.g., the use of an antibiotic) can necessitate a corresponding change in the pathogen (e.g., the evolution of antibiotic resistance).

What Is Ecology?

Ecology is the study of the relationship between a species and its total environment. Most often considered a subfield of biology, ecology deals with the interactions between organisms and their environment on the population, community, and ecosystem levels of organization (Ehrlich, Ehrlich, and Holdren 1973; Orlove 1980; Moran 1990). Integral to most ecological studies is the idea that the complex set of interactions between organisms in an ecological niche (territory) makes up a system (Odum 1971). This "ecosystem" includes not only natural resources (e.g., water, minerals) but also plants, animals, and humans. Two of the assumptions of this model are that the ecosystem is maintained through mutually dependent interactions between members of the system and that the common goal of the various species in the system is homeostasis. The primary benefit of homeostatic balance is the prevention of environmental degradation and thus the mutual survival of species in that environment.

In this view, human activities such as agriculture create imbalances in natural ecosystems. Humans are not capable of ecological change but also ecological destruction. There is no doubt that humans have often been responsible for radical changes in their environment and that such ecological changes have had negative effects on health. The impact of the construction of dams on the prevalence of schistosomiasis is a good example. Archaeologists and paleopathologists have shown that humans have systematically changed their environment all the way back to the paleolithic past (Swedlund and Armelagos 1990). But the ecological perspective does not require the assumption of a cooperative, mutually dependent "system" in nature, which would maintain itself if not for human disruption. Modern evolutionary theorists, in fact, question whether community ecosystems are a biological reality at all (Ayala 1983). With few exceptions, the apparent "system" may be nothing more than the sum total of individual behaviors aimed at the maximization of reproductive success.

In the social sciences, particularly in sociology, the term *ecology* is sometimes used to refer to studies of certain behavior traits, mapped from a central (usually urban) locale. This is not what anthropologists and biologists mean by the term. Medical geography, on the other hand, emphasizes the study of the distribution of disease in regard to place, using the mapping techniques of cartography as its basic tool (Learmonth 1988). The ecological approach in medical anthropology has been a standard paradigm, primarily because of the successful textbook by McElroy and Townsend (1989), who use the label "medical ecology" (McElroy 1990). This approach has been criticized for ignoring the political-economic dimensions of health and illness and therefore "blaming the victims" of disease (Singer 1989b). Such criticisms have a certain validity, just as traditional cultural ecological studies have been criticized for underemphasizing history and power relations (e.g., the "revisionist" studies of !Kung history; [Wilmsen 1989; Lee 1992]). Nevertheless, these criticisms have touched off an important debate, spearheaded by Wiley (1992), about the value of biocultural approaches and the concept of adaptation in medical anthropology. One consequence of this debate, we believe, has been a recognition by many biologically oriented medical anthropologists and biological anthropologists of the need to incorporate macrosociological political-economic variables into their ecological models (Goodman and Leatherman 1996).

We find the distinction between cultural ecology and political ecology to be useful in this regard. These refer, in large measure, to different levels of analysis: cultural ecology to the level of individuals or human groups interacting with other species (plants, animals, pathogens) in the environment and requiring a microsociological analysis; political ecology referring to historical interactions between human groups (ethnic groups, classes, nations) that affect the ecology through population movements, land use, or differential access to resources and requiring a macrosociological perspective. These approaches are complementary, as we will demonstrate. However, it is important to note here that adding the dimension of political ecology to microsociological studies reveals the "unnatural history" of many diseases (Turshen 1984).

What Is Disease Ecology?

Disease ecology focuses on the interactions between two organisms: the pathogen and the host. Unlike the more general ecological approach, however, the emphasis is not on the harmonic cooperation between humans and agents of disease (Armelagos et al. 1978). This is because diseases are most often viewed as serious threats to human health. Humans are, from the viewpoint of a disease organism, the "environment" in which the disease organism lives and reproduces and to which it must adapt. The disease ecologist tries, metaphorically, to understand the disease organism's "worldview" and its adaptive strategies for survival and reproduction. The ecological model is much more easily applied to diseases caused by infectious agents and often exacerbated by malnutrition than the "diseases of lifestyle" that characterize modern affluent populations. Furthermore, a basic understanding of the biology of disease is a prerequisite for this type of research.

The notion of adaptation is a fundamental principle of disease ecology—adaptation from the perspective of both the disease agent and the host. As Lieban states, "Health and disease are measures of the effectiveness with which human groups, combining cultural and biological resources, adapt to their environments" (1973:1031). This notion is valid only if our understanding of the concept of environment is broad enough to include the ways in which other human groups with superior political or economic power impinge on the environment, forcing accommodation.

As such, studies in disease ecology must include at least three levels of causation: (1) a microbiological level, in which agents of disease act within the human body; (2) a cultural ecological (or microsociological) level, in which individual behaviors, encouraged or constrained by sociocultural context, put people at risk for contracting particular diseases; and (3) a political ecological (or macrosociological) level, in which historical factors involving interactions between human groups shape people's (often differential) access to resources and their relationship with the physical environment.

Disease ecology is one of the foundations of medical anthropology and is, by definition, a biocultural enterprise, as are the closely related disciplines of medical geography and epidemiology. The study of disease ecology both allows and requires a bridging of the biological and cultural paradigms in anthropology. This approach in medical anthropology owes much to the pioneering work of Alland, whose book, *Adaptation in Cultural Evolution* (1970), first used evolutionary theory to examine how cultural behaviors enhance hygiene, health, and reproductive fitness. Although this early book suffered from some of the weakness of a group-selectionist argument, its underlying ecological and evolutionary approach for understanding human-pathogen interaction is still valid.

DISEASE AND BIOCULTURAL EVOLUTION

Evolution refers simply to the process of change over time. Human evolution includes changes in both biology, through modification of gene frequencies, and cultural forms. It is the latter, cultural change, that accounts for the tremendous success of our species. In fact, human evolution has never been a purely biological process. Evidence from paleoanthropology suggests a cultural dimension to hominid existence, as well as an ongoing interplay of genes and culture, which affected the survival and reproduction of early ancestors (Durham 1982, 1991). Furthermore, it is important to remember that evolutionary change does not imply progress; evolution, whether biological or cultural, does not necessarily mean that things get "better."

Evolutionary change occurs only in relation to a particular environment. For example, the evolution of the gene for the sickle cell trait was context dependent on an environment characterized by *Plasmodium falciparum* malaria. The gene codes for an abnormal structure of the hemoglobin molecule in the red blood cell. In moderate amounts, the abnormal hemoglobin can protect individuals from death from malaria and is therefore considered to be an evolutionary adaptation to the disease. Outside the malarial context, however, this genetic adaptation does not confer an advantage; in fact, homozygous carriers of the sickle cell allele are at the most extreme disadvantage, because they will die from sickle cell anemia. The threat of malaria continues to be an enormous and increasing problem throughout the world, with estimates of around 100 million clinical cases and 2 million deaths per year (Oaks et al. 1991). As such, the genetic "disorders" of the hemoglobinopathies, despite their relatively high costs, continue to protect millions of people from malaria-related death today, especially in sub-Saharan Africa.

Natural selection is the primary driving force for evolutionary change in both biological and cultural systems. This means that, in general, traits that improve the chance of survival and reproduction in an environment will be maintained or increase in frequency. Conversely, traits that result in premature death or lower fertility will, in the long run, become very rare or disappear. This does not mean that biological or cultural traits are always able to solve environmental problems. It is also important to remember that selection occurs only upon preexisting variations of genetic or cultural forms; it is not the case of necessity's being the mother of invention. The conditions of natural selection also depend on local ecological conditions: competition from other species, the availability of food and water, climatic conditions, and so forth. In both biological and cultural evolution, traits are selected that enhance reproductive fitness. However, there are important differences between these two processes, because biological and cultural evolution differ in terms of units of variation, sources of variation, and measurement of adaptive value (for an extended discussion of these differences, see Brown 1986).

Although the actual agents of natural selection are seldom specified in studies of biocultural evolution, these are generally factors that affect differential mortality, of which there are five major sources: (1) diseases, (2) food shortages, (3) trauma and accidents, (4) predation and competition with conspecifics, and (5) climate and thermoregulation. The geneticist Haldane (1949) was one of the first theoreticians to emphasize the importance of the first source, disease, in evolution. Disease is important in human biocultural evolution for the simple fact that it causes death—or, to put it in Darwinian terms, it results in differential rates of mortality and fertility. In other words, throughout human history, disease has been a significant force of natural selection, shaping both human biology and culture. In recent years, evolutionary biologists have come to focus on human-pathogen interactions in an area called "Darwinian medicine." Ewald (1994) has emphasized the evolution of virulence in pathogens, while Nesse and Williams (1994) have analyzed the evolution of host responses to infections and their symptomatology. While much of this recent work is reminiscent of Dubos's classic *Man Adapting* (1965), current work in Darwinian medicine has the advantage of more advanced evolutionary paradigms and a concern with practical medical questions such as the advisability of treatment for fevers or the origin of allergies.

Disease and Evolution: Three Mechanisms

There are three main mechanisms through which disease affects human biological and cultural evolution: (1) large-scale mortality from epidemics, (2) excess mortality from endemic diseases, and (3) parasitism (Brown 1987).

The primary way in which disease affects the process of natural selection has been through the massive mortality caused by epidemics. In the context of the enormously strong selective pressure of an epidemic, evolution can occur very rapidly; in other words, epidemic diseases play an important evolutionary role simply because they can cause extinction (Haldane 1949). A well-studied example of this phenomenon involves myxomatosis, a viral disease of rabbits that was introduced in 1950 to the wild rabbit population of Australia as a means of controlling overpopulation (Fenner and Ratcliffe 1965). In the first year after introduction, the die-off of the rabbit population was 99.8 percent; in the second year, it was 90 percent; and, by the seventh year, it was only 25 percent. Fifteen years following the introduction of the disease, the rabbit population was only one-fifth its original size, but the mortality due to myxomatosis was nearly zero. This change was the result of powerful selection of both the rabbit population and the virus. If rabbits had been eradicated in Australia, then the virus would have become extinct there too; thus, mutual adaptation was to the advantage of both species. The myxomatosis example illustrates an important process in which virulent epidemic diseases eventually become benign endemic diseases in a population through the process of mutual accommodation.

The massive mortality associated with epidemic diseases has also had an important effect on human cultural history. The most comprehensive treatment of this theme is in McNeill's landmark volume, *Plagues and Peoples* (1976), in which he demonstrates the active role that epidemics have played in the expansion of empires throughout history. Such expansion was facilitated, McNeill argues, by the "confluence of disease pools"; that is, infectious diseases were unwittingly spread from state-level societies with a complex repertoire of endemic childhood diseases to smaller and simpler societies, for which the introduction of these new diseases brought massive population losses and socioeconomic disorganization.

McNeill's general model of the active historical role of epidemic disease is significantly different from the earlier work of historians, who viewed diseases as minor and exceptional events that "spoiled" political plans (Zinssner 1943; Hopkins 1983). McNeill concludes that disease played a crucial role in accelerating the conquest, subjugation, and acculturation of tribes and chiefdoms. This process depended on the historical transition of introduced epidemic diseases into local endemic diseases characteristic of childhood. In addition to diseases of obvious historical importance, like plague, smallpox, and syphilis, McNeill suggests that less dramatic agents such as measles, chicken pox, diptheria, as well as unnamed respiratory and gastrointestinal disorders (which he generally calls "microparasites"), followed this pattern. The well-known example of infectious epidemics and the depopulation of North American Indian groups (sometimes before actual face-to-face contact with Europeans) is a case in point: disease played an important role in the saga of "how the West was won" (see Krech 1978). Recently, Kunitz (1994) has reconsidered the demographic impact of the initial contact of indigenous populations in Polynesia, Australia, and other parts of the world. He shows that the pattern McNeill described may not be generalizable as an overall theory of world history because of local conditions of population density and disease ecology.

The second mechanism by which disease affects the processes of natural and cultural selection is through gradual population losses from the chronically high mortality caused by endemic diseases. Endemic diseases can have important demographic effects that are often not recognized by the population itself. High infant mortality rates, for example, may be considered an uncontrollable fact of life and may be compensated for through high birthrates and associated cultural beliefs regarding child spacing and ideal family size. The negative demographic and socioeconomic effects of endemic childhood diseases are often hidden and therefore insidious. For example, endemic malaria in a tropical environment usually has a low case-fatality ratio (approximately 1 death per 100 cases), and mortality is even rarer in adults (Bruce-Chwatt 1980). However, because malarial infections are so widespread, debilitating victims who eventually succumb to other diseases, the demographic impact of endemic malaria can be remarkably strong. This can be seen in "natural experiments" of malaria eradication, in which health improvements have resulted in sudden and unprecedented increases in population growth rates. Such effects have been seen following malaria control programs in Sri Lanka (where malaria control appears to have accounted

for 26 percent of the increase in population growth rates [Gray 1974]) and in Sardinia (Brown 1986). In a different type of study, conducted in communities with endemic malaria along the northern shore of Lake Victoria, Kenya, the single health intervention of insecticide spraying resulted in a 50 percent overall reduction in child and infant mortality rates in four years (Payne et al. 1976; Oaks et al. 1991).

The third mechanism through which disease can affect the process of natural selection is parasitism, a concept that has generally been neglected by medical anthropologists (Brown 1987). Parasitism refers to an evolutionary strategy in the struggle for life in which the underlying problems are eating and being eaten. The relationship of hosts and parasites is usually one of mutual adaptation through interactions, which produce a state of equilibrium. McNeill (1976) suggested that a distinction between microparasites and macroparasites, based on whether the parasite can be seen by the host, is useful, because humans are much better able to design adaptations to visible macroparasites than microparasites. Using this distinction, Brown (1987) compared the relative energy drain from malaria parasites in comparison to the energy drain required by traditional landlord-tenant contracts in Sardinia; although neither parasite killed the host, the macroparasites represented a much larger energy drain. It is disadvantageous for a parasite to kill its host, although most parasites cause some degree of real damage to their hosts, manifested through diseases that may affect the growth rate of the host population (Anderson and May 1978). Parasitic species drain nurients and energy from their hosts, thereby affecting the host's fitness. There is a substantial literature on the economic costs of parasitic disease demonstrating lower agricultural productivity in populations suffering from guinea worm, schistosomiasis, or malaria (Basch 1990).

In the simplest sense, parasitism affects culture in three ways: (1) by consuming food energy produced by individuals, (2) by producing disease symptoms, and (3) by limiting population growth. It has often been assumed, particularly in the literature of public health, that parasitic diseases sap the energy of individuals and therefore limit the possibility of cultural advancement. This "vicious circle" argument—that "people are sick because they are poor and they get poorer because they are sick" (Winslow 1951)—is an underlying tenet of international health policy. There is much research yet to be done by medical anthropologists to understand better the effects of parasitism on human behavior. There has been more research on the role of human behavior on parasitic disease transmission (Dunn 1979; Holland 1989; Inhorn and Brown 1990).

Disease and Cultural Evolution

Cultural systems have evolved from the original human lifestyle of food foraging to modern industrialized states. Anthropologists have long recognized a general pattern of cultural evolution from simple to complex societies and from low-energy to high-energy-harnessing economies (Sahlins and Service 1960).

This is simply a pattern of general historical change from prehistory to the present that has been characterized by four processes: (1) increased population size, (2) expansion of technology, (3) increased social inequality, and (4) greater transformation of the environment.

Disease ecology and epidemiological patterns are correlated with stages in cultural evolution (Armelagos and Dewey 1970; McElroy and Townsend 1989; Cohen 1989). In general, food-foraging populations throughout history had relatively low rates of infectious diseases, due to their small population size and mobility, although the total morbidity and mortality from disease varied with ecological setting (Dunn 1968). Diseases that require larger contiguous populations in order to be transmitted (e.g., measles, mumps, smallpox, influenza) were probably nonexistent until the introduction of agriculture and preindustrial cities. Paleopathological studies of the health implications surrounding the introduction of agriculture have demonstrated that in virtually every society on record, the new economic form was associated with increases in malnutrition and infectious disease (Brothwell and Sandison 1967; Cohen and Armelagos 1984; Cohen 1989). The high prevalence of infectious diseases in the preindustrial cities of ancient civilization resulted in consistent labor shortages and population decline (McNeill 1976; Knauft 1987). Today, despite advances of biomedical science since the eighteenth century, modern complex societies are characterized by a new epidemiological pattern: the "Western diseases" of obesity, hypertension, cardiovascular disease, and so forth (Trowell and Burkitt 1981; Brown and Konner 1987). In short, new cultural lifestyles have brought new disease problems throughout history.

Biological and Cultural Adaptations to Disease

The concept of adaptation refers to a fundamental process of evolution in which particular traits are selected in a given environment because they increase an organism's chances for survival and reproduction. Adaptation implies that the environment poses certain "problems," which organisms in the environment must "solve." Natural selection is the mechanism by which such solutions are found (Lewontin 1978, 1984). The concept does not imply that the resulting biological or cultural traits are the only or optimal solutions to environmental problems. Most important, it does not mean that adaptations exist for every environmental problem (or disease). Indeed, the fact that cultural behaviors play a direct role in disease transmission and can hinder disease control programs is an important theme.

Although primarily used in evolutionary biology, the concept of adaptation has been central to discussions in both medical anthropology and cultural ecology (Alland 1966, 1970; Alland and McCay 1973; Brown 1986; Ellen 1982; Landy 1983a; McElroy and Townsend 1990; Netting 1965; Rappaport 1976, 1979; Wiley 1992). Anthropologists have been concerned with describing examples of the successful outcome of adaptations on a genetic or cultural level.

In terms of genetic adaptation to disease, the most comprehensive work focuses on polymorphisms of the hemoglobin system, such as sickle cell trait and other hereditary disorders of the blood, which are most likely the result of natural selection by malaria.

Similarly, the human immune system can be viewed as the product of genetic adaptation to disease pressures. A primary biological characteristic of the immune system is its adaptability; in other words, it is a generalized mechanism capable of providing protection against potential (i.e., yet-to-evolve) pathogens (Baker 1984). The evolution of the immune system is the product of human adaptation to disease; at the same time, the immune system has required that disease organisms adapt to their host-victims. This pattern of mutual adaptation is an important feature of the relationship between humans and disease (Dubos 1965). From this perspective, agents of acute, lethal infectious diseases are less well adapted to their human environment than the agents of endemic or chronic infections. Thus, more lethal forms of a disease, such as AIDS, are probably younger and have had a shorter history of contact and mutual adaptation.

Cultural adaptations to diseases include behaviors and beliefs that function to limit morbidity and mortality in two general ways. First, there are behaviors and beliefs that have preventive functions, by reducing exposure to disease organisms for certain segments of society. Second, there are beliefs and behaviors about appropriate therapy for diseases, generally termed *ethnomedicine.*

Particular patterns of social organization and behavior may have latent functions in preventing the spread of disease, even though their conscious purpose may be unrelated to health. Examples of such preventive adaptations include settlement patterns in elevated locations removed from malaria-endemic lowlands (Brown 1981); storage of night soil before its use as fertilizer (Alland 1970); and traditional laundry soaps with molluscicidal properties in schistosomiasis-endemic areas (Kloos and Lemma 1977). Another way of looking at this, however, is to consider the ways in which the presence of disease in various ecological settings has limited economic or productive possibilities. For example, the presence of endemic malaria may make lowland areas unsuitable for human habitation, thereby restricting subsistence strategies that are too costly in terms of health.

In contrast, the cultural behaviors related to curative medicine are usually the result of conscious attempts to control sickness and death. Yet there is little evidence to suggest that either traditional curative medicine or even modern scientific medicine has had any significant impact on general health or fecundity. McKeown (1976a, 1976b) has conclusively demonstrated that changes in lifestyle (better sanitation, nutrition, and birth control), not the advancement of medicine, best account for improvements in health over the past two centuries.

It is interesting to note that behaviors with disease-preventive functions may be a feature of nonhuman primate societies. Freeland (1976) suggests that many aspects of the social organization of terrestrial Old World monkeys may minimize the probability of acquiring new pathogens or the impact of a disease already harbored by an individual in the group. He argues that the composition of a primate group itself and sexual fidelity of individual primates to other members of the group is the result of selection for the avoidance of new diseases. Similarly, the maintenance of home ranges for groups and the patterns of movement within territories may be effective disease-avoidance mechanisms. Finally, the movement of groups between sleeping sites may reduce exposure to contamination from fecal material and thus limit the spread of a disease already harbored by a group member.

Examples of Cultural Adaptations to Disease: Malaria

Anthropologists interested in cultural adaptations to disease have paid particular attention to the problem of malaria. This may be due to the fact that malaria has reportedly killed more people than any other single disease (Livingstone 1971) and that genetic adaptations to this disease have been well studied. The importance of human behavioral factors in malaria control has long been recognized by malariologists (see bibliography by Sotiroff-Junker 1978). The identification of culturally adaptive behaviors requires knowledge of the biological etiology of the disease, the social distribution of the disease, and local variation in the ecology of insect vectors of the disease.

The medical anthropological literature includes five examples of cultural adaptations to malaria. May (1960), for one, has suggested that the traditional house type of the hill tribes of Vietnam—where cooking and sleeping platforms are elevated on stilts—reduced exposure of the population to the mosquito vector *Anopheles minimus,* which has a flight ceiling of about ten feet.

Brown in his analysis of traditional Sardinian culture (1981), argues that the nucleated settlement pattern, particularly the pastoral pattern of inverse transhumance (flock movement to high elevations in summer), reduces exposure to malaria. In the ecological context of a nondomestic vector (*A. labranchiae*), social groups that are expected to stay within the confines of the nucleated settlement have the lowest rates of the disease. In addition, traditional behaviors based on the folk etiology of miasma also have a preventive effect (Brown 1986).

MacCormack (1984, 1985) has studied cultural traditions and behavioral factors related to malaria control in Tanzania. This work has led to further explorations of preventive adaptations, which reduce exposure to the vector. In Sierra Leone, for example, individuals envelop themselves at night (the prime mosquito feeding period) in a thick cotton cloth, which is inpenetrable by the local malaria vector (*A. albimanus*). Similarly, in many parts of Africa, people traditionally sleep under locally woven bed nets that can be impregnated with mosquito repellent.

In a different vein, Katz and Schall (1979) have examined the practice of fava bean consumption and its relationship to malaria in the circum-Mediterranean region, where populations have high gene frequencies of glucose-6-

phosphate-dehydrogenase (G6PD) deficiency. This dietary staple appears to have antimalarial qualities. However, for males with the G6PD deficiency trait, fava bean consumption can trigger a potentially fatal hemolytic crisis. G6PD deficiency is a widespread sex-linked genetic trait that limits the production of an important red blood cell enzyme; understanding the evolution of this trait may help identify new pathways for the development of antimalarial drugs. Through an analysis of the biochemistry of the gene-bean interaction, Katz and Schall argue that the combination of nonexpressed gene and fava bean consumption provides significant protection from malaria death in females.

A final example is the herbal medicines of the Hausa of Nigeria. Etkin and Ross (1982a, 1982b) have identified thirty-one "antimalarial plant medicines" used by either herbal specialists or the general population in response to the general symptoms of malaria. Some of these medicinal plants have been shown to change the oxidation-reduction status of red blood cells, a physiological condition known to impede the development of the malaria parasite (Eaton et al. 1976). Empirical tests of the traditional medicines, using an animal model of malaria, also demonstrate that three of these substances were highly effective cures. More recently, Etkin (1986, 1994) has shown that ethnomedical and dietary preparations using *artemesium,* especially as used in traditional Chinese medicine, have clear antimalarial properties.

These five examples of disease-limiting cultural behaviors illustrate the general principles suggested by the current theory of biocultural evolution. However, this discussion should not imply that cultural behaviors always or regularly improve health. There are many examples, from both the historical and ethnographic record in which cultural behaviors function to increase the prevalence of diseases. A conpendium of such maladaptive behaviors can be found in Edgerton's recent book, *Sick Societies* (1992). Such cases represent a challenge to both theoretical and applied medical anthropology. Finally, the current worldwide resurgence of malaria, particularly choloroquine-resistant strains of the disease, represents the classic example of a reemerging infection caused, in large measure, by human behaviors (including overuse of certain insecticides and incomplete use of antimalarial chemoprophlyaxis) that have exacerbated the problems of insecticide-resistant strains of anopheles mosquitoes and chemotherapeutic-resistant strains of the parasite.

DISEASE AND HUMAN BEHAVIORAL PATTERNS

As the field of epidemiology has made clear since its inception in the late 1800s, diseases are not distributed randomly in human populations. Some individuals—and some groups of individuals—are at increased risk from various diseases, for reasons that are often unclear. Epidemiologists not only describe patterns of disease occurrence through space and through time, but they attempt to elucidate disease etiology through the search for risk factors that appear to be significantly associated with disease outcome.

Disease risk factors are of two major types. *Endogenous risk factors* are those that are biologically intrinsic to the human host. For example, genetic diseases, such as sickle cell anemia or hemophilia, have, by definition, an endogenous etiology. More commonly, however, genetic inheritance implies a predisposition to a disease that requires other variables or cofactors for expression to occur. *Exogenous risk factors* are those that are extrinsic to the body of the human host. Some of these may be biotic, such as microorganisms that cause infectious diseases; others are nonbiotic substances present in the environment, such as toxic chemicals in the workplace. In most cases of disease, both endogenous and exogenous factors are involved—hence, the notion of ''multiple causation,'' or ''multifactorial etiology'' (Dunn and Janes 1986).

Humans may unwittingly increase the likelihood of disease by exposing themselves or others to risk factors of both the exogenous and endogenous variety. In many cases, this enhanced exposure potential occurs through disruption of existing ecological relationships between the host, the agent(s) of disease, and the environment. In this way, human behavior itself may be said to be a risk factor for disease, in that human activity may be a necessary component in the chain of events leading to a disease outcome.

Anthropologists, as professional observers and interpreters of human behavior, have an obvious and crucial role to play in the understanding of disease etiology: they can facilitate risk factor identification by describing distinctive patterns of human behavior related to the social distribution of disease. In this capacity, anthropologists may contribute directly to the generation of causal hypotheses, as they did in the case of kuru and cannibalism in New Guinea (Hunt 1978). In addition, anthropological descriptions of risk factor exposure based on long-term ethnographic observation may be more valid than those normally obtained through the standard epidemiological technique of questionnaire surveys (Inhorn and Buss 1993, 1994).

Perhaps most important, anthropologists are especially equipped to understand disease-promoting human behaviors in sociocultural context. This includes the distribution of these behaviors through space and time, as well as the ideological and political-economic factors that serve to legitimate these behaviors. It is in this latter capacity—as interpreters of human behavior who elucidate how and why people act the way they do—that anthropologists may contribute directly to medical anthropological theory building and indirectly to disease prevention and control.

DISEASE ETIOLOGY: CATEGORIES AND CASE EXAMPLES

The endogenous and exogenous factors that contribute to the development of disease in humans are numerous and have yet to be fully delineated. In fact, the etiological causal web remains to be untangled for many diseases, especially those of a chronic nature (e.g., coronary heart disease, hypertension, diabetes mellitus, cancer). Understanding the multifactorial nature of disease causality is the primary task of analytical epidemiology, which, in recent years, has acknowledged the contributory role of human behavioral factors and their social and cultural determinants.

Indeed, human behavioral factors play a role in every major category of disease causation, although their role is sometimes subtle or indirect. In Western medical textbooks, six major etiological categories of disease are generally described, but rarely the behavioral components in their etiological causal webs or the ways in which anthropologists have contributed to their understanding, highlighted. Here, we briefly describe these categories, providing examples of anthropological interest to support the notion of a crucial disease-behavior link.

Genetic

Genetic abnormalities that are heritable or occur as a result of mutation may be responsible for disease if they interfere with the normal functioning of the affected individual. So-called genetic diseases must be distinguished from congenital diseases, which, although appearing at birth, may be due to factors in the intrauterine environment that act upon the fetus (Sheldon 1984).

Among the most thoroughly understood of the genetic diseases is a group of conditions called hemoglobinopathies, including the sickle cell trait (Hb^s), glucose-6-phosphate-dehydrogenase (G6PD) deficiency, thalassemia, and hemoglobins Hb^c and Hb^f (Livingstone 1985). These hemoglobin defects have received the most attention from anthropologists, who have been interested in their potentially protective effects against *Plasmodium falciparum* malaria.

In the 1950s, researchers began to suspect that various heritable human biochemical polymorphisms conferred protection on affected individuals against specific infectious diseases. Through descriptive epidemiology, Allison (1954) was the first to hypothesize that the heterozygous condition known as sickle cell trait appeared with greater frequency in areas of Africa in which potentially lethal *P. falciparum* malaria was present. This association led Allison to hypothesize that hemoglobin S, when present in the heterozygous condition, conferred protection from death by malaria; this association has only recently been systematically confirmed (Durham 1983, 1991).

In a now classic anthropological work that followed, Livingstone (1958) related the widespread distribution of the sickle cell trait in West Africa to the history of human behavior, technological transfer, and ecological disruption in that region. He suggested that falciparum malaria did not spread widely in West Africa until the introduction of iron tools and, subsequently, swidden agriculture. The diffusion of the new technology, leading to changes in production capacity and the alteration of the forest habitat, effectively increased the available breeding grounds for *A. gambiae,* the major mosquito vector of *P. falciparum,* as well as the density of sedentary human populations. This, in turn, allowed falciparum malaria to become established as an endemic disease among agricultural groups in West Africa and as a significant selective agent for the sickle cell allele. In short, human behavior (swidden agriculture), through its effect on the environment (destruction of forest habitats and creation of *A. gambiae* breeding sites), affected the distribution and incidence of not only one but two endemic diseases in West Africa (falciparum malaria and sickle cell anemia), as well as the structure of the gene pool in this region. (See Livingstone, 1976 for an historical reconstruction.)

In a refinement of Livingstone's work, Wiesenfeld (1967) demonstrated that the particular type of agricultural system utilized significantly affected the rates of both sickle cell trait and falciparum malaria. Specifically, societies heavily reliant on root and tree crops (the Malaysian agricultural complex) created a more malarious environment, leading to a selective advantage for individuals with the heterozygous condition in those societies.

Nutritional

Disease may result from malnutrition—from either dietary deficiency or excessive (or otherwise harmful) consumption patterns. The most common worldwide cause of disease attributable to nutrition is malnutrition due to inadequate caloric intake (protein-energy malnutrition) (Sheldon 1984). However, protein-energy malnutrition must be understood not only as a biomedical "disease," but as a reflection of social inequality and consequent hunger (Cassidy 1982).

In addition, nutrition plays a major role in most of the "diseases of civilization," including diabetes mellitus, coronary heart disease, hypertension, and even some forms of cancer. Yet because of the etiological complexity of these conditions, the magnitude of the contribution of nutritional risk factors has yet to be fully delineated. Furthermore, the nutritional component in, for example, coronary heart disease may vary from one population to the next and even between individuals.

Despite the current uncertainty surrounding nutritional factors in these First World diseases, it is clear that a number of specific vitamin- and mineral-deficiency diseases, largely eliminated in the industrialized world, continue to plague populations in poorer nations. These include the five major vitamin-deficiency diseases: beriberi (lack of thiamin), pellagra (lack of niacin), scurvy (lack of vitamin C), rickets (lack of vitamin D), and keratomalacia (lack of vitamin A). In addition, two of the mineral-deficiency diseases, anemia and goiter (from inadequate intake of iron and iodine, respectively), are found widely throughout the Third World.

In a study of nutritional deficiency and its effects on social organization in the Andean region of Ecuador, Greene (1973, 1977, 1980) has shown how the neurobiological consequences of nutritional deficiency diseases are related to the development and continuation of a highly stratified social system. In this context, adequately nourished landowners exploit the malnourished rural populace (*indigenas* and *mestizos*) for cheap labor. Indigenous diets low in iodine and protein have led to high rates of goiter and protein-energy malnutrition, the latter being

exacerbated in this case by the early weaning of children to low-protein diets. The problem of endemic goiter is serious because of its association with cretinism and deaf-mutism. As Greene explains, the large number of mentally deficient individuals in this population has led to a redefinition of normalcy to markedly lower levels of cognitive functioning and an attempt by society to integrate behaviorally impaired individuals into the community (see also Buchbinder 1977).

Environmental

Agents occurring naturally or as a result of human intervention in the external environment may cause disease. Physical agents, including unusual temperatures, electrical hazards, and irradiation, as well as trauma, may produce pathology (Sheldon 1984). In addition, contaminants in the air and water, especially in urban, industrial areas, may place the general public at increased risk of disease, although, as of now, the long-term health effects of environmental pollution remain speculative.

Of great interest to epidemiologists in the past twenty years has been the effect of exposure to various substances, especially toxic chemicals, in the workplace. For example, occupational epidemiologists have shown that exposure to the dust of asbestos, a substance once commonly used in construction, is a primary causal factor in the development of mesothelioma, an otherwise rare tumor of the mesothelium (Selikoff 1968). Moreover, exposure to asbestos appears to exacerbate the carcinogenic effects of cigarette smoking in the development of lung cancer (Hammond, Selikoff, and Seidman 1979). In another major occupational study of Pennsylvania steelworkers, investigators have shown that men who work on the coke (liquefied coal) ovens and are exposed to coke oven fumes over an extended period of time suffer significantly higher rates of mortality from respiratory cancers (Lloyd et al. 1970; Lloyd 1971). As with the previous example, coke oven workers who also smoke appear to be at increased risk.

Numerous other occupational groups have been shown to be at higher risk of various diseases because of workplace exposures. These include miners, agricultural laborers exposed to various pesticides, and workers in cotton mills, dry cleaners, and the reinforced plastics industry, to name only a few. In addition to the risk of toxic exposure, workers may suffer the physical trauma of manual labor that is repetitive and unceasing. For example, anthropologists in Australia (Reid and Reynolds 1990) have documented the 1980s "epidemic" of repetition strain injury (RSI), an occupational illness involving musculoskeletal pain of uncertain etiology. In their study, they seek to understand the diverse and contradictory explanatory models (EMs) of RSI forwarded by state agencies, industrial managers, clinicians, lawyers, and workers themselves, arguing that these disparate EMs reveal many of the structural tensions inherent in the Australian workplace and in Australian society at large.

Psychogenic

It is now recognized that "psychogenic" factors may cause organic disease. "Psychosomatic illness" is the broad rubric under which somatic complaints of unknown etiology with a presumed psychological component are often placed. Medical anthropologists have made major contributions to understanding the process of somatization, or the physical manifestation of psychological distress (e.g., Kleinman 1980). Unfortunately, however, etiological explanations for these conditions have tended to be reductionistic—involving either mental models or biological models but rarely synthetic models. Recent developments in the field of psychoneuroimmunology appear very promising in this regard (Sapolsky 1994).

In fact, anthropologists have perpetuated this dualism through an ongoing debate about the nature and etiology of "voodoo death." Some anthropologists have argued that voodoo death occurs when the psychosocially traumatized victim gives up the will to live, thereby experiencing a form of "social" death (Thompson 1939; Warner 1958; Lewis 1977); others have concluded that voodoo death occurs as the result of demonstrable biological mechanisms, such as dysfunction of the automatic nervous system (Cannon 1942), surgical shock from terror (Yap 1974, 1977), difficulty in swallowing (Lex 1974), or dehydration (Eastwell 1982). Although the cause of voodoo death probably involves some combination of biological, psychological, and culturally determined behavioral factors, such a synthetic model has yet to be fully developed.

Iatrogenic

With the expansion of medicine, iatrogenic factors, or the deleterious effects of medical interventions, have been recognized as a growing cause of disease (Illich 1975). Perhaps the most common type of clinical iatrogenesis involves the negative "side" effects of medications (e.g., stroke following the administration of oral contraceptives, congenital limb-reduction defects following the administration of the tranquilizer thalidomide to pregnant women, blindness following the administration of antiparasitic medications, involuntary facial and other body movements following the administration of antipsychotic drugs). However, nondrug therapies, and even diagnostic procedures, may be iatrogenic. For example, the common therapeutic practice during the first half of this century of irradiating the head and neck region for the treatment of, among other things, adolescent acne was later found to be a cause of thyroid cancer in individuals who had undergone this procedure ten to thirty-five years earlier (Jackson 1984).

Criticism of the iatrogenic nature of medical practice has been directed most vociferously at Western biomedicine (Illich 1975). Yet evidence from the ethnographic and clinical literature suggests that iatrogenesis is not an exclusively Western phenomenon. For example, on the Guinea coast of West Africa, where infection with the subcutaneous tissue-dwelling "guinea worm" (*Dracunculus medinensis*) is endemic, traditional healers' practices, which include piercing the guinea worm ulcer with a red-hot metal rod, are partly responsible for the high rates of secondary infection and considerable morbidity accompanying this helminthic parasitic disease (Edungbola and Watts 1985). Trotter (1987) has also shown that the Mexican-American folk remedies for empacho, azaron and greta, contain about 90 percent lead oxide and are a significant cause of lead poisoning. Anthropologists have recently been involved in alerting the local and medical communities to the dangers of these two folk remedies.

Similarly, in Egypt, where the chlamydial eye disease trachoma is endemic and leads to visual impairment and blindness in rural populations, traditional healers' practices may lead to futher ocular injury (Lane and Millar 1987; Millar and Lane 1988). These "ethno-ophthalmological" practices include, among other things, scraping the inner surface of the eyelid with an unsterilized shaving blade or "slicing" open an infant's eyes with the blood-drenched tip of a goose or pigeon feather, in order to ensure that the child's eyes are "big and beautiful." In addition, in Egypt, outdated biomedical practices maintained by physicians and "copied" by traditional healers may lead to significant iatrogenesis. This has been particularly well documented in the area of Egyptian gynecology, in which obsolete and irrational invasive procedures may cause or exacerbate infertility problems in patients being treated by gynecologists (Inhorn 1994; Inhorn and Buss 1993, 1994).

Infectious

Biologic agents, ranging in complexity from microscopic, obligate intracellular viruses to large and structurally complex helminthic parasites, are the cause of infectious diseases in humans. Disease occurs when the interaction between the human host and the infectious agent, or the "host-parasite relationship," is no longer symbiotic, shifting in favor of the agent. However, the most successful agents are not those that overcome and kill the host quickly, thus preventing their own reproduction. Rather, all the infectious agents, including viruses, bacteria, fungi, parasites, and several classes of intermediate forms, are more successful as either symbionts or commensals—as agents infecting the human host without causing disease (Sheldon 1984).

Whether infection with a specific microorganism results in disease depends on a number of intervening variables, the most important of which are the pathogenicity of the agent (i.e., its inherent ability to cause disease); the route of transmission of the agent to the host; and the nature and strength of host defense mechanisms (Brachman 1985b). All of these factors, in turn, are affected by the environment. Environmental factors, including such "natural" factors as temperature, moisture, altitude, and indigenous plants and animals, as well as such "artificial" factors as dams and irrigation schemes, human dwellings, and domesticated animals, may serve to promote the transmission of an infectious disease or, conversely, to limit or prevent its occurrence.

Typically, the infectious diseases are categorized into two major types: acute and chronic, according to the ways in which they affect susceptible populations through space and through time. *Acute* infectious diseases, like measles or influenza, are generally characterized by sudden onset, marked symptomatology, and, most important, rapid resolution, either through death of affected individuals or the self-limiting nature of the illness. In many cases, natural immunity to subsequent infection is acquired following recovery. When this occurs on a community-wide level, it is known as *herd immunity*. In so-called virgin-soil populations (those without herd immunity), acute infectious diseases tend to occur in epidemics, which are said to exist when an unusual number of cases of the disease occurs in a given time period and geographic area as compared with the previous experience with the disease in the same area (Evans 1982a). The classic diagnostic features of an epidemic are (1) an index case (i.e., the primary case of an illness that may serve as a source of infection to others), (2) an incubation period (i.e., the definable interval between exposure and the appearance of the first detectable sign or symptom of the illness), (3) an attack or case ratio (i.e., the incidence rate in the affected population during the outbreak), and (4) an epidemic curve (i.e., the temporal pattern of the epidemic as illustrated by a histogram plotting number of cases against time interval) (Evans 1986).

For diseases already present at some identifiable level in the community, it is necessary to know the total number of existing cases (prevalence), as well as the total number of new cases in the population still at risk (incidence), in order to determine whether an increase over normal levels of disease (i.e., an epidemic) has occurred. When such increases occur over a widespread area (e.g., a region, a continent, or globally), the term *pandemic* is used to designate the widespread geographic distribution of the epidemic.

Chronic infectious diseases, on the other hand, pose more difficult problems in definition, because their course of occurrence and diffusion in susceptible populations must be viewed over years rather than days, weeks, or months (Evans 1982b). Chronic infectious diseases, such as schistosomiasis, tuberculosis, or AIDS, not only lack the short course of the acute infections, but they typically—although not invariably—lack the classic diagnostic features of an epidemic as described above. In general, chronic infectious diseases are *endemic*, a term denoting the constant or usual presence of an infection or a disease in a community (Evans 1982a).

From the standpoint of disease and human behavioral studies, the chronic infectious diseases are of greatest inherent interest because of their crippling effect on societies. Although acute, epidemic infectious diseases are potentially devastating, they tend to burn themselves out quickly in human populations, before behavioral and ideological responses on the part of the affected population are typically called into play. Chronic infectious diseases, on the other hand, are often associated with high morbidity, which may result in the incapacitation of members of affected populations. Because of their morbidity and their continual presence in the community, chronic infectious diseases may trigger adaptive responses, including culturally conditioned behavioral changes that may reduce, intentionally or unintentionally, disease transmission.

Such behavioral change may be more likely to occur when affected populations are aware of the nature of the infectious agent, its route of transmission, and human behavioral factors involved in this transmission cycle (Alland 1970). Information of this sort, usually the domain of Western biomedicine, is not regularly or effectively communicated to those most in need of understanding. Moreover, health education programs designed to prevent infectious diseases through behavioral change have had a limited impact, because of a variety of complex problems, ranging from lack of voluntary community participation in prevention efforts (e.g., Phillips 1955; Barnes and Jenkins 1972) to health educators' lack of understanding of local channels of communication and authority (e.g., Hanks and Hanks 1955). These problems are apparent in the case of schistosomiasis and AIDS.

TWO PERSPECTIVES ON DISEASE AND HUMAN BEHAVIOR: SCHISTOSOMIASIS AND AIDS

So far, human behavioral factors in disease causation have been viewed largely from a cultural ecological (microsociological) perspective. That is, the individual manifestations of culturally prescribed behavioral patterns are seen as risk factors for individual contraction of disease.

Certainly, understanding human behavior, one of the most fundamental goals of sociocultural anthropology, is even more important in the context of a disease threat. However, the danger of viewing disease and human behavior on a solely microsociological level is that individuals may be incorrectly considered responsible, even culpable, for their own diseases. Even worse, entire societies may be blamed for maintaining unhealthful practices in their cultural repertoires.

To avoid such victim blaming and to truly understand disease causation, adoption of a political-ecological (macrosociological) perspective is also necessary. From this standpoint, disease is viewed on the level of the population, and disease rates are seen as the result of sociopolitical and economic forces, operating through time and in some cases on a worldwide level. The macrosociological perspective emphasizes larger social forces and not the cumulative effects of individual behaviors per se as the ultimate causes of poor health.

Any medical anthropological study that hopes to shed light on the disease-behavior connection must ultimately adopt these complementary perspectives. Unfortunately, the social scientific literature contains many examples of studies undertaken from one perspective or the other, but synthetic studies, which attempt to evaluate behavioral patterns and to place these patterns in macrostructural context, are rare. Furthermore, the current tendency within medical anthropology is to blame the overarching social-political-economic system for the health problems experienced at the local level without first describing in detail what those local health problems are and how behavioral risk factors may or may not be involved.

Human Behavior in Political-Economic Context: Shistosomiasis and Water Resources

The social scientific literature on the parasitic disease schistosomiasis is a particularly useful illustration of this problematic dualism. Furthermore, the rapid spread of schistosomiasis on the African continent today is largely due to the interaction of human behavioral and ecological factors, which must be viewed within a larger political-economic context.

Schistosomiasis (bilharzia) is a life-threatening blood fluke infection of humans. Like malaria and a number of other parasitic diseases, schistosomiasis is "water based" in that the three major species of schistosomes (*Schistosoma haematobium, S. mansoni,* and *S. japonicum*) share a developmental life cycle in which water plays a major role (Katz, Despommier, and Gwadz, 1982). Briefly, infected humans pass the eggs of the parasite, which are contained in their urine (*S. haematobium*) or feces (*S. mansoni* and *S. japonicum*), into the water, particularly in areas lacking modern sanitation. The eggs develop in the water, hatch, and release larval forms of the parasite. If the appropriate form of snail is present, these larvae penetrate the snail tissue, where they continue development. After several weeks, infective larvae (cercariae) are released from the snail into the water, where they live independently for up to forty-eight hours. These motile larvae seek out and penetrate human skin; once inside the human circulatory system, they mature into adult worms, mate, and pass to the veins of the bladder (*S. haematobium*) or mesenteric venules (*S. mansoni* and *S. japonicum*). Attached by their suckers to the walls of the veins, the adult worms, coupled for life, mate continuously during their five- to ten-year life span and produce hundreds to thousands of eggs each day. These eggs cause morbidity in humans, adhering to the vessel walls and causing damage to the bladder or intestine. After they are eliminated in human waste, these eggs allow the parasitic life cycle to continue.

Because of the obvious human role in the perpetuation of the schistosomal life cycle, numerous studies of human water-contact behavior and schistosomiasis transmission have been undertaken within the past thirty years. These studies, advocated and supported by the World Health Organization (WHO 1979b), can be characterized as macrosociological in nature, because of their primary focus on human behavioral factors in schistosomiasis transmission.

The first studies of this type were undertaken in the 1960s, in locations ranging from Surinam (Van der Kuyp 1961) and Puerto Rico (Jobin and Ruiz-Tiben 1968) to Rhodesia (Husting 1970; 1983) and Egypt (Farooq 1966; Farooq et al. 1966; Farooq and Mallah 1966; Farooq and Samaan 1967). The most extensive

investigations were carried out in Egypt, where Farooq and his colleagues performed elaborate observational studies of the daily social, occupational, and religious uses of water in a Nile Delta village. Their most striking finding was that Muslims had higher schistosomiasis prevalence rates than Christians, due to the frequent practice of *wudu,* or ritual ablution before prayer, among the Muslims. Furthermore, the researchers concluded that swimming, a popular summertime activity for children, was responsible for the high rates of infection in the younger age groups.

Following a decade-long gap in research activity, a "new generation" of schistosomiasis investigators began to undertake water-contact studies in Africa (Kloos et al. 1977, 1980–1981, 1983; Dalton and Pole 1978; Polderman 1979; Edungbola 1980; Fenwick et al. 1982). As with the earlier studies, most of these more recent works examined the ways in which individuals became infected through water contact rather than the ways in which individuals infected water through urination and defecation in waterways. A notable exception was provided by an anthropologist, Ann Cheesmond, who along with a colleague, studied human excretory behavior in a schistosomiasis-endemic area of the Gezira, Sudan (Cheesmond and Fenwick 1981). From the standpoint of schistosomiasis transmission and control, Cheesmond's findings were heartening: 70 percent of the urination episodes and 93 percent of the defecation episodes observed occurred in sites far removed from any body of water, privacy being a more important consideration than proximity to water for the purposes of ablution. In fact, only 31 percent of those observed washed themselves after excretion, despite Islamic prescriptions to do so.

Despite the large number of water-contact studies undertaken and the recent major impetus for future water-contact studies from WHO, such studies are limited by their reliance on observation alone. As anthropologist Frederick Dunn aptly noted in "Behavioural Aspects of the Control of Parasitic Diseases":

> Let us consider human water contact, as one important element in the epidemiology of schistosomiasis. Any study of water contact must take into account at least the following: consumption of water (drinking, cooking, etc.); excretion and postexcretory ablutions in the water; bathing for hygienic reasons and laundering; swimming and other play in the water; ritual bathing; health education efforts to minimize water contact through changes in behaviour; technical efforts to minimize water contact by providing alternatives, e.g., bridges, safe laundry sites, and latrines; fishing; agricultural practices involving water use and contact; washing and watering of domestic animals; and travel practices, especially stream-crossing and boating, that require contact with water. . . . In so far as the programme may require change in human behaviour it will not suffice to have only this detailed description. A further series of studies, essentially anthropological and psychological, will be needed in each situation to specify why people behave as they do, where and when. . . . Any effort to change human behaviour must rest on such studies. (1979: 503)

Unfortunately, few of the behavioral studies surrounding schistosomiasis have assessed the underlying cultural logic of water-contact patterns or, for that matter, whether groups affected by schistosomiasis associate this condition with water and water-related activities. In three studies in which community members were actually questioned about their knowledge of schistosomiasis and its transmission, investigators found high levels of awareness of the disease and its symptoms but varying levels of knowledge about transmission or ways in which individuals could protect themselves from infection (Kloos et al. 1980–1981; Tiglao 1982; Zumstein 1983). Furthermore, as Kloos and colleagues noted, villagers in rural Ethiopia perceived schistosomiasis, with its vague symptoms, to be a relatively minor health problem, considering their struggle with more readily apparent helminthic infections, such as ascaris (giant roundworm).

Most of these schistosomiasis studies have attempted to quantify behavior and correlate disease-promoting behavior and disease prevalence. However, few are truly anthropological, because they fail to place the behavioral patterns observed in sociocultural context. Moreover, none of the studies successfully bridges the micro-to-macro gap, by contextualizing water-contact patterns in terms of political, economic or ecological origins of unsafe water itself.

This last issue can be raised in terms of water resource development projects and their effect on the spread of schistosomiasis. Research on this issue can be characterized as macrosociological, because it focuses on the ecological disruption and health hazards engendered by politically and economically motivated development schemes. As Hughes and Hunter (1970) note in their review of disease and development in Africa, few of the economic development projects initiated on that continent over the past two centuries have been undertaken within a preconceived, ecological framework. This lack of ecological foresight has resulted in the escalation of "developogenic" diseases, including schistosomiasis, onchocerciasis, trypanosomiasis, and malaria.

Of these diseases, schistosomiasis is the most rapidly spreading (Heyneman 1983)—a spread that is attributable almost entirely to the construction of high dams for hydroelectric power, artificial lakes for fish breeding, reservoirs for water storage, and irrigation systems for agriculture (Heyneman 1971, 1979, 1983; Scudder 1973; Kloos and Thompson 1979). The expansion of old waterways and the creation of new ones has provided an ecological "free zone" for snails, the intermediate hosts. As the snail population has spread into new aquatic environments, so have schistosomal parasites and human infections.

The spread of schistosomiasis has been the most severe in Africa, and particularly in Egypt. This is largely due to the construction over the past century of the Aswan Dam–Lake Nasser complex (designed to provide hydroelectric power and perennial irrigation to the country). In a cross-sectional survey carried out in the 1950s in four selected sites in Egypt, schistosomiasis prevalence rates increased an average of 51 percent in three years (Lanoix 1958). Although the Egyptian government has made efforts over the past two decades to control the schistosomiasis problem among the rural population through mass treatment campaigns and mollusciciding (chemical extermination of the snail population),

a report by Egyptian scholars has suggested that few, if any, real gains in schistosomiasis control have been made (Abdel-Salam et al., 1986).

Egypt is not alone in its predicament. The schistosomal upsurge witnessed in that country has been repeated over and over again in other parts of Africa, following the construction of virtually every major dam and reservoir complex, irrigation system, and artificial lake (Desowitz 1981). For example, in studies undertaken in the Awash Valley of Ethiopia, Kloos and his colleagues have described the expanding distribution of schistosome-transmitting snail populations and escalating rates of human infection following government-sponsored creation of large, irrigated farming estates (Kloos 1977, 1985; Kloos and Lemma 1977; Kloos, Lemma, and De Sole 1978; Kloos and Thompson 1979). In Sudan, the disease cycle was established within a few years of the start of the Gezira scheme, a large-scale, irrigated cotton project south of Khartoum (Kloos and Thompson 1979; Fenwick, Cheesmond, and Amin 1981; Gruenbaum 1983). In this case, the change in irrigation methods from seasonal flooding to the use of pump irrigation created more extensive and stable snail habitats and intensified human water contact during periods of crop irrigation. In Nigeria, *S. haematobium* prevalence rates soared following construction of a low earth dam and perennial access to a large body of infective water (Pugh and Gilles 1978). This increase was likely to continue, researchers predicted, given government plans to build more dams in the area.

Culture as Ecological Context: The AIDS Epidemic in Sub-Saharan Africa

Over the past decade, Western biomedicine has become less sanguine about its ability to control infectious diseases. Parasite resistance to antibiotics (Institute of Medicine 1992), a resurgence in the West of diseases such as tuberculosis (Ryan 1993), and the dramatic human consequences of the AIDS pandemic have reminded biomedicine that the relationship between human populations and disease parasites continues to evolve. Perhaps more than any other disease in modern history, AIDS demonstrates the complex interactions between a disease agent and human behavior within varying ecological contexts. More pointedly, the AIDS pandemic underlines the need to understand ecological context as social, political and economic—that is, as cultural as well as biological.

The AIDS pandemic has spurred a vast literature in medical anthropology and related social and biological sciences (Bolton and Orozco 1994). Here we review briefly some of the recent anthropological literature on AIDS in sub-Saharan Africa in order to demonstrate the productivity of an ecological perspective that includes human culture as a central component of the environment. Given that no vaccine or cure for AIDS appears to be on the horizon and given that HIV transmission is potentially controllable through modifications in human behavior, understanding the dynamic relationship of culture, behavior, and disease is crucial if efforts to limit the tragedy of HIV/AIDS are to succeed.

Already the dimensions of the AIDS epidemic in sub-Saharan Africa are staggering. While about 10 percent of the world's population resides in the region, it is estimated that more than half of persons infected with HIV live in sub-Saharan Africa (Merson 1993). With more than 8 million Africans already infected and the numbers continuing to grow, the degree of human suffering is and will continue to be immense, even without taking into account dire projections about wider social, economic, and demographic consequences (Danzinger 1994). In addition, up to 80 percent of women with HIV live in sub-Saharan Africa (Caldwell, Orubuloye, and Caldwell 1992), and given rates of perinatal transmission (Ryder et al. 1989), the proportion of children with HIV is also high relative to other regions of the world.

The anthropological literature on HIV/AIDS in sub-Saharan Africa has uncovered some of the assumptions and blinders that shape and restrict efforts to control the transmission of HIV. The studies reviewed here represent only a small fraction of the anthropological contribution and have been selected because they raise issues about the relationship between macro- and microsociological parameters that shape human behavior and pose problems for what kind of definition of "culture" is appropriate. These are questions that must be addressed by an ecologically oriented medical anthropology if an ecological approach is to be wide enough to account for the complex interaction of disease, ecology, and human behavior. Because the culture concept has been misused to blame the victims of AIDS in ways similar to those with regard to schistosomiasis, we must emphasize that cultural issues are no less relevant for understanding the AIDS pandemic in other parts of the world than they are in sub-Saharan Africa.

Three overlapping areas of research demonstrate the importance of understanding both macrosociological and microsociological contexts in order to address more effectively and control the AIDS epidemic in Africa. These areas of research include: (1) examination and deconstruction of epidemiological categories, particularly so-called high-risk groups; (2) ethnographic study of the dynamics of sexual decision making and sexual networking; and (3) critical assessments of the promotion of condoms to stem HIV transmission.

High-Risk Groups

The early anthropological literature on AIDS in Africa focused on identifying cultural practices that might contribute to the transmission of HIV. Identified cultural practices included: "promiscuity"; blood rituals; ritual/medical enemas; female circumcision/infibulation; shared instruments for injections, ritual scarification, group circumcision, tattooing and shaving; and contact with nonhuman primates (Hrdy 1987). Epidemiologists identified patterns of HIV transmission that seemed to predominate in different regions of the world, with sub-Saharan Africa classified as "Pattern II," meaning that heterosexual relations were believed to be the principal means of transmission. "Pattern I" regions included the United States, where homosexual relations and intravenous drug use were believed to be the main modes of transmission. The usefulness and veracity of these epidemiological categories have been questioned by cross-cultural and historical research (Parker 1987, 1992; Packard and Epstein 1991; Farmer 1992). Nonetheless, there remains a wide consensus among both epidemiologists and anthropologists that heterosexual transmission accounts for about 80 percent of HIV transmission in sub-Saharan Africa.

The epidemiological categorization of high-risk groups has been criticized by some anthropologists as oversimplified constructions that deny variation and mask the underlying social influences on individual behavior (Carovano 1991, Schoepf et al. 1991; Schoepf 1992b; Schiller, Crystal, and Lewellen 1994). Membership in such groups, like sexual behavior more generally, has been treated as if it were an independent variable rather than as itself subject to complex economic, political and cultural constraints (de Zalduondo 1991; Seidel 1993). In sub-Saharan Africa, identified high-risk groups have included truck drivers, long-distance traders, mobile military personnel, and, most prominently, "prostitutes." Anthropologically oriented research in Africa has contributed much to deconstructing the category of "prostitute" and contextualizing the heterogeneous practices and settings of commercial sex work.

A number of studies have commented on the difficulty of defining prostitution without accounting for local social and historical contexts (Day 1988; Caldwell, Caldwell, and Quigger 1989; Larson 1989). Larson (1989) used historical and anthropological data to show significant differences in commercial sex patterns between African cities characterized as indigenous and those created by colonial powers. The structure of colonially created urban centers with large male populations and few females produced social and economic consequences that affected the dynamics and networks of sexual relations. Comparing Kampala, Uganda, and Nairobi, Kenya, she demonstrates that patterns of sexual relations in general and commercial sex in particular were determined by a complex interplay between social and economic forces, such as colonial labor migration policies and traditional marriage norms of dominant ethnic groups.

Women engaged in commercial sex work have been depicted as reservoirs of HIV infection rather than as links in broader networks of HIV transmission. Interventions aimed at prostitutes have been criticized as constructed to protect men from women, ignoring the role of male clients in the transmission of HIV (de Zalduondo 1991). Anthropologist Brooke Schoepf (1988, 1992a, 1992b) and historian Luise White (1986, 1990) have shown that prostitution involves much more than the sale of a commodity. Relationships between commercial sex workers and their clients sometimes involve long-term social investments and significant emotional ties. In addition, commercial sex workers maintain other important social ties, including relationships with noncommercial lovers and families in both urban and rural areas (de Zalduondo 1991). Such ties complicate the messages for condom use targeted at this high-risk group. Women in prostitution may find it difficult to negotiate condom use with more intimate partners because of its implications for the emotional and reproductive aspects of the relationship. In more economic relationships, women may not have the power to insist on safer sex because commercial sex work is in most instances primarily an economic survival strategy (Schoepf 1988, 1992b).

The use of the category of high-risk group, particularly of ''prostitute,'' has hampered prevention efforts by homogenizing rather dissimilar relationships and practices, depersonalizing women, and decontextualizing the sexual encounter. Much evidence on sexual networking has shown that simple constructions of risk groups are not appropriate for understanding situations of risk, particularly for women who are not prostitutes (Orubuloye, Caldwell, and Caldwell, 1991, 1992; Obbo 1993; McGrath et al. 1993). Interventions aimed at commercial sex workers must necessarily take into account the economic, political, and gendered context of the sexual behavior, acknowledging the constraints on women's behavior imposed by economic necessity and culturally defined sexual norms. ''Prostitution'' is not a behavior to be modified but a catch-all category that masks a complex web of social forces and diverse practices that must be addressed with local specificity if the reduction of risk is to be realistic.

Sexual Networking and Decision Making

To some extent the focus on high-risk groups such as commercial sex workers has obscured the wider risks to women in Africa who are not prostitutes (Schoepf 1992b; McGrath et al. 1993). Studies of sexual networking have shown that men and women are at risk through a wide range of ''normal'' sexual practices (Orubuloye, Caldwell, and Caldwell 1991, 1993; Ulin 1992; Schoepf 1992b; Obbo 1993; McGrath et al. 1993; Orubuloye et al. 1993). In Uganda, Obbo has shown that HIV transmission in local urban and rural settings occurs through small circles of lovers who are connected by common school, workplace, or residence affiliations. In such relationships interpersonal and emotional ties are strong, and these ties color perceptions of risk. Messages aimed at promiscuity will not be effective in situations where sexual relationships are not perceived as promiscuous.

Studies in Nigeria (Orubuloye, Caldwell, and Caldwell 1991, 1992) and Uganda (McGrath et al. 1993) have shown that women's sexual networking has three principal motivations: (1) economic survival, (2) sexual satisfaction, and (3) revenge against the sexual adventures of husbands or partners. As part of a long-term study of sexuality and fertility among a Yoruba population in southwestern Nigeria, Orubuloye and the Caldwells have shown that high levels of sexual networking exist in both rural and urban settings. While their research suggests that levels of sexual networking are slightly higher among men than women and in urban as opposed to rural settings, it also shows that frequent migration back and forth between rural and urban areas makes simple dichotomous characterizations erroneous. Similar evidence of high rural-urban interdependence (sexual as well as economic) has been demonstrated throughout the continent (e.g., Larson 1989; Obbo 1993).

The Nigeria studies suggest that Yoruba women's sexual networking is most frequently associated with economic need and among married women occurs most often among the younger wives in polygynous marriages, who feel economically insecure. Sexual networking by married men is most common among men in monogamous unions. Orubuloye, Caldwell, and Caldwell (1991) suggest that nonmarital male sexuality (both pre- and extramarital) is shaped by social structural factors such as the late age of marriage and the maintenance of long postpartum sexual prohibitions for lactating women, as well as by cultural beliefs in men's polygynous rights. Orubuloye and the Caldwells are somewhat exceptional in exploring men's sexual beliefs and practices, as well as women's. The literature is dominated by explorations of women's sexuality, a phenomenon perhaps partly explained by efforts to help empower women (Schoepf 1988, 1992b) but also perhaps by age-old associations of women's bodies with sexuality and reproduction (Douglas 1966; Ortner 1974; MacCormack and Strathern 1980).

Efforts to prevent the spread of HIV in Africa have focused on two messages for behavior change: limit sexual partners and use condoms. While data on sexual networking are useful for understanding HIV transmission and for targeting preventive interventions, designing effective prevention strategies depends on understanding the dynamics of sexual decision making. Women may find it difficult, if not impossible, to limit their sexual partners when sex is used as a means for economic survival. Guyer (1988) has shown that some Nigerian women use a strategy of lateral fertility (having children with several men) as opposed to lineal fertility (many children with one man) to expand economic support and reduce the risks of poverty. Many women in the commercial sex industry rely on multiple partners as a matter of sheer survival (de Zalduondo 1991; Schoepf 1992b). To such people the risk of AIDS somewhere down the line may not be perceived as nearly as risky as the economic consequences of partner reduction.

In addition, even women who limit sex to exclusive relations with their husband often perceive themselves to be at risk because they cannot control their spouses' sexual behavior. McGrath et al. (1993) have shown that women in Kampala, Uganda, feel unable to control their risk for HIV because they lack the power to negotiate conjugal sexual decision making. Because of poverty and cultural constructions of women's status, many African women are unable to control their sexual relationships with men (de Zalduondo 1991; Bledsoe 1990; Schoepf 1988, 1992b). Men's behavior has been influenced by the AIDS epidemic but not always in ways that reduce risk. For example, Schoepf (1992c) has shown that in Zaire men believe they can reduce risk by being more selective in choosing partners, including: (1) very young girls, who because of their youth are believed to have had fewer sexual contacts; (2) plump women, as stoutness is perceived as a sign of health; (3) women from rural areas, as AIDS is perceived to be an urban disease; and (4) women whom one already knows, as such women are perceived as less dangerous. In addition, traditional beliefs about disease therapy sometimes lead men to believe that they can rid themselves of AIDS by having sex with another women (thereby passing sickness out of themselves and onto another) or by having sex with a virgin. Needless to say, these strategies are unlikely to decrease risk and may lead to greater infection among school girls and rural women.

Women are often in no position to refuse sex, as they are economically dependent on men for child support, jobs, school fees, and commodities to which they have no other means of access (Bledsoe 1990). Orubuloye, Caldwell, and Caldwell (1993) have shown that Yoruba women in Nigeria can say "no" to sex in some culturally defined situations, such as during menstruation, during traditional periods of postpartum abstinence, at latter stages of pregnancy, after achieving grandmotherhood, and after menopause. But within marriage, or even within other stable informal sexual relationships, women have only a limited ability to refuse sex, and then only for a short period of time. Refusal over a matter of weeks or months becomes a threat to the conjugal union. Women are usually economically and socially disinclined to end marriage and other stable sexual relationships.

That Yoruba women have difficulty refusing their men sex is particularly interesting for understanding women's power in sexual decision making, because women's status among the Yoruba is considered high and their autonomy relatively great in comparison to groups in eastern and central Africa, where the AIDS epidemic is worst. Yoruba women have a tradition of economic independence as traders who maintain separate household budgets from their husbands. In addition, Yoruba women maintain close ties with their patrilineage and are much more easily accepted back to their natal communities after divorce than women in many societies in eastern and central Africa, where marriage more dramatically reduces a woman's affiliation with her natal family. Yet despite this relative autonomy, Orubuloye, Caldwell, and Caldwell (1993) found that Yoruba women face considerable constraints in refusing men sex. The lesson for AIDS prevention programs is that efforts to promote behavior change need to understand what is culturally permissive behavior change (McGrath et al. 1993). Knowledge of risk, and even the desire of individual actors to reduce risk, is not necessarily sufficient to enable individuals to alter their behavior.

Condom Promotion

African interpretations of condoms and the apparent reluctance of many people to use condoms during sex as a method of HIV-AIDS prevention illustrates the complex relationship between social and economic structures, cultural beliefs, sexuality, and HIV. While AIDS-prevention programs tend to view condoms as a simple technology designed to reduce risk, African responses to condoms and condom promotion programs are not necessarily those predicted by public health planners (Bledsoe 1990). For Africans the introduction of condoms can be more than a simple transfer of technology. A rich tradition in anthropology has demonstrated that bodily substances are replete with symbolic

meaning and cosmic importance (Douglas 1966, 1970; Buckley and Gottlieb 1988; Schoepf et al. 1991).

Chris Taylor (1990) has examined the low use of condoms in Rwanda, despite high awareness of AIDS and its sexual transmission and widespread availability of condoms. Taylor shows that Rwandan concepts of personhood are closely tied to notions of shared body fluids. Individual physiology and the exchange of bodily fluids during sex are related symbolically to collective health and fertility. Explanations of pathology often include notions of blockage in the natural and reciprocal flow of body fluids. "The person" in Rwanda is defined and completed relationally. Conception is believed to result from the cumulative admixture of male semen and female blood. Condoms represent blockage and therefore pose a threat to fertility, health, and collective well-being. In such a cosmological setting condoms may be perceived as a greater risk than HIV-AIDS.

Condoms impede fertility, a central value in many African societies. Using evidence from the local print media in a number of African countries, Caroline Bledsoe (1990) has examined the cultural logic that underlies Africans' views of AIDS and condoms. She identifies the following constellation of perceptions that inhibit condom use, particularly condom use initiated by women: (1) condoms deny the man and his lineage children; (2) women who ask for condoms are promiscuous or prostitutes; (3) condom use signals a desire to end a relationship; (4) women who use condoms keep outside lovers; (5) women who request condoms suspect their male partners of harboring HIV infection; and (6) women who request condoms are HIV infected. Given such perceptions, women are unlikely to use condoms with partners with whom they want a relationship. Ethnographic reports from a variety of African countries and populations have reinforced the conclusion that condom use in intimate noncommercial relationships is highly problematic (Irwin et al. 1991; Orubuloye, Caldwell, and Caldwell 1991; Schoepf 1992c; McGrath et al. 1993). Priscilla Ulin (1992) has correctly noted that "to provide women exclusively with HIV prevention methods that contradict most societies' fertility norms is to provide many women no options at all" (p. 136). For commercial sex workers, who may not be concerned with issues of fertility, trust, and intimacy in their sexual encounters, often the ability to negotiate condom use is prohibited by more immediate economic concerns.

Clearly efforts to promote behavior change to prevent HIV-AIDS transmission require an understanding of the complex relationship between individual decision making and action and larger social, economic, and cultural constraints that shape the actual and perceived boundaries of possibility. Increasingly, ecologically oriented anthropologists have recognized the need for integrating larger sociocultural and political-economic influences and constraints into models of the relationship between disease and human behavior (McGrath 1990; Armelagos, Ryan, and Anderson 1990). We are only beginning to understand the complex relationship between HIV and human behavior. Efforts to prevent the spread of HIV-AIDS will depend on integrated, interdisciplinary biocultural research that recognizes human culture as a key component of ecology.

CONCLUSION: DIRECTIONS FOR FUTURE RESEARCH

The study of disease and human behavior from an ecological perspective has contributed, and should continue to contribute, to the solution of both theoretical questions in general and medical anthropology and practical problems in public health. The research strategy described in this chapter has two complementary dimensions: (1) analysis of the social and ecological distribution of disease as it affects human culture and biology and (2) analysis of human behavior, and its sociocultural and political-economic determinants, as it affects the changing distribution of disease. Both of these approaches require the crossing of the subdisciplinary boundaries that currently divide anthropology, for they examine the interaction of cultural and biological phenomena from both a diachronic and synchronic perspective. We believe that this biocultural orientation, stemming from an earlier, holistic tradition in anthropology, continues to be theoretically attractive and is directly applicable to the improvement of health, particularly in less-''developed'' countries. Furthermore, because this biocultural approach to problems of disease and human behavior concerns all of the subdisciplines of anthropology (as well as epidemiology and medical geography), it has the potential to provide a synthesizing theoretical framework and, in so doing, to unify the now fragmented discipline itself.

This chapter on the study of disease and human behavior from an ecological perspective has emphasized five major themes:

1. Diseases occur within ecological settings and thus are context dependent and the diseases themselves are subject to evolutionary pressures.
2. Cultural practices can directly alter ecological relationships between hosts and agents of disease and can thereby influence, either positively or negatively, human health.
3. Biological and cultural traits with adaptive value against disease will generally be selected for and maintained in a population, according to evolutionary theory, because they enhance reproductive fitness.
4. Human behavior plays a significant role in the etiology of every major category of disease, and particularly the infectious diseases.
5. The understanding of the influence of human behavior on disease rates requires a synthesis of micro- and macrosociological perspectives.

Although a significant amount of exemplary research on the interaction of disease and human behavior in ecological context has already been conducted, the opportunities for future medical anthropological research in this field are great. Of the numerous diseases that now plague populations and individuals around the world, an inordinately small number of them has ever been studied by anthropologists, despite the fact that many of these diseases are significant causes of morbidity and mortality and are recognized as such by those afflicted, who may view the disease with great alarm. Moreover, many of the anthropological studies of disease that have been conducted to date have not been undertaken for their own sake; rather, they have been part and parcel of biomedical initiatives to elucidate the causes of diseases or to eliminate them in a ''culturally appropriate'' manner. Finally, both diseases themselves, as well as the culturally determined behaviors influencing them, are constantly changing, and new diseases, such as HIV-AIDS, Ebola virus, and other emerging infections, continue to appear (Garrett 1994; Morse 1994). In fact, the recognition of new diseases, many of them evolving in the environments of modern hospitals, is very impressive: the Institute of Medicine's analysis recognized seventeen emergent bacteria, twenty-seven emergent viruses, and eleven examples of emergent protozoa, helminths, and fungi (Lederberg, Shope, and Oaks, 1992). The introduction of new diseases and the appearance of new twists on old ones present major challenges to anthropologists interested in biological and cultural adaptations to disease threats.

Given this scenario, three research priorities stand out as being particularly important at this time. First, bioculturally oriented medical anthropologists must attempt to refine the definition of disease so that it is no longer defined by what it is not (the absence of ''health'') or by juxtaposing it as the objective counterpart to the more subjective concept of illness. If bioculturally oriented medical anthropologists are to study diseases without being labeled handmaidens of the biomedical establishment by so-called critical medical anthropologists, then disease models that acknowledge and incorporate the fundamental differences in culturally constructed notions of disease (including, necessarily, the Western biomedical construction) must be formulated.

Second, studies of cultural adaptations to disease threats must progress beyond the level of description to quantitatively rigorous analyses of the effects of particular behaviors on disease morbidity and mortality. However, quantitative research on the impact of human behavior, including traditional ethnomedical practices, on disease rates has yet to be undertaken for almost any disease category.

Finally, future studies of the disease-culture interaction must begin to combine the cultural, ecological (microsociological) and political ecological (macrosociological) levels of analysis. There is a paucity of, and hence a pressing need for, synthetic models to describe disease problems. Most research today tends to focus on either individual behavioral risk factors for various diseases (often based on observational or questionnaire survey data alone) or the overarching political-economic system that allows such diseases to be maintained (often in the absence of supportive ethnographic data). Unfortunately, such either-or research often leads to victim blaming—if not by the researchers themselves (who may never have intended to assign culpability for the disease problems under study), then by those who use the research to justify their own political and economic biases and objectives. Synthetic models, which attempt to examine in detail the interaction of disease and culture on a local level and then frame this interaction in terms of the regional, national, and global forces impinging on it, are desperately needed if disease problems are to be fully understood. Only with such full understanding will the utopian goal of disease control and the elimination of unnecessary human suffering be possible.

NOTE

1. In fact, infection with *Mycobacterium tubcerulosis* itself is not a necessary cause of tuberculosis, since the disease can be caused by other species of mycobacteria (see Harris and McClement 1983, cited by Hahn 1995).