CHAPTER 8

Context and Complexity in Human Biological Research

Thomas Leatherman and Alan Goodman

BIOLOGICAL ANTHROPOLOGY takes as its object of study human biological variation in the past and present. It draws on method and theory from reductionist sciences such as evolutionary ecology, molecular biology, and physiology. Yet biological anthropology also has a home in anthropology—a holistic and humanistic discipline that recognizes the diversity and complexity inherent in social and cultural systems—and practices an ethnographic approach that attends to everyday life experiences. As a subdiscipline, biological anthropology thus provides a unique experiment in bridging C. P. Snow's (1959) two cultures: the scientific and the humanistic.

The basic assumption of this chapter is that complex biology/behavior and human/environment interactions cannot be adequately understood using only reductionist approaches that try to explain such interactions as the product of a small number of independent and autonomous factors. A more adequate biocultural approach must also take the "cultural" side of the equation seriously by situating local peoples and environments within global and historical contexts, and by examining social and behavioral variation in relation to structures of power that shape the way people interact with their environments, cultures, and each other.

In this chapter, we first outline basic aspects of reductionism, oversimplification, and determinism in biological anthropology. We then provide two examples to highlight how reductive oversimplifications can limit our understanding of human biology. We argue that attention to the dialectical relationship between people and their environments and to the contexts and dynamics of local-global interactions provides a more integrated, socially contextualized, and ultimately more relevant understanding of human biology.

Reductionisms, Complexities, and Contexts

Reductionist approaches in anthropology attempt to explain biological, behavioral, and social phenomena by the operation of a few invariant factors and processes. For example, racial affiliation was long thought to predict biological constitution and behavior. Indeed, diseases such as hypertension, osteoporosis, and diabetes are still discussed in direct reference to race. Today, the genome is metaphorically characterized as the "blueprint" for building the organism,[1] and genetic differences are given primacy as explanations for biobehavioral variations. External meteorological conditions such as extreme cold, heat, and high-altitude hypoxia have been proposed as primary determinants of patterns of child growth and adult morphology (understood as adaptations), largely apart from other intervening factors such as nutritional status. The Cartesian model, which metaphorically treats the operation of the body like a machine, and the reductionist methods that follow from it have been highly successful, but they have also tended to ignore a range of contexts (hence contributing factors) that we believe need to be included in analyses, and therefore, they have restricted the sorts of questions we ask. It is this restriction of questions, contexts, and analyses that limits the utility of reductionist approaches.

There are three main components of reductionist methodologies with which we take issue. First, the phenomenon in question—for example, the body or the ecosystem—is broken down into its constituent parts, each taken as an independent and autonomous unit. The whole is taken as the sum of the parts, and ideally the whole can be explained by the functional characteristics of one or a few of its most important fundamental units. The operation of the parts then takes on determinative qualities in cause-and-effect relationships. Thus, germs or pathogens cause disease; the carrying capacity of an environment is determined by the least abundant, "limiting factor"; and disease, depression, and even risk taking are explained as a function of genes. In this view, the most elegant explanation is the simplest—that is, the one reduced to the smallest, most segregated, and autonomous units. And an even higher goal of biobehavioral reductionism is the development of deterministic equations and universal laws of causation.

Second, reductionist evolutionary and ecological science separates or "alienates" the organism from its environment. As Smith and Thomas put it: "This is an analysis where the natural environment and organism assume an independent and dependent variable relationship, and where finding out how the parts work is expected to lead us to the dynamics of the whole. Thus, the organism is seen mostly as a passive adjuster to environmental conditions it cannot really control" (1998: 461). This is an alienated view of

human-organism interaction and of adaptation in that it assumes that there is a fixed, local, and external world and that individuals simply react to it and are molded by it. It also follows that human-environment interactions can be studied as relatively closed independent systems apart from global and regional connections.

Third, following from the above, a reductive simplification in the representation of complex and differentiated features and processes occurs when categorical constructs are assumed to be relatively homogeneous across broad groups of people. For over half of the twentieth century, a rich array of biological variation was reduced and simplified to a handful of racial categories. Likewise, varying degrees of wealth, poverty, and even social inequality are often categorized in terms of tripartite rankings of socioeconomic status (SES). In "modernization" approaches to studying the biological correlates of social change, individuals, households, and communities differentially involved in complex social and economic changes associated with the spread of capitalism into less capitalized areas are categorized as "traditional" versus "modern." Such reductive simplifications are often found in statistical analyses that seek to "control for" a number of environmental and social factors while seeking the influence of a single, independent biological factor. But can we really account for the social environment (and thereby remove it from consideration) by controlling for "occupation," "years of education," or "socioeconomic status" and thereby conclude that intelligence, disease, or infant mortality rates are primarily determined by racial or genetic characters?

The approach we advocate, in contrast, pays attention to both the specifics of local human-environment interactions and to the need for situating people and environments in broader global processes. In dealing with the subject matter of biological anthropology and evolutionary biology, the metaphor of the "triple helix" (Lewontin 2001) is particularly useful. The triple helix calls attention to the dynamic interactions of genes, organisms, and their environment. First, genes provide input, but in no way do they compute organisms; rather, organisms use the information they provide to construct themselves in specific environmental contexts (2001: 17). A great deal of random developmental noise is involved in translating genetic information to body parts and processes, and hence to the entire organism (2001: 36, 38). Second, organisms do not simply react to an autonomous external environment; they interact with nature, selecting relevant resources and modifying the environment as they construct niches (2001: 51). Just as there is no organism without an environmental niche, so there is no niche without an organism. The relationship between organism and environment is a *dialectical* one of codetermination—that is, each is mutually constituted in the

other, and both organism and environment are at once subject and object (Levins and Lewontin 1985). This interaction (and the relative survival and reproductive success of individuals), in turn, influences gene frequencies.

A starting point for any biocultural approach is a conceptual understanding of humanity's place in nature. Eric Wolf summarizes such an understanding in rephrasing Marx's concept of mode of production: "The human species is an outgrowth of natural processes; at the same time the species is naturally social. The human species is, however, not merely a passive product of natural processes; it has also in the course of evolution acquired the ability to transform nature to human use" (1982: 73). In transforming nature (through the production process) humans transform themselves—by developing specific modes and relations of production and by building webs of social relationships, institutions, practices, and beliefs. The point is that humans are not only part of nature but also intensely social. To deal adequately with the social dimension, moreover, it is critical to locate it within broad historical contexts.

Thus, a more synthetic biocultural approach must reconnect the parts with the whole and recognize subjects of study as actors in their own history. It must place human biology and its study in historical, economic, cultural, and ideological contexts. It must take culture seriously—attending both to how it structures material reality and people's lived experiences *and* to how it shapes the questions we ask and the interpretations we make.

Using such an approach, we can clarify how genes or pathogens and other insults might best be seen as contributing *agents* as opposed to *causes* of disease (Lewontin 2001; Singer 1989). The cause of disease prevalence in a particular group ultimately lies in the social, biological, and environmental conditions that increase *exposure to* pathogens, as well as unhealthy and unhygienic environments, stress, food insecurity (and malnutrition), and other factors that reduce disease resistance and that limit access to health care and other means of coping with health problems when they arise. Hence, poverty, discrimination, violence, environmental racism, and differential entitlements to land, jobs, and income, as well as other structural inequalities, are certainly as relevant "causes" of disease as the pathogens that invoke biological or psychosocial dysfunction. This is a key message in the metaphor often used by medical anthropologists when they say they need to search "upstream" for the broader causes and contexts of the origins of distress and disease (Goodman and Leatherman 1998; McKinley 1986; Scheper-Hughes 1990; Singer 1989).

In the following sections, we offer an alternative to reductive methodologies. First, taking diabetes as an example, we critique disease etiology that focuses only on a part—racialized genetics—and that fails to situate the growing epidemic of obesity and diabetes within the larger context of increasingly delocalized food systems in which the most affordable foods are high in sugars and fat. We then consider how this epidemic can be better comprehended, in the case of the Yucatec Maya, by attention to the commoditization of food systems, dietary change, and nutrition. We underscore the need to situate local-level analyses of individuals, households, and communities within broader social fields of power, including interregional, national, and global economies—that is, we seek to contextualize human biology.

"Race" and Disease: The Limitations of Genetic Explanations

The idea of race was invented and is constantly being maintained, reinvented, reconfigured, or rejected by scientists in the contexts of specific social and cultural ideologies, technologies, and geographic locations. While most scientists no longer see races as separate and unchanging biological types, race still frequently stands in for genetics, and genetic analyses and explanations currently dominate the study of biological variation (Goodman 1997). As chameleon-like and flexible as the idea of race is, it nonetheless remains a concept that continues to carry analytic force in anthropology and human biology. However defined, race is employed as a categorizing variable in the U.S. census, on birth and death certificates, and on the first line of patients' medical records. The deployment of a "racial discourse" in analyses of diabetes in Native Americans demonstrates the limitations of genetic and "race"-based explanations and points to the importance of considering the cultural and political-economic contexts within which such a disease manifests itself.

Two reductionisms are necessary to accept the idea that "racial" differences in disease patterns are due to genetic differences among "races." The first reductionism involves geneticization: the belief that most biology and behavior is "in the genes." Genes, of course, are often a part of the complex web of disease causality, but they are almost always a minor, unstable, and insufficient cause. The presence of a Gm haplotype that is common in Native Americans, for example, might correlate with increased rates of diabetes in Native Americans (Knowler et al. 1988), but the causal link is unknown.

The second reductionism involves scientific racialism: the belief that races are real and useful constructs. This leap propels one from an explanation of disease variation in terms of genetic variation to one that sees differences in disease frequency as due to genetic variation among "races." To accept this reductive proposition, one must assume not only that races exist but also that most genetic variation occurs among (rather than within)

"races." However, we know from the work of Lewontin (1972) and Templeton (1998)—and from the results of the Human Genome Project—that this assumption is false.

The presumption that so-called racial differences in disease are due to genetic differences illustrates the flaws in both these reductionisms. For example, the rise in diabetes among some Native Americans is often thought to be due to a genetic variation that separates Native Americans from European Americans (Weiss, Ferrell, and Hanis 1984). Along with obesity, gallstones, and heart disease, type 2 diabetes is part of what has been called a New World Syndrome (Weiss, Ferrell, and Hanis 1984). The assumption that there is a panracial syndrome helps to reify the idea of race as a bounded and homogeneous entity that is marked by genetically determined features.

In fact, there is enormous variation in diabetes rates among Native North American groups. This variation is almost as great as the variation between European groups and Native Americans. Furthermore, the rise in diabetes rates is a relatively recent phenomenon (Young 1994). Finally, other groups such as Polynesians, West Africans, and poor whites in the United States, who are all experiencing similar shifts in diet and physical activity (from complex carbohydrates to colas, from rigorous exercise to inactivity), have experienced similar increases in the rates of the same diseases that are part of the New World Syndrome. Rather than fatalistically assuming that diabetes is "in our blood," as the Pima have (Kozak 1996), it would be more productive to contextualize the rising incidence of diabetes within a changing political economy that has reverberations in changing diet, activity patterns, ideas about health, and disease rates.

Combined with geneticization, racialization can be deadly in practice—a sort of ideological iatrogenesis, a disease produced by contact with Western medicine. To label the Native American epidemic of diabetes, obesity, heart disease, and related conditions as a *racial syndrome* focuses causality and research dollars on genetics rather than larger cultural and political-economic factors. For those who suffer from these diseases, it encourages both fatalism and the hope that a miracle cure will be found sometime in the future through genetic medicine. But what if we looked at the etiology of these chronic diseases in the interconnections of developing bodies, local conditions, and globalizing processes? What understandings might be produced if we began to call these conditions "diseases of mal-development"?[2]

The "Coca-colonization" of Diets in the Yucatan

The Maya of Mexico's Yucatan Peninsula are one of the populations cited as examples of the epidemic of obesity and diabetes among Native Americans.

Indeed, studies from urban locales such as Merida find a substantial number of men and women—over 50 percent—either clinically overweight or obese (Arroyo et al. 1999; Bastarrachea-Sosa, Laviada-Molina, and Vargas-Ancona 2001; Dickinson et al. 1993). Diabetes has become the fourth leading cause of death in this region (Arroyo et al. 1999). We argue that the etiology of these chronic diseases is best understood not in terms of genetic risk but rather in relation to larger political-economic and cultural forces that shape food systems and dietary change on the local level. Specifically, we situate the changing patterns of diet, nutrition, and health in Mayan communities in the context of the global tourism industry and the ways in which individuals, households, and communities differentially experience tourism-led development.

To be discussing problems of *overnutrition* among the Yucatec Maya is something new: the Maya have frequently and correctly been depicted as economically marginal, impoverished, and *undernourished* (Bastarrachea-Sosa, Laviada-Molina, and Vargas-Ancona 2001). Indeed, studies of Maya child growth—one key indicator of community-level nutrition—have shown severe stunting (low height-for-age), with little change in stature between the 1930s and early 1980s (Daltabuit 1988; Leatherman, Stillman, and Goodman 2000). Increases in both heights and weights occurred in the 1980s and mid-1990s (Leatherman, Stillman, and Goodman 2000; Gurri, Balam, and Moran 2001), yet indications of chronic undernutrition persist—suggesting that the caloric content in diets has increased but dietary quality has not. Moreover, alongside indications of childhood malnutrition there is adult obesity, a situation that Dickinson and coworkers have termed the "double-edged sword of malnutrition" (1993: 315). How has this pattern of "undernutrition" coupled with "overnutrition" emerged in the Yucatan?

A notable aspect of tourism development is the commoditization of food systems, that is, the increased distribution and consumption of commercialized foods, including junk foods. Thus, a proximate answer to the above question would cite a trend toward high fat and sugar consumption typical of Western diets. Yet, to gloss dietary trends as "Westernization" misses the local and regional dynamics of food systems and diets that are the result of processes linked to tourism-based social and economic change.

"Westernization" of the Yucatecan diet is one form of what has been called "dietary delocalization," a process whereby local peoples consume foods produced outside the region (Pelto and Pelto 1983). Since ancient times, trade, internal colonization, and migration have promoted the exchange of foods across regions. After 1492 such exchanges became worldwide as well as regional, and more recently, dietary delocalization has been linked increasingly to global and regional economic development and to the

commoditization of food systems and diets (Dewey 1989; Pelto and Pelto 1983). Shifts from locally produced to marketed and commercialized foods have been associated with increased dietary diversity and improved levels of nutrition in industrialized nations (Pelto and Pelto 1983), and at least for some sectors of the population, such shifts have provided a nutritional rationale for economic development. However, growth in the commoditization of foodstuffs typically also means higher market prices that stress the budgets of the poor, thereby resulting in a decreased diversity of foods and nutrients in local diets. Junk foods, including sodas and colas, are highly advertised, widely available, inexpensive, and prominently displayed in local stores. When funds are limited, poor Mayans may reach for these foods, which are high in sugars, calories, and fats, but little else.

Thus, our assessment of changing food systems, nutrition, and health in the context of tourism-based economic and social transformations begins with the identification of contradictions. Child growth has improved somewhat but nutritional deficiencies persist, and at the same time there is an epidemic of obesity and diabetes in adults. Commoditization of food systems can lead to an overall increase in food availability and consumption, but it can also heighten inequalities in access and detrimentally affect nutrition and health. From our perspective, these contradictions reveal how the social, cultural, and health impacts of tourism-led development are distributed unevenly and experienced unequally among Mayan communities, families, and individuals. This variation reflects the way in which communities, households, and individuals articulate with local production systems and with the tourism-based economy.

GLOBAL CONTEXTS AND LOCAL DIETARY CHANGE

Throughout much of the developing world, nations are turning to tourism as a means of attracting foreign capital and generating economic development. Mexico leads this trend in Latin America, and the primary destination for tourists in Mexico is the Caribbean coast of the Yucatan Peninsula. Over the last three decades, this region has experienced a transformation from one of the most economically marginal areas of Mexico into a tourist bonanza. Cancun, the center of this development, grew from a fishing village of 426 inhabitants in the early 1970s to become, by the early 1990s, the state's most important city, numbering over 400,000 people (Daltabuit and Leatherman 1998).

This development has been an unqualified economic success for the Mexican government, and even more so for foreign investors. But such rapid and totalizing development does not come without costs to local populations (Pi-Sunyer and Thomas 1997; Daltabuit and Leatherman 1998). As environmental resources, labor, and food become increasingly commoditized and as symbols of prestige become increasingly Western, substantial disruptions to local patterns of life are inevitable.

Our concern here is with one form of change: the commoditization of food systems and the way it might be linked to the dietary changes and contradictory patterns of nutrition and health that have emerged in the Yucatan. To examine these links, we studied food systems, diet, and nutrition in several Mayan communities that differ in subsistence base and articulation with the tourist industry. One set of communities (Akumal and Ciudad Chemuyil) comprises service villages to a popular resort on the Caribbean coast. The local economy here is based on wage work and small-scale commerce. There are no agricultural lands and little land for home gardens; thus, households are totally dependent on local markets for their food. Coba is an inland farming village with direct local involvement in the tourist economy through archaeotourism. Yalcoba, another inland farming community, has little direct exposure to tourists but experiences substantial out-migration of men to Cancun on a weekly basis, primarily for work in construction.[3]

DIETARY DELOCALIZATION AND FOOD COMMODITIZATION IN CONTEXTS OF CHANGE

While all communities in the Yucatan are increasingly consuming foods from farther and farther away, the nature of changing food systems is markedly different for the coastal and inland communities. In the coastal communities, a fully commercialized system is now in place. Most foods are purchased year-round from local stores and traveling vendors that often specialize in particular foodstuffs from different growing regions. In the two inland communities, products from local slash-and-burn milpa agriculture (primarily corn, beans, and squash) and home gardens are key components of many households' diets, at least for part of the year. By the mid-1980s, however, Daltabuit (1988) had already noted for Yalcoba the decreased consumption of local foods, such as honey, tubers, posole, and wild meat, and an increased consumption of commercial foodstuffs, including rice, pasta, sodas, and snack foods.

This trend was accentuated in the 1990s. Even maize and beans, two key staples, are now imported and purchased from government-subsidized stores or small local variety stores (*tiendas*). Compared to ten years ago, the varieties of food are greater but they come at high prices. As one resident of Coba said, "there are more foods available now, but no money to buy them." The experience of change is thus unequal: many informants in Coba

and Yalcoba view the past twenty years as a time of steadily decreasing food availability, while others see it as a time of growth in opportunity and consumption.

Shifts in the local food systems have occurred in the context of a decline in milpa production, a shift toward wage work, and an expansion of local and global markets and of commercialized foods in the regional economy. A common complaint in both inland communities is that the productivity of local communal (*ejido*) lands has decreased markedly in the past several decades. Very few families grow enough corn to last a year, and many of the households more fully engaged in wage work or commercial enterprises no longer plant their fields or else hire someone to plant for them. Mayan youths now prefer to seek their fortune in Cancun rather than in the milpa. Some speak of the drudgery of the *trabajo rudo* (coarse, rough work) of the milpa and hope for a future in the service and construction jobs to be found at tourist centers.

Despite a continued practice of patrilocal residence, some young families supported by wage work have ceased to pool resources and labor or even to share food and meal preparation with their parents and in-laws. The young welcome this social independence, but for their parents it signifies an erosion of the very meaning of family and community. Thus, Pi-Sunyer and Thomas (1997) speak of tourism as a "totalizing" experience that impacts not only the way people produce and consume but also the core fabric of social and cultural life.

The most dramatic aspect of commercialization of food systems in the region is the pervasive presence of Coke, Pepsi, and a variety of chips, cookies, candies, and other snack foods—known locally as *comidas chatarros* (junk foods). Mexico is one of the world's largest consumers of soft drinks, accounting for over 20 percent of Pepsi's and 15 percent of Coke's international sales (Jabbonsky 1993). Indeed, the Mexican market is so important that it is the site of an ongoing "Cola War" between Coke and Pepsi. Company executives see it as a fight over the "stomach share" of the Mexican people. Coke's goal and company slogan is "an arm's length from desire"—to make Coke available at every corner in every town or village in every part of Mexico. Pepsico has waged its version of the Cola War using a strategy of "the Power of One." This entails marketing Pepsi in conjunction with junk foods, and indeed Pepsico's logo is found on most of the chips, cookies, candies, and other processed snack foods prominently displayed in *tiendas*. As this fight for "stomach share" intensifies, we can expect to see an even greater penetration of sodas and snack foods into the diets of the Yucatec Maya.

DIET AND NUTRITION

As shifts in food systems unfold at the intersection of global and local economies, so also do local diets and nutrition. Using a food-frequency questionnaire (see Leatherman and Goodman, in press), we assessed food and nutrient intakes in the coastal and inland communities. We also compared nutrient profiles in households from Yalcoba that have steady employment in the tourist economy with those of households that rely more on subsistence production and irregular wage work to meet basic needs. This comparison sought to further register differential experiences in the local and tourist economies and their impacts on diet and nutrition.

The leading food categories in the diets of the communities we studied were tortillas, fats (oil and lard), sodas, snacks and sugar, beans, meat, and rice or pasta. We found that people in the coastal communities and inland residents with steady wage employment consume half the tortillas and over twice the fruits, meat, dairy, and junk foods of those in the inland communities without steady employment. Although sugar and junk foods accounted for 16 percent of calories in the coastal communities and around 10 percent in the inland communities, these calculations are underestimates because our dietary surveys recorded primarily foods eaten in the household, and most sodas and snacks are consumed away from home. Local sales of soft drinks reflected an average per capita consumption of one soda per day in inland communities and at least 50 percent more in the coastal communities. School-aged children in Yalcoba reported average weekly intakes of over seven soft drinks and ten snack foods (e.g., chips or cookies). During school breaks, it was typical for children to buy a soda and a snack, amounting to about 350 calories, or a fifth of a child's daily caloric requirement (Daltabuit 1988; McGarty 1995). The marketing of chips and sweets in one-peso packages—something everyone can afford—encouraged the choice of these foods.

We found that the diets in all the communities were fairly adequate for macronutrients—carbohydrates, fats, and protein—but exhibited micronutrient deficiencies that can affect both nutrition and growth. The coastal and inland households with steady employment consumed more high-quality animal protein and also exhibited a better micronutrient profile; only the mineral zinc was deficient. In the inland community of Coba we found deficiencies of zinc and vitamins B_2 (riboflavin), B_{12} (cobalamin), and A. In addition, poorer Yalcoba households without steady incomes, reliant on irregular wage work and marginal milpa production, experienced deficiencies in vitamins A and C as well as in the B vitamins and zinc.

These potential micronutrient deficiencies gain importance in the context of diets high in maize and junk foods. Plant-based diets, high in fiber and phytates, are associated with increased requirements and low bioavailability of a number of micronutrients such as zinc, iron, calcium, and vitamin B_{12} (Allen, Backstrand, and Stanek 1992; Calloway et al. 1993). Thus, when the remaining nonmaize calories come from sugar, soft drinks, and snack foods, micronutrient status inexorably worsens.

In sum, food consumption patterns in these communities reflect an increased level of fats, sugars, and other foods with "empty calories" (i.e., with few nutrients) in the diet—the sort of diet often associated with increases in obesity and diabetes. When coupled with poor nutritional quality, such as the micronutrient deficiencies we found, such a diet could contribute to the pattern of stunted but heavy individuals found in studies of adult obesity in the Yucatan (Bastarrachea-Sosa, Laviada-Molina, and Vargas-Ancona 2001; Dickinson et al. 1993).

THE DOUBLE-EDGED SWORD OF MALNUTRITION

Our research bears out Dickinson's description of a "double-edged sword" in the Yucatan, whereby undernourished and stunted children grow up to be obese adults (Dickinson et al. 1993: 315). Children in Yalcoba are growing taller but are still stunted by Mexican and international standards of growth (Leatherman and Goodman, in press). This may well reflect persistent micronutrient deficiencies, since caloric intakes appear to be adequate. An analysis of adult weights collected from clinic records in Yalcoba in the 1990s found that about 40 percent of the men were overweight and 10 percent obese, and that 64 percent of the women were overweight and 20 percent obese (Leatherman and Goodman, in press). While these rates of obesity are not as high as in urban areas of the Yucatan, where obesity and diabetes have reached epidemic proportions (Bastarrachea-Sosa, Laviada-Molina, and Vargas-Ancona 2001), the trends are clearly moving in that direction.

The Yucatan, historically an area of persistent hunger and malnutrition, is now the site of an epidemic of overnutrition—of obesity and diabetes. Diets with limited nutritional quality but high in calorie-dense foods, such as sodas and snack foods, are associated with overweight individuals in urban locales (Bastarrachea-Sosa, Laviada-Molina, and Vargas-Ancona 2001), and this appears increasingly to be the case in the communities we studied as well. The Cola Wars and consumption of junk foods show no sign of slowing, and the emerging pattern of childhood undernutrition and adult overnutrition is a serious threat to well-being. These dietary changes are a product of the commoditization and commercialization of foods linked to a growing tourist economy, and they are differentially experienced—for better and for worse—by communities, households, and individuals depending upon their position within this economy.

To return to the larger themes of reductionism and complexities, our point is that the changing biological realities and lived experiences in the Yucatan are shaped by the intersection of global and local processes of change, and that individuals experience and respond to these changes unequally and in different ways. Perspectives that homogenize global transformations into monolithic entities such as "Westernization" or "modernization"—and that essentialize how the Yucatecan population experiences these transformations—cannot comprehend the contradictions that define the culture, biology, and health of these and similar groups worldwide.

Contexts and Complexities

Biocultural anthropologists today face a set of tensions that are difficult to resolve. To what extent do we follow the simplifying assumptions of a mechanistic and reductionist natural science and so earn our "science" credentials (and funding)? Can we remain true to the founding principles of holism and recognize the diversity and complexity inherent in social and cultural systems? Do we ignore new ideas that are seemingly antithetical to dominant positions in the field, or do we take seriously theoretical developments in anthropology that might open up new lines of inquiry and new avenues of dialogue? These tensions are not limited to biological and biocultural anthropologists, but they are especially challenging for those committed to connecting biology and culture.

The evolutionary and ecological frameworks that have guided biological anthropology over the past three decades provide an incomplete framework for inquiry into many of the factors shaping human biology now and in the future. They may help us detail some of the consequences of global economic change such as increased inequalities in wealth and health, environmental degradation, impaired production, heightened food insecurity, and the growing numbers of displaced peoples and communities ravaged by new and resurgent diseases. But, they will not, in themselves, provide sufficient and satisfying explanations of how such problems arise, why some groups are more vulnerable than others, or how the consequences and responses to such conditions set the stage for future change. We will need to expand our theories, the kinds of questions we ask, and the range of contexts we examine.

In this chapter, we have argued that reductionist approaches to the explanation of biology and behavior restrict possible research questions, oversimplify measurement and analysis, and ignore the broader contexts and

social dynamics of human-environment interaction. First, such approaches break down environmental systems into constituent parts for analyses but rarely put them back together so as to obtain a picture of the whole or a description of how the parts relate to the whole. Second, they tend to essentialize variables and processes as autonomous and "natural"—dehistoricized and alienated from their interactions with other components of the system. Such naturalized processes are often seen as inevitable and as affecting all members of a population in the same way. Rarely, do environmental descriptions include extralocal (interregional, national, global) processes that influence local-level environments or confront the complexities of human-environment interactions. And even when we do attempt to explain biology in terms of social factors such as social inequalities, we fail to ask what created these inequalities and why some people are more vulnerable than others. Third, human-environment interaction is too often viewed as a one-way process whereby autonomous external environments stimulate adaptive responses. In this view, people are often treated as passive agents who adjust and accommodate to environmental variations rather than participate in constructing the environments in which they operate (Leatherman 1996, 1998; Lewontin 1995).

Thus, we advocate for a different approach—one that investigates the dialectics of human-environment interactions. Just as the environment makes humans, so the environment is human made—made by direct physical manipulation and *made relevant* by the cultural meanings humans assign it. Resources are not just "out there" but are made relevant as people mobilize them within a framework of cultural meanings and as they become sites of power struggles over who will or will not control them. Global-local interactions need to be part of environmental analyses, and social dimensions of biological variation need to be analyzed in terms of relations of power, not taken as natural. Indeed, whatever the unit of analysis may be—individuals, households, communities, populations, or others—this unit is always embedded in webs of relationships, which are directly and indirectly tied to both local and global systems and histories. If we cannot acknowledge these broad connections and frame our questions and interpretations within them, how can we hope that our analyses will have relevance in the real world?

Notes

1. Lewontin, however, argues that the current idea that "the development of an individual is the unfolding of a genetic program immanent in the fertilized egg" (2001: 17) is not much different from the eighteenth-century preformationist notions that viewed the organism's development as the unfolding and enlarging of the miniature person (called a homunculus) contained in the sperm. He states, "there is no essential difference, but only one of mechanical details, between the view that the organism is already formed in the fertilized egg, and the view that the complete blueprint of the organism and all the information necessary to specify it is contained there, a view that dominates modern studies of development" (2001: 6).

2. Here we refer to the consequences of economic and social development that affect people's diet and activity level (i.e., overnutrition and underactivity). However, by "maldevelopment" we can also refer to problems of physiological growth and development that result from these broader social changes. Recent proposals of a "thrifty phenotype hypothesis" (in contrast to a "thrifty genotype") suggest that the physiological development of a malnourished fetus and infant increases the risk of obesity and non-insulin-dependent diabetes mellitus (NIDDM; type 2) later in life (Hales and Barker 1992).

3. We draw on research begun by Magalí Daltabuit (1988) and continued by us in collaboration with Daltabuit, other colleagues, and students (Leatherman and Goodman, in press).

References

Allen, Lindsay, J. R. Backstrand, and E. J. Stanek. 1992. The Interactive Effects of Dietary Quality on the Growth of Young Mexican Children. *American Journal of Clinical Nutrition* 56: 353–64.

Arroyo, P., J. Pardio, V. Fernandez, L. Vargas-Ancona, G. Canul, and A. Loria. 1999. Obesity and Cultural Environment in the Yucatan Region. *Nutrition Reviews* 57(5): S78–S82.

Bastarrachea-Sosa, Raul, Hugo Laviada-Molina, and Lizardo Vargas-Ancona. 2001. La obesidad y enfermedades relacionadas con la nutricion en Yucatan. *Revista de Endocrinologia y Nutricion* 9(2): 73–76.

Calloway, Doris, S. P. Murphy, G. H. Beaton, and D. Lein. 1993. Estimated Vitamin Intakes of Toddlers: Predicted Prevalence of Inadequacy in Village Populations in Egypt, Kenya, and Mexico. *American Journal of Clinical Nutrition* 58: 376–84.

Daltabuit, Magalí. 1988. Mayan Women: Work, Nutrition and Child Care. PhD dissertation, University of Massachusetts, Amherst.

Daltabuit, Magalí, and Thomas Leatherman. 1998. The Biocultural Impact of Tourism on Mayan Communities. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology*, ed. Alan Goodman and Thomas Leatherman, pp. 317–38. Ann Arbor: University of Michigan Press.

Dewey, Katherine. 1989. Nutrition and the Commoditization of Food Systems in Latin America. *Social Science and Medicine* 28: 415–24.

Dickinson, Federico, M. T. Castillo, L. Vales, and L. Uc. 1993. Obesity and Women's Health in Two Socioeconomic Areas of Yucatan, Mexico. *Colloquia Antropologia* 2: 309–17.

Goodman, Alan. 1997. Bred in the Bone? *The Sciences*, March/April, pp. 20–25.

Goodman, Alan, and Thomas Leatherman. 1998. Traversing the Chasm between Biology and Culture: An Introduction. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology*, ed. Alan Goodman and Thomas Leatherman, pp. 3–41. Ann Arbor: University of Michigan Press.

Gurri, Francisco D., G. Balam, and Emilio Moran. 2001. Well-Being Changes in Response to 30 Years of Regional Integration in Maya Populations from Yucatan, Mexico. *American Journal of Human Biology* 13: 590–602.

Hales, C. N., and D. J. P. Barker. 1992. Type 2 (Non-Insulin-Dependent) Diabetes Mellitus: The Thrifty Phenotype Hypothesis. *Diabetologia* 35: 595–601.

Jabbonsky, Larry. 1993. The Mexican Resurrection. *Beverage World* 112(1547): 38–40.

Knowler, William C., R. C. Williams, D. J. Pettitt, and A. G. Steinberg. 1988. Gm and Type 2 Diabetes Mellitus: An Association in American Indians with Genetic Admixture. *American Journal of Human Genetics* 43: 520–26.

Kozak, David. Surrendering to Diabetes: An Embodied Response to Perceptions of Diabetes and Death in the Gila Indian Community. *Omega: Journal of Death and Dying* 35(4): 347–59.

Leatherman, Thomas. 1996. A Biocultural Perspective on Health and Household Economy in Southern Peru. *Medical Anthropology Quarterly* 10(4): 476–95.

———. 1998. Illness, Social Relations, and Household Production and Reproduction in the Andes of Southern Peru. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology,* ed. Alan Goodman and Thomas Leatherman, pp. 255–67. Ann Arbor: University of Michigan Press.

Leatherman, Thomas, and Alan Goodman. In press. Coca-Colonization of Diets in the Yucatan. *Social Science and Medicine.*

Leatherman, Thomas, J. T. Stillman, and Alan Goodman. 2000. The Effects of Tourism-Led Development on the Nutritional Status of Yucatec Mayan Children. *American Journal of Physical Anthropology* Supplement 30: 207.

Levins, Richard, and Richard C. Lewontin. 1985. *The Dialectical Biologist.* Cambridge: Harvard University Press.

Lewontin, Richard C. 1972. The Apportionment of Human Diversity. *Evolutionary Biology* 6: 381–98.

———. 1995. Genes, Environment, and Organisms. In *Hidden Histories of Science,* ed. Robert B. Silver, pp. 115–38. New York: New York Review of Books.

———. 2001. *The Triple Helix.* Cambridge: Harvard University Press.

McGarty, Catherine A. 1995. Dietary Delocalization in a Yucatecan Resort Community in Quintana Roo, Mexico: Junk Food in Paradise. Honors thesis, School of Nursing, University of Massachusetts, Amherst.

McKinley, John B. 1986. A Case for Refocussing Upstream: The Political Economy of Illness. In *The Sociology of Health and Illness,* ed. P. Conrad and R. Kerr, pp. 613–33. New York: St. Martins Press.

Pelto, Gretel H., and Pertti J. Pelto. 1983. Diet and Delocalization: Dietary Changes since 1750. *Journal of Interdisciplinary History* 14: 507–28.

Pi-Sunyer, Oriole, and R. Brooke Thomas. 1997. Tourism, Environmentalism and Cultural Survival in Quintana Roo, Mexico. In *Life and Death Matters: Human Rights and the Environment at the End of the Millennium,* ed. Barbara Johnston, pp. 187–212. Walnut Creek, CA: Altamira Press.

Scheper-Hughes, Nancy. 1990. Three Propositions for a Critically Applied Medical Anthropology. *Social Science and Medicine* 30(2): 189–97.

Singer, Merrill. 1989. The Limitations of Medical Ecology: The Concept of Adaptation in the Context of Social Stratification and Social Transformation. *Medical Anthropology* 10(4): 218–29.

Smith, Gavin A., and R. Brooke Thomas. 1998. What Could Be: Biological Anthropology for the Next Generation. In *Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology,* ed. Alan Goodman and Thomas Leatherman, pp. 451–73. Ann Arbor: University of Michigan Press.

Snow, Charles P. 1959. *The Two Cultures and the Scientific Revolution.* New York: Cambridge University Press.

Templeton, Alan. 1998. Human Races: A Genetic and Evolutionary Perspective. *American Anthropologist* 100: 632–50.

Weiss, Kenneth, R. Ferrell, and C. L. Hanis. 1984. New World Syndrome of Metabolic Diseases with a Genetic and Evolutionary Basis. *Yearbook of Physical Anthropology* 27: 153–78.

Wolf, Eric R. 1982. *Europe and the People without History.* Berkeley and Los Angeles: University of California Press.

Young, T. Kue. 1994. *The Health of Native Americans: Toward a Biocultural Epidemiology.* New York: Oxford University Press.

View publication stats