

Human Ecology in Anthropology: Past, Present, and Prospects

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INTRODUCTION

Anthropology is, by its very nature and tradition, a kind of multidisciplinary science. Sociocultural anthropology has history and humanities as components of its heritage, but is squarely situated within the social sciences. Linguistic anthropology, in some ways, is even closer to the humanities than sociocultural anthropology, yet several branches of this field are quite empirical, and some are experimental, and can be allied with psychology. The archaeology branch of anthropology, while also firmly tied to social science, has somewhat closer linkages to the natural sciences for purposes of dating, faunal and floral analysis, and stratigraphy and geomorphology. Archaeologists also feel a close affinity to historians. Biological anthropology is often considered the least associated with social science, being linked to the biological, evolutionary, and biomedical sciences. However, its real contribution to scientific inquiry comes from an integration of the biological and social sciences along with a long-standing interest in human evolution. These four branches of anthropology, despite a common concern with the central concept of *culture* and of social behavior, have quite different traditions of theory, training, method, and practice. The traditions of human ecology in anthropology tend also to be separated into their constituent subfields, although there have been efforts at integration in anthropology under the theoretical framework of human ecology. Some of these bases for division and integration of human ecology will be discussed.

Cultural Ecology

Within anthropology, ecological approaches have been employed in a variety of ways. *Cultural ecology* has been applied in sociocultural studies as an alternative to a deterministic application of “culture” as the primary causal agent leading to new “culture.” In other words, culture, as ideas and behavior, can arise from the environmental circumstances (both social and physical) of people’s lives *or* culture can arise

sui generis, that is, in and of itself! Historical processes play an important role in this latter scenario. These two fundamental approaches to anthropological inquiry have characterized the science for many years. The *functionalist* school of anthropological theory, in which cultural attributes were identified as part of an interrelated system, was heavily criticized because it neglected historical explanation and *human agency*, that is human actions contributing to culture. Environmental determinism and possibilism, functionalism, culture-area approaches, racism, evolutionism, and historicism were conceptual and theoretical perspectives that were all mixed in complex ways during the late 19th and early 20th centuries in anthropology. Franz Boas, the founder of American anthropology, demonstrated the influence of the environment on body size and form in migrants in the first decade of the 20th century, yet he rejected evolutionary explanations and identified human behavior and culture as arising from historical forces not environmental forces.

Early social studies of humans and their environment moved from the “environmental determinism” of the anthropogeographers (Ratzel, 1889-91; Semple, 1911), to the “environmental possibilism” of the ethnographers (Forde, 1934; Evans-Pritchard, 1940), and to the “cultural ecology” of Julian Steward (1938, 1955). In the 1930s, Steward moved cultural ecology a step forward by rejecting the “...fruitless assumption that culture comes from culture...” (Steward, 1955: 36). He also developed the concept of *culture core* as the behavior patterns most closely linked to the environment (e.g., subsistence and food acquisition). He advocated a three-fold analysis of relationships between (1) the environment and subsistence, (2) subsistence and behavior patterns, and (3) behavior patterns and other components of the culture, and his view of ecology was closely linked to the concept of “adaptation to the environment” (Vayda and Rappaport, 1968). Later studies criticized Steward’s “culture core” concept as too narrowly conceived. This form of criticism is quite characteristic of anthropology: rather than building on previous ideas and data, ideas are rejected sequentially as new theoretical

approaches appear and rise in popularity. Anthropological progress over the past century has been constrained because the pattern of exploration has been: first, limited application of scientific design and hypothesis testing; second, a continual succession of new theoretical frameworks and approaches without full exploration; and third, little validation of research results and limited development of a tested body of fundamental principles.

Ecology within Archaeology

Within archaeology, interests in the environment date back to the 19th century. Ecological theory in archaeology tended to be linked to processes of culture change and evolution through the writings of Leslie White (1949) on unilinear evolution and Julian Steward (1955) on multilineal evolution. More recent interests in the 1960s and 1970s were in systems theory in behavior, and most recently, within the past decade or so, archaeologists have directed their interests toward regional climate change, historical ecology, and landscape ecology. It is also the case, as Karl Butzer (1990: 92) stated: that there has been an "...advantage of exposing archaeology to the intellectual cross-currents of anthropology. But it has also been disadvantageous, exposing archaeology to disciplinary fads and limiting effective contacts with other scientists."

Ecology within Biological Anthropology

Biological anthropologists moved from 19th century and early 20th century typological approaches and race studies to the understanding of humans and their evolution via modern ideas about adaptation to the environment as a basis for understanding human variation. Ecological theory was tied also to evolutionary processes, but more in the realm of biobehavioral evolution and associated with the Darwinian concepts of "selection" and "adaptation to the environment" (Warren, 1951; Weiner, 1964). Ecological theory in biological anthropology became a fusion of evolutionary and ecological theory (Bates, 1953, 1960), along with ideas from environmental physiology (Dill et al., 1964), biogeography and human biogeography (Coon et al., 1950), demography (Spuhler, 1959), and human biology (Baker and Weiner, 1966; Lasker, 1969; Little, 1982; Little et al., 1990). Recently, socioecological

theory has successfully been used to extend the synthesis between ecology and anthropology, focusing primarily on individuals rather than higher levels of organization (Winterhalder and Smith, 1981; Smith and Winterhalder, 1993). Prominent in nearly all ecological theory in anthropology has been the concept of adaptation to the environment (Alland, 1975; Baker, 1966; Moran, 1979). Ecological studies in biological anthropology were stimulated in the 1960s by the work being done in ecosystems ecology by the scientists in the International Biological Program or IBP. At this time, there were several Human Adaptability Projects associated with the IBP that were influenced by systems science and efforts to modeling complex ecological systems.

TWO EARLY STUDIES

There were two very original anthropological studies that were done in the 1960s that were subject to a great deal of criticism in the anthropological literature. The first is the ecological study of the Tsembaga Maring of New Guinea by the late Roy Rappaport. The work was done in the central highlands of New Guinea. The second is the energy-flow study of Andean Quechua Indians of Peru by Brooke Thomas. This work was done on the Peuvian *altiplano* at a base elevation of 4,000 meters above sea level. In the first case, Rappaport was a single investigator with an overwhelming task that he set out for himself. This is a long-established tradition in anthropology for one investigator to live with a people and, through participant-observation, to learn about the workings of the society or culture. Rappaport not only took on the job of describing and understanding the inner workings of Tsembaga culture, he also attempted to understand this in the context of Tsembaga ecology. In the second case, Thomas's task was no less daunting, but his work was done within the framework of an integrated project. This was the Andean Biocultural Studies project, initiated by Paul Baker (Baker and Little, 1976) at the Pennsylvania State University in the U.S., with the primary objective of studying the patterns of adaptation of high-altitude natives to the hypoxia and cold of the Andean *altiplano*. When Thomas began his work, several years of data on social conditions, nutrition, human physiology, demography, and weather conditions had already been collected, and the area had been mapped.

Rappaport's Work

Rappaport's research was reported in a now famous book entitled *Pigs for the Ancestors*, which was published in 1968, and reprinted in 1984 with a 190-page *Epilogue*, in which he addressed his critics and reevaluated some of the research (Rappaport, 1968, 1984). The work is brilliant, in that it addresses some of the fundamental issues underlying anthropological theory, including: social control, environmental causality for behavior, and the connection between individual behavior and cultural norms or prescribed social behavior. In the work, Rappaport suggested first, that human population numbers, pig population numbers, the warfare cycle, agricultural productivity, patterns of exchange of goods, the distribution of land and people, and the maintenance of the ecosystem as a productive system were all tightly interrelated as a working system. Second, he suggested that the system was in a state of equilibrium maintained by feedback mechanisms. And third, and perhaps most controversial, that the regulating or controlling mechanism that kept the system going was the information provided in the form of ritual and a ritual cycle. Within this research, he took both a *materialistic* and a *functionalist* approach to social science, he identified human behavior as *adaptive* in the context of the social and ecological systems, and he identified human behaviors as subject to *selection* of favorable behaviors in the context of maintenance of the human/ecological system.

Needless to say, and despite the fact that ecological anthropology was in vogue at that time, Rappaport's critics in sociocultural anthropology were severe in their verbal assaults. His work had attacked some of the fundamental icons of anthropology. He and other ecological anthropologists were accused of: (1) reifying the ecosystem (to treat the abstraction of an ecosystem as if it had material existence); (2) vulgar materialism (a belief that the materialistic approaches used in ecological anthropology were simplistic in their social context); (3) a calorific obsession (placing too much emphasis on flows of energy through the system); (4) excluding historical factors (too much emphasis on equilibrium and stability in diachronic state in the systems studied); (5) setting up false boundaries (human cultures go beyond ecosystem boundaries); (6) shifting levels of analysis (applying one level

of interpretation to another); and (7) dealing with an "impoverished" ecosystem approach (in contrast to "evolutionary ecology"). Scientists in the ecology community were debating some of these issues, but in many cases, anthropologists did not fully understand the bases for the debates, plus the human dimension added profound levels of complexity to these issues. In any case, the emotion behind these critical writings and the use of such intemperate terms such as "reification," "vulgar," "obsession," "false," and "impoverished" reflected the intense feelings about ecological and cultural materialistic approaches by a majority of anthropologists.

Thomas's Work

The work that Brooke Thomas conducted on energy flow research in a highland native community in Peru was begun in the late 1960s after Rappaport's and Vayda's ecological studies of New Guinea populations. The work was stimulated by Rappaport's and others' research and by the ecologist H.T. Odum's graphic shorthand language to represent the flows and controls of energy through ecosystems. At the time of the study, Quechua natives of the altiplano employed a mixed subsistence of cultivation of potatoes (and other tubers) and quinoa (chenopods) and herding of llamas, alpacas, and sheep. By comparing food energy production (outputs) with labor expenditures (inputs), Thomas demonstrated that cultivation provided a 10: 1 return, while livestock herding provided only a 2: 1 energy return (Thomas, 1976). Animal products (meat, hides, wool) were highly prized at lower elevations; hence, trade of animal products for other foods (e.g., maize, sugar) increased the ratio to more than 7: 1. Thomas's model, although representing averages and a simplified view of the energetics of production and expenditure in this community, nevertheless quantitatively demonstrated the utility of some of the principles of Quechua native subsistence through energy flow.

Thomas's work was the focus of an intense critique in a book called *Energy and Effort* that was edited by the distinguished human biologist Geoffrey A. Harrison (1982). The critique was penned by Philip Burnham, who began his comments by criticizing H.T. Odum's (1971) work on *Environment, Power, and Society*, identifying it as "reductionist" and "breathtakingly naive."

This book *was* somewhat naive, particularly in its chapters on human politics and religion, but many of the analytical approaches were very useful. Burnham (1982) continued his comments by outlining methodological problems that he saw as limiting understanding of human behavior by energy flow studies. One point has merit, where he stated: "...there is the problem of the multi-disciplinary competencies required of a single researcher engaged in human ecological field study..." (Burnham, 1982: 233). Other arguments that he made were: (1) that the costs are too high for the "pay-offs" of energetics (anthropologists have grown accustomed to very modest research budgets); (2) adequate nutritional assessment is impossible from field studies (Michael Latham, an eminent nutritional scientist from Cornell University once told me that it was really the anthropologist who could address several key nutritional issues from extended field work); (3) too many simplifying assumptions were made (this is a key to modeling, but only at the outset); (4) it is impossible to account for all of the social issues (but, this is never even possible in sociocultural analyses); (5) it is inappropriate to apply the functional/adaptational paradigm borrowed from biology (this reflects the hostile views toward the biological sciences that many social scientists feel). *Adaptation* as a concept was criticized heavily where he expressed his view on "...the inadequacy of the concept of adaptation as applied to social behavior!" In brief, Burnham typified the views of many sociocultural anthropologists (despite his interests in human ecology) where a materialistic, adaptational, quantitative approach that draws on basic biological principles somehow sidesteps the fundamental bases of human culture and society.

CHANGES FROM THE 1980S TO 1990S

Ecological anthropology was popular within the anthropological community during the 1960s and early 1970s. This was also the period of the International Biological Programme and dramatic advances in ecosystems science, but these were largely separate events. In anthropology the ecological approach to understanding human social behavior soon began to fall out of favor, such that the late 1970s and 1980s were characterized by approaches that were antithetical to science. During the 20th century and into the 21st century there have been tensions within

anthropology linked to different traditions and approaches to inquiry. For sociocultural anthropology, the balance between scientific and humanistic approaches moved in favor of the humanistic in the late 1970s. "Critical anthropology," "deconstructionist," Marxist, and "postmodern" literary approaches began to find their way into anthropology theory. Applied studies, within the realm of economic development in the Third World, began to increase. At the same time, in the United States many graduate programs in anthropology moved away from what limited scientific and quantitative training that they had received in the past. Biological anthropology during the second half of the 20th century had been the most scientific of the subfields of anthropology. But because the traditions of research were growing apart, biological anthropologists and scientifically-oriented sociocultural anthropologists were becoming marginalized within the anthropological community. All of these events affected the application of ecological principles to the solution of anthropological problems during that period.

By the early 1990s, the position of human ecology within anthropology appeared to be moving in a positive direction. In a revised version of Emilio Moran's (1984) edited work on *The Ecosystem Concept in Anthropology* published by Moran in 1990, the introduction and papers that followed were forward looking and encouraging about ecological approaches to anthropology. Rappaport (1990), who contributed to this edition discussed the frequent shifts in theoretical perspectives that plague the field of anthropology:

"I both predict and encourage another swing of the pendulum. I predict revitalization of the ecosystem concept because it seems in accord with a general public's commonsense experience of a world beset by multiplying and interrelated environmental disorders, most of which it can attribute to humanity itself. I encourage this revitalization, with appropriate modifications, because the ecosystem concept itself is a vital element in the construction, maintenance and reconstruction of the webs of life upon which, by whatever name we call them, we are absolutely dependent." (Rappaport, 1990: 69)

The anthropological pendulum did appear to be swinging back, but with a series of different approaches than those in the 1960s when Rappaport's first research was conducted.

But before we deal with some of these newer ecological approaches in anthropology, let me discuss some of the theoretical issues that make it difficult for mainstream sociocultural anthropologists to accept ecological approaches within their field.

DIVISIVE ISSUES IN ANTHROPOLOGY (AND OTHER SOCIAL SCIENCES)

In 1968, Vayda and Rappaport stated that: "...a unified science of ecology has definite contributions to make towards the realization of anthropological goals and does not entail any appreciable sacrifice of traditional anthropological interests" (Vayda and Rappaport, 1968: 497). There are a number of reasons why this objective has been achieved only in small measure that relate to some fundamental traditions in anthropology.

Following the Second World War, as with many other sciences, there was an increasing specialization by subfield accompanied by a tension between sociocultural anthropology and biological anthropology. Part of the basis for this was that in the 19th century and early 20th century, physical anthropology was preoccupied with race studies and there were clear racist elements in many of these studies. This tension between "social" and "biological" intensified during the second half of the 20th century, when social scientists were concerned about "biological" and "genetic determinism" and other paradigms that placed heavy emphasis on human biological processes taking precedence over behavioral and social processes. A suspicion by social scientists of all biologically based paradigms arose on the one hand and was paralleled on the other by a need to defend fundamental social processes and theory on the other. This "biophobia" is by no means universal in the social side of anthropology, but it does play an important role in the acceptance of certain ideas.

Another tension that divides anthropology is the difference in approach between the scientists and the social humanist/historian (materialist interpretation vs. a symbolic/cultural interpretation). Beliefs that human social behavior is so complex that it can never be fully understood by conventional scientific approaches are quite common among anthropologists, and, in fact, limit attempts to systematically study human behavior.

Some time ago, postmodernism entered anthropology via literary theory with challenges against the fundamental value of systematically-gathered information, and even objective reality.

Within the social humanistic side of anthropology, there is a strong interest in "praxis" or *practice* or applied anthropology in reducing the effects of poverty in the Third World as well as in Western nations. Associated with these applications of anthropological knowledge is a kind of "anthropocentrism" (Rappaport, 1984: 387), which places the environmentalists and scientists who are concerned with the conservation of nature at odds with the social scientists, who see the world filled with poverty that has arisen in part because of differential knowledge and what is known as unequal power relationships. In this context, the social scientists are inclined to follow the idea of "putting people first," also the title of a successful collection of papers of development in the Third World (Cernea, 1991). This struggle between human needs and the need to maintain viable ecosystems is an exquisite conflict with an uncertain outcome (Newmark and Hough, 2000). It is an area of investigation where collaboration between natural and social scientists is urgent!

Another issue is an extraordinarily complex one: that of Garrett Hardin's "Tragedy of the Commons" (Hardin 1968). A great deal has been written about this issue, both within and outside of anthropology (Bollig and Schulte, 1999; Casimir and Rao, 1998; McCabe, 1990; McCay and Acheson, 1987). The fundamental objection that the anthropologists have against Hardin's basic premise is that it violates the concept of *human agency*; that is, the ability of humans to manage their own environments, and through cooperation, to avoid the tragedy of environmental exploitation that Hardin described. This belief in *human agency* is also linked to the unwillingness of many anthropologists to even entertain the idea that human behavior can be influenced by the circumstances of their environment.

An issue of the Social Science Research Council *Items & Issues* newsletter (Wissoker, 2000) was devoted to an article and commentaries on "advancing interdisciplinary research." In the lead-in to the collection, the editor noted: "...indeed, the idea of interdisciplinarity was practically born here..." What is significant about the contributions is that all of the commentary is by social scientists, and there is absolutely no

mention of health, disease, the environment, ecology, or any of the natural sciences in their schemes of interdisciplinarity! These social science approaches to human ecology, are what in anthropology was called "cultural ecology." This approach, with an ecological emphasis on sociocultural process within the context of current anthropological theory was reviewed 25 years ago by Orlove (1980) and more recently by P. Little (1999).

Despite the bleak picture I have painted of social science and of anthropology in the context of science and ecology, some good work has already been done, and I am hopeful that new programs of collaborative and multidisciplinary research can be initiated between ecologists and anthropologists. However, it should be emphasized again that it is probably impossible for a single anthropologist or a single ecologist to conduct a study of human ecology and reach meaningful conclusions. The tasks are too vast for single scientists working alone and the solution is, of course, to establish multidisciplinary projects. Some examples of earlier and ongoing research and prospective ecological studies can be discussed.

INTEGRATED STUDIES OF SINGLE POPULATIONS

Beginning in the early 1960s, at the time that the International Biological Programme (IBP) was being organized, a number of single-population integrated projects were begun. Most of the projects were identified as a part of the Human Adaptability component of the IBP and were initiated with the concern that these populations were endangered, and their extinction would mean the loss to science of populations that most closely resemble human populations during the greater part of our evolutionary past. Later projects in the same pattern of investigation were started in the 1970s, some under the Unesco Man and the Biosphere (MaB) program. Human biologists or biological anthropologists organized most of these projects, but some were integrated with social scientists playing key roles. There were several themes that these projects represented, including: *adaptation to the environment*, in its broadest sense; *microevolution*; *cultural and biobehavioral evolution*; *health, epidemiology, and culture change*; and *ecology and systems science* (Little et al., 1997).

Some of these major integrated and multidisciplinary projects are listed here. Adaptation to (1) arid environmental conditions and limited resources in Kalahari hunter-gatherers; (2) high-altitude hypoxia and cold in Andean Quechua; and (3) Arctic cold in circum-polar Siberian, Inuit, and Algonkian populations, were studies conducted within a framework of populations living under the stress of extreme environmental conditions. Microevolutionary studies were conducted of the genetics of the Amazonian Yanomama, Makiretare, Cayapo, and Xavante, the Andean Aymara, the Central American Garifuna, Solomon Islanders, and several populations of central African Pygmies. Language, genes, demography, culture, and phenotype, were used to explore ongoing evolutionary processes in these populations, and to reconstruct processes in the past. Attempts to reconstruct cultural and biobehavioral evolution of the paleolithic were made in the Kalahari and Pygmy studies. Health, epidemiology, and culture change were central issues in the Circumpolar, Tokelau Island Migrant, Samoan Migrant, and several other projects. Here the effects of modernization on native populations were a primary objective. Finally, although an interest in the influence of the environment on a population's behavior and biology was a common theme in all of these integrated projects, only a few had real interests in ecology and systems approaches (Little et al., 1991).

As already noted, Thomas (1976) carried out energy flow modeling on Andean Quechua farmer-herders. Later modeling focused on attempts to explain why some nutrient sources are important and why others are not. Gage (1986) applied optimal foraging theory to the slash and burn agriculture of the Samoans and identified that the net rate of energy production (NREP) was indeed a central guiding principle when Samoans considered production of their three primary crops: breadfruit, banana, and taro. Hett and O'Neill (1974) developed a carbon flow model for Aleuts that demonstrated a heavy dependence on marine organisms and the need to incorporate terrestrial and marine ecosystems in the analysis of Aleut food webs. Finally, systems ecology figured prominently in the Kenya Turkana research because that was a central approach taken, but also because ecologists and anthropologists worked closely together (Coughenour et al., 1985; Ellis and Swift, 1988; Little et al., 1990; Little and Leslie, 1999). The synthesis of this

work concluded that Turkana pastoralists were capable of surviving and flourishing in a dry and highly variable ecosystem by complex livestock management, mobility, opportunistic exploitation of resources, and adaptive social patterns of sharing – while at the same time, avoiding degradation of the ecosystem (Leslie et al., 1999)

CURRENT APPROACHES IN ECOLOGICAL ANTHROPOLOGY

There are a number of approaches to a *human ecology* that have been applied since the early 1980s. These represent the increasing specialization in anthropology, not only by the subfields that were described earlier on, but also by different theoretical approaches. Some approaches, parallel those taken in the field of ecology, but with time lags of several years.

Political Ecology

Political ecology is derived from *political economy*, in which there is concern with social inequalities and power relationships. It developed as a reaction to what some considered as an emphasis on ecological explanation for human social behavior to the neglect of political factors. The label has also been used in a Marxist context with the argument that “...an expanding capitalist economy is destructive to the environment.” (Vayda and Walters, 1999). In this latter context, the ideas are principally Marxist in origin, not anthropological. Some anthropologists have criticized the contemporary application of *political ecology* as moving toward too much emphasis on “political” and too little emphasis on “ecological” relationships (Vayda and Walters, 1999).

Evolutionary Ecology

Evolutionary ecology arose from MacArthur’s (MacArthur, 1960; MacArthur and Pianka, 1966) work in the 1960s that combined ideas from Darwinian evolution, ethology, population biology, and mathematical modeling. Much of the work deals with mathematical models of behavior within an adaptation framework. Anthropologists have been interested in this area of combined economic and ecological modeling of human behavior since the 1970s (Dyson-Hudson and Smith, 1978; Smith, 1979; Thomas

et al., 1979). Sometimes the research is identified as *behavioral ecology* (Borgerhoff Mulder and Sellen, 1994). Four areas of research that are germane to anthropology were identified: (1) foraging strategies; (2) mating systems and life-history strategies; (3) spatial organization and group formation; and (4) niche theory, population dynamics, and community structure (Smith, 1983). Much of the research to date has focused on optimal foraging among hunter-gatherers such as the Peruvian Amazonian Piro (Alvard, 1995), Ituri Pygmies (Bailey, 1991), Paraguayan Ache (Hill, 1988), Canadian Inujjuamiut (Smith, 1991), and Canadian Cree (Winterhalder, 1983). Other applications, such as optimal foraging of nomadic pastoralists have only been applied in a handful of cases (De Boer and Prins, 1989; Edwards et al., 1994). Borgerhoff Mulder and Sellen (1994: 225) identify the future of pastoralist studies as lying in “...a successful combination of quantitatively based studies and powerful modeling techniques,” especially in the application of optimality models. Anthropologists are particularly well-suited to this kind of detailed observational research, because of lengthy time requirements for field observation within the tradition of extended field work in anthropology.

Historical Ecology

Historical ecology is a relatively new approach in ecological anthropology that has been embraced by some archaeologists and ethnohistorians. Early works of interest to anthropologists were, among others, by William McNeill (1976) and Alfred Crosby (1972, 1986), historians who documented events linking human health and the environment in historical perspective. Based on a conference held at the New School of American Research in Santa Fe, New Mexico (Crumley, 1994), the field appears to be defined as a framework for studies of past ecosystems and their changes through time, with attempts to sort out the effects of anthropogenic and natural (non-anthropogenic) processes. Most practitioners of this approach are from ethnohistory and archaeology, and they build their theory on ideas from landscape ecology, geography, archaeology, history, and ethnohistory. This is an important application of ecology to anthropology, since losses in biodiversity during the present century can be placed in the context of earlier times

through studies of prehistory. This will be discussed below in the context of biodiversity.

Landscape Ecology

Landscape ecology, with its background in geography and geomorphology, has a particular appeal to sociocultural anthropologists because of their current interests in land use in the Third World (Coppolillo, 2000). Archaeologists, as noted, are also drawn to this framework (in the context of *historical ecology*) for research because of the anthropogenic transformations of the landscape that are a part of human prehistory and history (Balée, 1998).

Ecosystems Ecology

Ecosystems ecology became the dominant research paradigm of the International Biological Programme (IBP), but still, the incorporation of human populations was limited (Worthington, 1975; Collins and Weiner, 1977). One of the problems with the Human Adaptability Component of the IBP was a conflict that arose between sociocultural and biological anthropologists during the early planning of the IBP. Margaret Mead argued for a largely social approach to the Human Adaptability research, but was voted down at an ICSU General Assembly. She then pulled out her support for the program and the anthropological community followed suit (Weiner 1977). This then led to a dominance of the Human Adaptability research by human biologists and biological anthropologists. Later, two conferences were held in an attempt to coordinate some of the IBP biome research with human adaptability research projects, but with limited success (Little and Friedman, 1973; Jamison et al., 1976). There is still resistance among some biological scientists who have interests in ecosystems analysis to incorporate human biologists or social scientists in their research for some of the obvious reasons discussed above. However, more projects in the 1980s and 1990s, including those under the aegis of Unesco's Man and the Biosphere Programme, have successfully conducted collaborative ecosystems work on human populations (Boyden, 1992; Hladik et al., 1993, Little and Leslie, 1999; Lusigi, 1981). Collaborative efforts between ecologists, other natural scientists, and social scientists have been initiated in the urban LTER (Long Term Ecological Research) projects. The

Central Arizona-Phoenix LTER was co-directed by an archaeologist, and the program is dependent on social scientists to develop realistic models within an ecosystems framework (Collins et al., 2000; Redman, 2005).

Ecology of Health and Adaptability

Studies of the *ecology of health and adaptability* of non-Western populations provide a breadth of environmental and health conditions not usually experienced by Western peoples. It is therefore important to study traditional as well as industrial peoples to gain insights into the full spectrum of environmental influences on health. Ecological and biogeographical approaches and models are often useful in understanding health threats and risks. One model that has been useful employs the movement of people from one environment to another to test for effects of the new environment on health. An IBP project investigated the effects of movement of nearly 1000 Pacific Tokelauan Islanders to New Zealand after a disastrous hurricane struck their island in 1966. Baseline health data of Tokelauans collected in 1963 were compared with New Zealand Tokelauan health, and these migrants were found to have higher prevalences of obesity, type II diabetes, asthma, and hypertension than the native islanders (Prior et al., 1977; Fleming and Prior, 1981). Studies of migrant American Samoans to Hawaii demonstrated essentially the same effects of migration and modernization (Baker, 1984; Baker et al., 1986). The principal variables associated with declines in health have been identified as diet, activity, and levels of stress associated with a Western life style.

Ecology of Reproduction

The *Ecology of reproduction* is an area of interest that is central to human population ecology and bears on the ecological processes that influence human reproduction. Biological scientists have known for a long time that the environment, particularly the availability of resources, profoundly influences reproduction. The earliest interest in this area was by anthropological demographers, with training in biobehavioral sciences, who were willing to entertain the possibility that humans were subject to the same biological rules as other organisms (Ellison 1990). I recall the advice of my close

colleague in social anthropology, Neville Dyson-Hudson, who had a deep interest in livestock. During the planning of the Turkana research, we agreed that if we could identify environmental effects on the livestock, then we should look for similar effects in the human population. This was a radical view and would have been scorned by our sociocultural colleagues, but turned out to be a very productive way to generate hypotheses. It was particularly useful in Turkana studies of child growth, lactation and breastfeeding, maternal health, reproduction, and fertility (Gray, 1996; Little et al., 1992, 1993; Little and Leslie, 1999; Leslie and Fry, 1989; Leslie et al., 1996).

PRODUCTIVE DIRECTIONS FOR ECOLOGICAL RESEARCH IN ANTHROPOLOGY

I believe that the answer to the question posed in the title of an earlier talk on whether there is a future for ecological studies in anthropology is "yes," but probably still at the margins of anthropology, not in the mainstream. Carole Crumley (1998: ix-x), an archaeologist with interests in historical and landscape ecology, observed that the anthropological subdisciplines most closely allied with the sciences—archaeology, biological anthropology, and human ecology within sociocultural anthropology—have been marginalized in anthropology for much of the latter half of the 20th century. These are also the subdisciplines most closely allied with environmental sciences, and, hence, are more receptive to ecological approaches.

There are several areas of exploration within anthropology that would profit from ecological applications and multidisciplinary collaboration. These include studies of: *landscape ecology* within sociocultural anthropology, *historical ecology* within archaeology, *urban ecology and managed ecosystems*, within anthropology, broadly, and *biodiversity and global studies*, again, within anthropology, broadly.

Landscape Ecology within Sociocultural Anthropology

There is considerable interest in land use in the Third World by sociocultural anthropologists and other social scientists, particularly in the context of human population growth and increasing pressure on soil and land resources.

There are disagreements over whether pastoralists and cultivators contribute to desertification, and how cultivation of the land can be best managed in semi-arid or wet tropical lands. I recall an important observation that George Innis made in modeling slash-and-burn agriculture in the tropical rain forest more than 25 years ago. Innis (1973) reported that repeated use of tropical swidden plots, even with up to 40 years of fallow between each period of cultivation, would lead to depletion of several essential soil nutrients (potassium and soil organic matter), and that some of these nutrients required more than a hundred years for full recovery. What struck me was that conventional anthropological wisdom dictated that the indigenous pattern of eight years fallow was sufficient to maintain sustainability indefinitely. The value of this pattern of use was embedded in the anthropological literature, yet it was clearly false. In this case, so much could have been gained by collaboration.

Historical and Landscape Ecology within Archaeology

Historical ecology, as a new paradigm, has been embraced by archaeologists with materialist and environmental interests. Since the landscape and landscape transformation are central concerns, the ecological conditions of human history must be understood within the context of the cultural conditions for a comprehensive interpretation. Some consider it "...the most important current intellectual advance in the study of human and environmental relationships" (Balée, 1998: 2). I would moderate this statement a bit, but I agree that this approach does hold great promise for integrating archaeology, ecology, and history in interesting ways.

Anthropogenic landscape alteration in prehistoric times is well documented, especially in the New World before Columbus. Terrace, canal, and road construction in the Andes produced dramatic transformation of the landscape, and the lowland Amazon forest was modified by slash-and-burn cultivation and by raised fields. Raised-field cultivation was a widespread agricultural technique and used throughout the lowlands of Central and South America. A recent application of this kind of landscape archaeology is in the exploration of raised cultivation fields in the seasonally flooded areas of the Bolivian Llanos de Mojos (Erickson,

1995). Techniques used in the Llanos de Mojos work, in addition to archaeological methods, included agro-climatic modeling, ethnobotany, remote sensing, and experimental construction. Few people use these raised fields today in South America despite their effectiveness and the apparent sustainability of this indigenous pattern of cultivation.

Urban Ecology and Managed Ecosystems

One of the dominant trends in human populations over the past century has been the movement of people from rural to urban settings (Bogin, 1988). Rural-to-urban migration takes place largely because individuals perceive that cities are centers of economic opportunity and excitement. The process, whether within or between national boundaries, has contributed to remarkable urban growth and widespread conditions of congested living that are unprecedented in human history. The beginning of the 21st century was marked as the time in which more than 50 percent of the earth's population were living in cities. Migration from the countryside to the city dates back to the rise of cities in antiquity (McNeill, 1978), and has been one of the most common types of migration since that time. Indeed, until the last century, urban mortality rates were so high that most cities could not even maintain their sizes, much less grow, without substantial numbers of immigrants (McNeill, 1979).

The linkages between rural-to-urban migration, demography, epidemiology, and urban ecology are crucial ones if we are to understand this highly-modified urban ecosystem. The urban LTERs in Phoenix and Baltimore, as well as other urban studies around the world, can serve as test cases. If the topical mix is demography, epidemiology, and urban ecology, the disciplinary mix should certainly include the social, biomedical, and ecological sciences.

Biodiversity and Global Studies within Anthropology

Within the past two decades or more, ecologists have become increasingly aware of losses in numbers and kinds of organisms around the globe and in alterations in the biosphere (Raven, 1997; Solbrig et al., 1992; Wilson, 1988). At the same time, climatologists and other scientists tracing global trends have identified

disturbing patterns associated with anthropogenic effects on the planet (e.g., increased atmospheric CO₂ and pollution, progressive soil loss). Since anthropologists, particularly biological anthropologists, are more closely attuned to environmental effects on humans, they have been slow to become involved in exploration of biodiversity losses. Another limiting factor to the participation of anthropologists in assessing changes in the biosphere is the problem of spatial scale; that is, such large-scale, global problems are usually outside the scope of anthropological investigation.

One international program in which anthropologists and other social scientists might participate as members of multidisciplinary teams is *DIVERSITAS*, an international program of biodiversity research, consisting of 11 research components (Diversitas, 1996). The "Human Dimensions of Biodiversity" component of *DIVERSITAS* incorporates human-oriented disciplines within the general themes of the other components and is designed to contribute to an integrated approach to the study of losses in biodiversity. Most recently, the U.S. National Committee for the International Union of Biological Sciences (IUBS) prepared a document that defines how some social scientists and human biologists might contribute to *DIVERSITAS* efforts (Little et al., 2001). The U.S. National Committee for the International Union of Anthropological and Ethnological Sciences (IUAES) will also contribute to the definition of a U.S. Program in this area.

There are several essential areas in which anthropologists might contribute to these very important studies. First, there is the area of *human impacts on biodiversity*, which is certainly the central feature of biodiversity losses. The impacts of human populations in transforming the landscape, competing for habitats, contributing to pollution, and outright predation, are profound, indeed. Among many kinds of studies, it is here that archaeologists and ethnohistorians can document some of the long-term changes in biodiversity and how rates of loss have varied through time. Second, how has *human biodiversity* changed in the context of other species' losses? This is a vast area of exploration, but one that might draw human biologists into *DIVERSITAS* research. In a third area of exploration: how do *human perceptions of biodiversity* influence our abilities to respond to losses or to take action?

How does culture play a role in these responses? Finally, there are the *interactive dynamics between human diversity and the environment*, that is, the influences that losses in biodiversity will have on human health and well-being, including human social health (Hauser et al., 1994).

These are all problems for the future that may or may not be soluble, particularly since solutions depend *not only on technology but on human behavior*, as well. Such behavior is dependent on a complex mix of culture, politics, economics, health, psychological perception, and many other categories of variables. If these problems are soluble, it will only be through integrated and multidisciplinary investigations in which social scientists join forces with natural scientists in this challenging endeavor to preserve our biosphere, including the species, *Homo sapiens*.

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KEYWORDS History of Ecological Anthropology. Ecosystems. Multidisciplinary Studies

ABSTRACT Ecological interests in anthropology date back to the 1930s or earlier, but some work in anthropology is based on the natural history and population biology of Charles Darwin. Anthropology, as a science made up of diverse subfields, has selectively incorporated ecological principals and knowledge over the years. Incorporation of ecological ideas has been hampered by cyclic paradigm shifts in the dominant subfield of sociocultural anthropology. Other divisive issues that have prevented a unified science of human ecology in anthropology are: (1) tension between scientific and humanistic (and applied) anthropology, (2) a modest amount of biophobia in the social sciences, (3) an unwillingness to seek causal bases of behavior beyond human agency, (4) poor training in sciences outside of the social sciences, and (5) limited ability to attack problems by testing hypotheses and good scientific design. Despite these widespread problems in anthropology, there are many anthropologists who take scientific and materialistic approaches to problem solving and are receptive to ecological approaches in the social sciences and collaborative, multidisciplinary work. Some of this work is cited and prospects for a positive future in research are suggested.

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