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National Open University
School of Social Sciences

MANE-005
Environmental Anthropology

Block

1

INTRODUCTION TO ENVIRONMENTAL ANTHROPOLOGY

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BLOCK 1 INTRODUCTION TO ENVIRONMENTAL ANTHROPOLOGY

Introduction

Humans have a long history of interacting with their immediate environment that has resulted in shaping biological as well as cultural evolution to a large extent.Anthropology as a discipline, specializing in bio-cultural study of humans, right from its inception has taken keen interest in such interactions. The ancient Greeko-Roman philosophers as observers of human behaviour and values have hypothesized that environmental factors like climate and humidity, etc. determine human culture. Although strict environmental determinism has been rejected, environmental anthropologists have long focused on how humans adjust and adapt to their natural environment. Therefore, the question of the degree to which human action is conditioned by the environment and how human groups might be classified according to the ways in which they interact with their environment are some of the on-going anthropological concerns.

As a sub-branch of socio-cultural anthropology, environmental anthropology concentrates on basic scientific and academic research on the relationship between people and their environment and how culture mediates in this relationship. It can be the basis for understanding how past and present human populations contribute and respond to local and global environmental change. The relationship between humans and environment through the looking glass of culture can help understanding the major environmental problems that we confront today and their possible solutions.

In this Block, assuming that the learner has no prior knowledge of the subject of Environmental Anthropology, the Unit 1 tries to introduce a basic understanding of the subject, from introduction to environmental enthropology to its scientific inquiry, and ends upwith a brief history of its growth and development.The Unit 2 provides an introduction to the basic concepts used in ecology and environmental anthropology.The Unit 3 describes various environmental pressures which shape primate behaviour and evaluates different bio-cultural activities adopted as adaptive strategies by the humans.The Unit 4 discusses about environmental stress and how these stresses disturb homeostasis. Further, itprovides information about how the human population with its biological plasticity and cultural adaptability tries to minimise environmentalstress or increases its strain tolerance.

All the Units in this Block explore key concepts, theories and approaches in the study of human culture and social activity in relation to ecological systems and environment. This Block introduces the learners to Environmental Anthropology and focuses on developing an understanding of natural resources and community values. Emphasis is placed on cultural, social, economic and political linkages in natural resource use regimes. The Block also identifies some key areas where Anthropology can contribute to our understanding of human-environmental relations.

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UNIT 1 HISTORY AND DEVELOPMENT OF ENVIRONMENTAL ANTHROPOLOGY

Contents

Learning Objectives

By the end of this unit, you will be able to:

- gain understanding of the ecological relationships between humans and the environment;
- learn the aims and scope of ecological and environmental anthropology;
- know the key authors and theoretical perspectives in environmental anthropology;
- be familiar with the emergence and development of environmental anthropology; and
- discover how ecological and environmental anthropology is shaping new ways of thinking about current local, national and global environmental problems.

1.1 INTRODUCTION

Since its inception, the discipline of Anthropology has broadly dealt with "environmental" questions, including human perceptions of the natural world and the relationship between "Nature" and "Culture," as well as the ways human populations use culture as an adaptive strategy to cope up with their habitats and ecosystems. Late in the 19th century and early in the 20th studies of humans and their environment moved from the "environmental determinism" of the anthropogeographers, to the "environmental possibilism" of the ethnographers, and to the "cultural ecology" of Julian Steward (for detail see block 2, unit 1). More recently, "Environmental Anthropology" has grown as a specialisation within Anthropology, focusing broadly on the study of environmental issues, problems, and solutions from an anthropological perspective.Assuming that the

learner has no prior knowledge of the subject or Environmental Anthropology, the unit tries to build an understanding from the ground up introduction to ecological anthropology, to scientific inquiry, and endswith an overview of growth and development of Environmental Anthropology.

Ecology is the study of the interaction between living things and their environment. **Human ecology** is the study of the relationships and interactions among humans, their biology, their cultures, and their physical environments. Before going to know the meaning, definition and scope of Environmental Anthropology, it is important to first understand what Ecological Anthropology is historically and philosophically speaking, the roots of Western notions of the interrelations between man and environment are very old. Since the 1950s Anthropology has developed approaches to human-environment interactions and developed the concept Ecological Anthropology. Ecological Anthropology is the study of how people interact with their social and biophysical environments. Mostly we try to understand why people behave or think the way that they do. It represents the link between the sciences of ecology and human culture. The core ideas – human adaptation, ecosystems, and environmental change – are similar to those of traditional ecology, but the anthropological notion of culture is added as an additional level of complexity.

1.2 DEVELOPMENT OF ECOLOGICAL PERSPECTIVE IN ANTHROPOLOGY

Interest in the study between people and the environment around them has a long history in anthropology. Since the beginnings of the discipline in the 19th century, scholars have been concerned with the ways in which societies interact with their environment and utilise natural resources, as with the ways in which natural processes are conceptualised and classified (Rival, 1998). Much of this interest centered on the study of subsistence patterns by which populations adapted to particular biophysical conditions. Precisely for this, according to E. F. Moran (1996) environmental researchin Anthropology has been a part of the discipline from its very beginning. It is often referred to as the ecological approach in Anthropology. Ecological or environmental approach in Anthropology includes topics as diverse as Primate Ecology, Human Ecology, Ethno-ecology, Historical Ecology, Political Ecology, Ecofeminism, Environmentalism, Environmental Justice, Evolutionary ecology, Traditional Ecological Knowledge (TEK), Conservation, Environmental Risk, Liberation Ecology, and a number of other areas, many of them interdisciplinary in scope and methodology.

1.2.1 Defining Ecological Anthropology

Ecological Anthropology is broadly concerned with people's perceptions of and interactions with their physical and biological surroundings, and the various linkages between biological, cultural, and linguistic diversity. In Ecological Anthropology topics to be explored from simple to complex and general to specific which include subsistence strategies, the ecology of ethnic foodways, human alteration of the environment, traditional knowledge of wild plants, ethnobiological classification, natural resource sustainability, intellectual property rights among indigenous peoples, the Anthropology of tourism, environmental racism, and conservation policies in both simple and complex societies. It can involve skills like analyzing tape recordings of conversations to find out what

environmental themes are important to people, following people and recording their behaviour, or archeology. Ecological anthropology tries to explore the multilevel ways in which humans adjust to their surrounding by both biological and socio-cultural processes.

Salzman and Attwood (1996) defined Ecological Anthropology is a subfield of anthropology that deals with complex relationships between humans and their environment, or between nature and culture, over time and space. It investigates the ways that a population shapes its environment and may be shaped by it, and the subsequent manners in which these relations form the population's social, economic, and political life. In a general sense Seymour-Smith (1986) describe show Ecological Anthropology attempts to provide a materialist explanation of human society and culture as products of adaptation to given environmental conditions.According to Ellen (1982) Ecological Anthropology applies a systems approach to the study of the interrelationship between culture and environment. At the heart of contemporary ecological anthropology is an at the heart of contemporary ecological anthropology is an "understanding that proceeds from a notion of the mutualism of person and environment" (Ingold, 1992) and the reciprocity between nature and culture (Harvey, 1996). As such, ecological anthropology is itself closely related to human behavioural ecology and environmental anthropology (Stacy McGrath).

Activity

What is the difference between Ecology and Ecological Anthropology?

1.2.2 Environmental Determinism Vs. Cultural Determinism

There have been several attempts to structure and organize the area of man-environment relations in anthropology over roughly hundred from now. In the era before the turn of the century, when anthropology was evolving as a distinct discipline, anthropologists and geographers were concerned about the man-environment relationships.Development of basic conceptsin ecological anthropology was not as a smooth accumulation of information and insights, but as a series of stages.Every stage was a reaction to the previous one rather than merely an addition to it. "The first stage, is characterised by the work of Julian Steward and Leslie White, the second is termed neo-functionalism and neo-evolutionism, and the third one is called processual ecological anthropology.The attempts to address the similarities and differences of Steward and White mark the second stage of Ecological Anthropology. Boldly oversimplifying, one could argue that there are two main trends in this second stage: the neoevolutionists, who claimed that Steward and White were both correct, and the neofunctionalists, who argued that they were both wrong". (see Orlove, 1980).

During thue late 19th and early the 20th centuries a number of comprehensive treatment of environmental thinking in Anthropology and the environment vs culture controversy have been complied by socio-cultural anthropologists who have found that an ecological approach is fruitful both in research and teaching. The framework of these theoretical perspectives reviews has been provided by some contrasting major schools of thoughts or conceptual approaches, viz, environmental determinism, environmental possibilsm, functionalism, culture-area approaches, cultural ecology, racism, evolutionism, historicismand current approaches in ecological Anthropology including actor-based model, eco-system based model, ethno-ecology and systems-ecology model etc.

The above conceptual and theoretical perspectives you will learn in detail in the block 2, unit 1, 2, and 3.In this unit, I will briefly discuss development stages of basic theoretical Concepts in Ecological Anthropology and history of development of an environmental perspective in Anthropology.

The concept of cultural evolution and the series of ideas on the relationship between culture and environment were developed in early Greek view. This idea was widely accepted throughout the nineteenth century. In the twentieth century ecological anthropology has proposed, or drawn on, several useful and innovative theories. Smith, along with Thomas Malthus (1977), developed the ideas of competition in nature and in human affairs that later fed into contemporary ecological theories.

Ecological Anthropology was named as such during the 1960s, but it has many ancestors, including Daryll Forde, Alfred Kroeber, and, especially, Julian Steward. Columbia University can be identified as the birthplace of Ecological Anthropology. Early studies of humans and their environment moved from the "environmental determinism" of the anthropogeographers, to the "Environmental Possibilism" of the ethnographers, and to the "cultural ecology" of Julian Steward (Michael A. Little, 2007). The first major theory regarding the interaction between culture and environment, one that has been in circulation since the time of classical Greece, is Environmental Determinism (ED), or Environmentalism.In this concept the idea basically states that environment mechanically "dictates" how a culture adapts(for detail see block 2, unit 1).For example, the Polynesians must fish and live in grass huts because they live on tropical islands.

The general orientation of explanations of man-environment interrelations in the United States shifted towards what came to be called "possibilism"/ environmental possibilism (EP) in the late 1920s and the 1930s. In possibilism, the environment is seen as a limiting or enabling factor rather than a determining factor. Possibilism is really an interactive process between culture and the environment.Daryll Forde, Boas, Wissler and Kroeber are the believers of this thought (for detail see block 2, unit 1)The common features of the above themes ED and EP are that they conceptualised the interaction between the human and their environment as mainly unidirectional, rather than systematic. They emphasised stages rather than the process.

During the 1920s-30s the time was ripe for a reassessment of the prevalent views on the relation between man, culture, and environment; as well as the evolution of cultures. The inadequacy in explaining cultural diversity, however, remained an issue and in a search for a more precise understanding of the effect of the environment on cultures Steward (1955) developed a methodology called *Cultural Ecology*.Due to contact with noted geographer Carl Sauer, Steward's work in cultural ecology led him to examine the effect of environment on culture. In the 1950s-60s significant progress came from the development of what came to be known as "Cultural Ecology," engaged with the analysis of cultural adaptation to natural environments.He conducted pioneering field research on the interaction of a particular human society and its natural environment in the Western United States working with Shoshone, Paiute, and other Native Americans. He moved cultural ecology a step forward by rejecting the "fruitless assumption that culture comes from culture" (Steward, 1955). Steward searched for the adaptive responses of various cultures to similar environments (Orlove, 1980). He examined the

available resources and distribution in relation to the technology, economic arrangements, social organisation and demography of a certain place. As a result, he identified a 'culture core' consisting of the elements of a culture influenced by the environment, i.e. the features most closely related to subsistence activities and economic arrangements. Yet, cultural ecology could neither provide a model for explaining the origin and persistence of cultural features, nor for determining the extent of environmental influence in the evolution of specific cultures (Netting 1977; Orlove, 1980).

As a reaction, in the 1960s and 1970s new schools of thought were formed based on cultural determinism, i.e. the idea that culture influences the environment. One of those schools, *ethno-ecology*, describes the conceptual models that people have of their environment (see details in the block 2, unit 3). Researchers like Brent Berlin, Harold Conklin, Charles Frake, and others pioneered the development of ethno-ecology. It distinguished, for example, 'folk nature' or the perceptions that people have on nature, from 'real nature' on which these perceptions are based. The approach used classifications and shared its methods and underlying premises with cognitive Anthropology. In the end, however, neither environmental nor cultural determinism formed a satisfactory basis to describe human-environment relationships. Alternatively, instead of shaping or being shaped by environmental factors, human beings were understood to interact with their environments in mutually constructive ways (Milton, 1996).

1.2.3 The Ecosystem Approach, Human Ecology and Processual Human Ecology

Other approaches followed Cultural Ecology that expanded the scope of environmental research inAnthropology. In the 1960s and 1970s, the field became influenced by new concepts developed by anthropologists who largely structured their data based on ecological models. Roy A. Rappaport, and Andrew P. Vayda (1968), developed an ecosystem approach that treated human populations as one of a number of interacting species and physical components and transformed *Cultural Ecology* into *Ecological* A*nthropology.*While Steward tied culture with the environment, a new approach, called the "new ecology," tied culture with the emerging science of systems ecology (e.g.,Vayda and Rappaport, 1968). The *ecosystem approach*, brought into play by anthropologists like Rappaport (1968) and Vayda (1969), conceptualised human populations as participants in ecosystems. It was a first attempt to reconcile ecological sciences with functionalismin Anthropology. Research focused, amongst others, on the material outcomes of economic activities and the efficiency of subsistence systems. Yet, the approach was limited with its focus on 'units' and 'populations' rather than cultures and its preference for small-scale (Island) societies (Rappaport, 1969).They suggested that instead of studying how cultures are adapted to the environment, attention should be focused on the relationship of specific human population to specific ecosystem. In their view, human beings constitute simply another population among the many populations of plants and animals species that interact with each other with the non-living components (climate, soil, water etc) of their local ecosystem. Thus, the ecosystem rather that culture, constitutes the fundamental unit of analysis in their conceptual framework for human ecology. The analytic unit shifted from "culture" to the ecological population, which was seen as using culture as a means (the primary means) of adaptation to environments. It was argued that human cultures were not unique but formed

only one of the population units interacting "to form food webs, biotic communities, and ecosystems" (Vayda and Rappaport, 1968). A broader focus was presented by *Human Ecology* which was concerned with the ways human populations interact with their environment. Yet, even though it acknowledged the importance of knowledge, information, and people's understanding of the world (Ellen, 1982), the ecosystem approach excluded the unobservable components of culture.

In the mid 1970s, in contrast to Cultural Ecology, neo-evolutionism and neofunctionalism, another approach emerged: *Processual Ecological Anthropology*. The use of the term "process" refers to the importance of diachronic studies in Ecological Anthropology and to the need to examine mechanisms of change. However, the term "ProcessualEcological Anthropology" signifying current developments in the field does appear to be new. It focused on the processual relationship between the local population and their immediate environment conditioned by the intervention of external political, legal, and economic factors. Important research trends were, amongst others, the relation between demographic variables and production systems, the response of populations to environmental stress, and the formation and consolidation of adaptive strategies (Orlove, 1980). ProcessualEcological Anthropology examined shifts and changes in individual and group activities and focused on the mechanisms by which behaviour and external constraints influenced each other. It stimulated the importance of decision-making models in Ecological Anthropology.

Two additional theoretical and methodological frameworks were developed mainly in the 1980s and 1990s to try to render Ecological Anthropology more scientific. The Neomaterialist, Marvin Harris, developed the approach of Cultural Materialism. It is a practical, rather straightforward, functionalist approach to Anthropology with a focus on the specific hows and whys of culture.Marvin Harris vigorously pursued explicitly and systematically the development of cultural materialism as a research strategy to reveal and explain the ecological rationale underlying various aspects of culture. He divided the cultural system into three components infrastructure,structure, and superstructure. Harris argued that the infrastructure is most basic and most influential because it functions as the ultimate adaptive mechanism for the very survival and maintenance of individuals and society as a whole (see details in the block 2, unit 2).

Human behavioural or evolutionary ecology is the second innovative framework pioneered by Eric Alden Smith and Bruce Winterhalder. It shifts attention to individuals as the locus of adaptation with an emphasis on decision making in the use of natural resources ranked according to their relative costs and benefits (optimal foraging theory). This connects human ecology more directly with natural selection and other evolutionary theories. Both of these special frameworks, cultural materialism and human behavioural ecology, have been criticized as simplistic and reductionistic. Nevertheless, both have proven to have some validity and utility in advancing the anthropological understanding of human-environment interactions.

In the following years, anthropologist who had borrowed analytic concepts from other disciplines used them to critique then-prevailing understandings of human-environment relations, including the view that indigenous landuse systems were

inferior to modern scientific models. Numerous research experiences by ecological anthropologists demonstrated the intimate associations between local communities and their environments and the extensive knowledge generated through these associations. The insights acquired into such resource use systems contributed to undermining orthodoxy in natural sciences. Of particular importance was that they showed that these systems were not always destructive for the environment. This was critical for the late-modern move away from a dichotomised conception of *nature* and *culture* (Dove, 2001).

Previous research had been largely synchronic, examining a particular society as if it wereisolated, traditional, static, and timeless, and also as if the society had no lasting cumulative impact on its environment and the latter was static as well. Ecological anthropology diversified further in 1990s by adding research variously focused on historical, political, or spiritual aspects of human ecology and adaptation. William Balee, John Bennett, and Carole Crumley, among others, developed a diachronic approach to examining the interactions between the sociocultural and environmental systems over extended periods of time as they transformed one another within a regional landscape. Since the 1990s substantial diversification of approaches within ecological anthropology involves a growing emphasis on applied rather than basic research, although certainly the two are often interdependent. However, with the worsening ecocrisis and other factors, increasingly research has concentrated on identifying and solving practical environmental questions, problems, and issues. This is the arena of environmental anthropology per se. Researchers in this arena still pursue various approaches within Ecological Anthropology to investigate matters of survival, adaptation, and change with an emphasis on culture, communities, and fieldwork.

Activity

Explain how analytic unit shifted from culture to the ecological population?

1.3 DEVELOPMENT OF ENVIRONMENTALISM PERSPECTIVE IN ANTHROPOLOGY

Anthropology traditionally has strong links to the study of the environment through its focus on human interaction in environmental context. This basic connection is depicted by Milton, who says: 'If one accepts the anthropological cliche´ that culture is the mechanism through which human beings interact with (or, more controversially, adapt to) their environment (Ingold, 1992), then the whole field of cultural anthropology can be characterised as human ecology'.

Since the 1980s, anthropological research on environmental issues has been part of a broad public sphere that has witnessed a sharp increase in environmental concerns and activism throughout the world. That has, in turn, been accompanied by significant interrelational changes between humans and their environment, resulting from the use of new communication and biological technologies. Given the breadth and complexity of environmental issues, academic disciplinary boundaries are easily crossed and new sites of transdisciplinary research have emerged that combine natural and social-scientific approaches in unique ways. Anthropology, however, has specific contributions to make to the wider environmental research field (Paul Little, 1999).

1.3.1 Anthropological Engagement with Environmentalism

In common usage, the term environment is often used as a synonym for Nature (i.e. the biophysical or nonhuman environment), but this usage creates great conceptual confusion because the environment of a particular human group includes both cultural and biophysical elements. By extension, the organism/ environment dynamic, which is relational and perspectivist, is often incorrectly fused with the nature/cultured dualism, which is essentialist and substantive. The concept of environment as a research tool allows for the delimitation of a wide range of socio-natural units of analysis that transect the nature/culture division orthogonally (see Paul Little, 1999).

In this context, Paul Little and other anthropologists preferthe term environmentalism to an explicit, active concern with the relationship between human groups and their respective environments. Although "environmentalist" usually refersto political activists, the termcan reasonablyinclude persons and groups that are directly involved with understandingand/or mediating thisrelationship. Thus, anthropologists and other social scientistswho are involved in environmental research can be considered as representingthe environmental wing of their respective disciplines.

Current environmental research in Anthropology falls into two major areas that have distinct methodologies and objects of study. The first, called Ecological Anthropology, uses ecological methodologies to study the interrelations between human groups and their environment. The second, called Environmental Anthropology involve policy and value orientation, application,analytic unit, scale, and method to study environmentalism as a type of human action.

The sub field Environmental Anthropology holisticallyunderstands the importance of cultural perceptions when dealing with environmental issues. There are number of anthropologists who are concerned to engage with the discourse of environmentalism. Initially, let us consider Brosius' (1999) statement that environmentalism refers broadly to the field of 'discursive constructions of nature and human agency'. He makes the point that the study of environmentalism should encompass much more than an analysis of the different social movements involved and their various trajectories over time and space. As stated above, he feels that at the crux of environmentalism is the ongoing discourse about human beings and their place within nature. As a postmodernist thinker and an anthropologist, Brosius declares that the relevance of Anthropology in this field of investigation is due to its unique concentration upon the phenomenon of culture. He urges anthropologists to see environmentalism as a 'rich site of cultural production' (ibid:277) and stresses that 'a whole new discursive regime is emerging and giving shape to the relationships between and among natures, nations, movements, individuals, and institutions' (*ibid*).

Similarly, Milton depictsenvironmentalism as a trans-cultural discourse that, not being rooted in any specific culture, spans the local through to the global and now has become a specific cultural discourse existing within, although not bounded by, other cultural systems. Thus, environmentalism is perceived by her to transcend many traditional geographical and conceptual boundaries such as east/west, north/south, first world/third world and left/right. As Milton describes it, environmentalism incorporates 'all culturally defined environmental

responsibilities, whether they are innovative or conventional, radical or conservative'.Obviously, these responsibilities vary between cultural settings but, as Milton observes, they originate from the recognition that environmental problems are caused by human interaction with the environment. She feels that the key to a viable future lies in a better understanding of human activity (*ibid*:11). Furthermore, in her view environ-mental discourse does not merely articulate perceptions of the environment, it contributes to their formulation. In this way, the whole spectrum of thought is included in Milton's analysis because a pro-environmentalist stance is not required for discourse to be considered environmental (*ibid*:8). If we also take into account Brosius' description of environmentalism provided earlier, we see that anthropologists have begun to discern environmentalism as being expressed through a myriad of social and cultural relationships and situations. Milton explains this well when she writes:

"In this framework, social movements and political ideologies become specific cultural forms through which environmental responsibilities might be expressed and communicated. Instead of environmentalism being seen as a category of social movement or ideology, these forms of cultural expression become types of environmentalism". (*ibid*: 8).

Many environmental problems that have emerged from the multiplicity of interrelations between humans and their environments have been accompanied by a concomitant surge in environmentalisms, each with their respective environmentalists. The ethnographic analysis of and political involvement in these many environmentalisms on the part of anthropologists and other social scientists have generated, during the past two decades, a field of study in its own right.

In recent past there has been much discussion about the relevance of the discipline of Anthropology to the various emergent discourses on the environment. Kay Milton has made a number of important contributions to this area of anthropological investigation over recent years. In 1993 she edited a work, entitled *Environmentalism: The View from Anthropology*, which attempted to position anthropology more centrally with in the multi-disciplinary study of environmentalism (see Milton, 1993).Eeva Berglund is another anthropologist who wishes to establish Anthropology as a legitimate participant in the study of environmentalism. In her book, *Knowing Nature, Knowing Science: An Ethnography of Environmental Activism*, she explores the role of what she terms 'techno-science' in environmental discourse (see Berglund, 1998).

Brosius in his article in *Current Anthropology* (1999) provides an overview of the engagement by anthropologists in the field of environmentalism, which includes aspects of the past, present and future. He says the recent trend toward anthropological engagement with environmentalism was not at all inevitable. Rather, it is the result of a series of particular historical contingencies, both practical and theoretical. He addressed this by noting significant differences between 'the Ecological Anthropology of the 1960s and early 1970s and what some are calling the ''Environmental Anthropology'' of the present. Drawing its insights primarily from the field of ecology, the former is characterised by a persistent interest in localised adaptations to specific ecosystems and by an abiding scientism: to the extent that cultural or ideational factors enter into analyses of this sort, they are viewed primarily with respect to their adaptive significance.

The latter draws its insights from a range of sources: poststructuralist social and cultural theory, political economy, and recent explorations of transnationalism and globalisation, among others.

Brosius' (1999: 278) assertion that environmentalism refers broadly to the field of 'discursive constructions of nature and human agency'. He makes the point that the study of environmentalism should encompass much more than an analysis of the different social movements involved and their various trajectories over time and space. As stated above, he feels that at the crux of environmentalism is the ongoing discourse about human beings and their place within nature. As a postmodernist thinker and an anthropologist, Brosius declares that the relevance of Anthropology in this field of investigation is due to its unique concentration upon the phenomenon of culture. He urges anthropologists to see environmentalism as a 'rich site of cultural production' (*ibid*: 277) and stresses that 'a whole new discursive regime is emerging and giving shape to the relationships between and among natures, nations, movements, individuals, and institutions' (*ibid*).

In assessing what lies behind the rather striking growth in interest in environmentalism among anthropologists,Brosiuscites three factors. The first is simplythe more general trajectory of growth in environmentalscholarship across a wide range of disciplines, a processwhich accelerated in the late 1980s. Indeed, the past decadehas witnessed a remarkable florescence in environmental scholarship and the emergence or growth ofa host of new subdisciplines: environmental history, environmental ethics, environmental economics, environmentallaw, environmental security, and politicalecology, to name just a few. To the extent that anthropologistshave developed an interest in environmentalism,then, we are participating in a larger, transdisciplinaryprocess. One of the things that makes thecurrent moment so promising is the degree to whichscholars from a range of disciplines—geography, politicalscience, history, legal studies, science and technologystudies, media studies, and others—are engaged inprojects that converge on an interest in environmentalism.

This a period with great potential for buildingrich transdisciplinaryintersections, and many anthropologistsappear to be doing that. One might go so faras to claim that, in the study of environmentalism atleast, the boundaries between disciplines are eroding toa degree not seen before.

A second factor leading to the present anthropological interest in environmentalism is the simple fact that so many of us have witnessed the emergence (or arrival) of environmental movements at our field sites. According to Brosius, Fisher and Turner environmental NGOs have become highly visible players in the terrain that we once thought we could claim as our own—the rural/remote community. As this has occurred, we have seen local communities mobilise or adopt elements of transnational environmental discourse in ways we had not witnessed before (see Brosius, 1999).

A third element that has engendered an interest in environmentalism among anthropologists has been a series of recent theoretical trends both within our discipline and beyond. This is a rather complicated scenario, with a considerable degree of overlap between various areas of theoretical and empirical focus. Most notable, perhaps, has been the trend since the mid-1980s toward what Marcus

and Fischer refer to as ''the repatriation of anthropology as cultural critique'' (1986). Uncomfortable with the way we see otherness essentialised in indigenous rights campaigns, acculturative processes elided in an effort to stress the authenticity of indigenous peoples, and concepts such as ''wilderness'' deployed in environmentalist campaigns, we have taken it as our task to provide critical commentary (see Brosius, 1999).

The study of social movements with environmental concerns has expanded the notion of environmentalism in Anthropology to include not only explicitly environmentalist nongovernmental organisations (NGOs) in the northern hemisphere, but also a large number of movements in the industrializing nations of poor or marginalised peoples that are struggling with such environmentally based issues as control over and access to natural resources, encroachment on their lands and livelihood, and protests against environmentally destructive development projects. Martinez-Alier developed the concept of the environmentalism of the poor and it has been applied to India by Guha, who mentions situations that have ''pitted rich against poor: logging companies against hill villagers, dam builders against forest tribals, multinational corporations deploying trawlers against artisanal fisherfolk rowing country-boats (see Paul Little, 1999).

In the meantime, women's environmental movements tend to arise when gender is a determining factor in issues involving the division of labor, access to natural resources, and property relations in ways that are disadvantageous to women (Carney, 1996). In efforts to maintain existing rights or to resist new policies that seek to extinguish them, the emergence of women's resistance movements that are directly related to environmental issues has generated the new fields of feminist political ecology and ecofeminism.The ways in which these insights have been refracted into other concerns is an important part of the Anthropology engagement with environmentalism (see Paul Little, 1999).

According to Miller (1993) the complex domain of environmental rights refers to those cases where the claims and rights of peoples to territories, natural resources, knowledge systems, and even their bodies are being ignored or abused. The rights of ''indigenous or tribal peoplesto the lands and natural resources they have historically occupied and continue to use have been a central focus of anthropologists working with these groups. Anthropological research on various environmental rights issues has been ethnographically well documented by anthropologists.Studies of other environmental issues like biodiversity conservation, displacement, ecodevelopment, and planning are explored by anthropologists within the framework of the concept of resident peoples, which defines highly diverse societies in relation to their presence in protected areas that are taken for granted as an existing good.Importance in contributing anthropologists' interest in environmentalism has been the work of a series of writers interested in critical examinations of contemporary discourses of development. Anthropologists interventions and efforts to understand the phenomenon of globalisation and the forms of articulation between ''the local'' and globalizing processes of environmentalism have also been of significance in the field of Environmental Anthropology(see Paul Little, 1999).

Activity

What is environmentalism according to anthropologists?

1.3.2 Emergence and Development of Environmental Anthropology

Although the discipline of Anthropology has its origin in the study of small-scale societies, anthropologists began to consider human entities and their environments as located in complex social processes. Greater appreciation of the complexity of social and ecological systems developed alongside a growing interest in interpreting the dynamics of ecological systems in terms of the dynamics of larger political systems. Beyond the study of subsistence communities, scholars enlarged their frame of reference to encompass global structures and situated the cultures they studied within the broader international political economy. The changes in Ecological Anthropology reflect a more general shift in anthropological research drawing attention towards the intersection of global, national, regional and local systems. New approaches emerged mainly in the 1990s concerned with the impact of markets, social inequalities, and political conflicts to analyse forms of social and cultural disintegration associated with the incorporation of local communities into a modern world system (Paulson et al., 2005). It became a challenge for anthropology to study local environmental and social changes associated with global trends. Thereby, anthropologists have shown an extensive interest in questions of nationalism and identity, of focusing on the hybrid relationships between local integration and global politics, places-in-between, and on what has come to be termed modernity (Lovell, 1999). While looking at the mutual processes of definition and appropriation that take place between what has been termed local and global settings, conceptual, spatial, and cultural scales expanded in academic discourse.

A major difficulty in analysing the complexity of human-nature relationship is that no single social theory of environmental phenomena in human experience has been developed, just as there is a lack of methods and basic categories to study them (Arizpe et al., 1996). Finding an appropriate methodology to shed light on amalgamations between nature and culture is the prime challenge in cross-cultural investigation. The understanding of how nature is constructed and resource management is conceived in different cultural settings is not an easy task, for the questions raised and the answers sought lie along the margins of several disciplines. Referring to recent theoretical trends, Brosius writes of a rather complicated scenario that is informed by a considerable degree of overlap between various areas of theoretical and empirical focus (1999). To address both the dynamics of culture and natural resources requires not only transcending disciplinary lines but also that natural and social sciences be brought together. The result, it has been suggested by Nakashima (1998), may be compared to a labyrinth through which one must navigate with caution. This challenge has been taken up by a number of anthropologists with different scopes and research traditions. Out of the multi-layered engagement an *environmental anthropology* emerged (see Townsend, 2000; Haenn and Wilk, 2006). While the Ecological Anthropology of the 1960s and 1970s was characterised by an interest in localised adaptations to specific ecosystems and by an ethnoscientific gaze, contemporary environmental anthropology is more attentive to issues of power and inequality, the contingency of cultural and historical formations, the significance of regimes of knowledge production, and the acceleration of translocal processes (Brosius, 1999).The primary approaches within contemporary Ecological Anthropology are cultural ecology, historical ecology, political ecology, and spiritual ecology. Environmental anthropology builds on the above past experience of

anthropologists work. Environmental anthropology blends theory and analysis with political awareness and policy concerns. Accordingly, new subfields have emerged, such as applied ecological anthropology and political ecology (Greenberg and Park, 1994).

As it is threaded through all subfields of the discipline, environmental anthropology combines a multitude of prevailing perspectives and conceptual approaches in multi-sited contexts. Focusing on the interactions of local and global patterns of resource management, a growing body of contributions has appeared examining the dynamic linkages of human societies with their natural environments. The implication of pluralist genres of research involves a wide range of orientations in the emergence of new disciplinary factions. The scale ranges from site-specific studies focused on local economies to perspectives aimed at questions of global scope. At the same time, accounts on environmentalism itself (Argyrou, 2005) and environmental bureaucracies and agencies (Little, 1995) appeared as objects of recent study.

Environmental Anthropology, as you will learn, is a general term that can be applied to many ways of studying humans as integral components of the environment. Environmental Anthropology may be viewed as the study of applied action and/or advocacy research to address practical environmental questions, problems, and concerns. Often, new policy is the outcome of such applied action or research. In most cases, such study centers upon the dynamic interaction between human beings and their ecosystems or natural environments. Although Environmental Anthropology only emerged in the 1980s, it has flourished since the 1990s.

1.3.3 Definition and Scope of Environmental Anthropology

Environmental Anthropology is a more recent outgrowth of Ecological Anthropology, which can be characterised as the study of the interrelationship between human groups, cultures, and societies and the ecosystems in which they are embedded in all times and all places across planet earth. Scholars have delineated Environmental Anthropology as becoming more prominent in the 1980s and typically focusing on analysis and application of anthropological knowledge to contemporary environmental issues. Ecological and Environmental anthropology can most productively be viewed as a single interrelated discipline, with Ecological Anthropology focusing more on basic academic research and Environmental Anthropology being more focused on contemporary environmental issues and having more of an applied, practicing, critical, and/or advocacy approach.

According to Peter Brosius (1999) Environmental Anthropology provides a broad disciplinary framework.He describes Environmental Anthropology as investigating discourse, power, knowledge, resistance, development, cultural studies, and political ecology through transdisciplinary work, and he identifies three major current trends: a critique of essentialised images, an emphasis on contestation and consideration of stakeholders, and an interest in globalisation.

Environment anthropology studies the way communities and social groups identify and solve environmental problems by examining culturally diverse perceptions, values and behaviours. Environmental anthropology contributes to policy formulation and planning by improving and facilitating the communication

process among diverse stakeholder groups. Environmental Anthropology helps bridge the gaps between scientists, resource managers and resource users and the public (Society for Applied Anthropology, 2002).

Kottak (1999) describe Environmental Anthropology is a new approach linking global to local systems, blends theoretical and applied research, focuses on political aspects, and recognizes culture as mediating in ecological processes rather than as merely an adaptive tool.In Environmental Anthropology, everything is on a larger scale. The focus is no longer mainly the local ecosystem. The "outsiders" who impinge on local and regional ecosystems become key players in the analysis, as contact with external agents and agencies (for example, migrants, refugees, warriors, tourists, developers) has become commonplace. Concerned with proposing and evaluating policy, Environmental Anthropology attempts not only to understand but also to devise culturally informed and appropriate solutions to such problems and issues as environmental degradation, environmental racism, and the role of the media, NGOs, and various kinds of hazards in triggering ecological awareness, action, and sustainability. Environmental anthropologists focus on new units of analysis—national and international, in addition to the local and regional, as these levels vary and link in time and space. Entering into a dialogue with schools of natural resources and the environment, anthropology's comparative perspective adds an international dimension to the understanding of issues like environmental justice and ecosystems management, which natural resource specialists have been studying for decades.

Environmental Anthropology increasingly contributing research of broader relevance to the local, national, international, and global communities in coping with natural resources, hazards, and other environmental problems and issues. In various ways anthropologists have addressed pivotal environmental issues including the population explosion, natural resource depletion such as soil erosion, unsustainable economic development and consumption levels, habitat destruction like deforestation, biodiversity loss, environmental mismanagement, pollution, hazards, environmental problems, conflict zones, climate change and environmental justice. Environmental anthropology have developed the foundation, maturity, momentum, and achievements to continue to contribute to our understanding and advancement of human ecology and adaptation from the local to the global levels as long as humanity has a future.

Increasing interest in environmentalism in recent years has shaped anthropology's role in analyzing these efforts. Brosius (1999) believes the goal is not simply to understand human impact on the environment, but also to investigate how the environment is constructed, represented, and contested, recognizing the power of discourse in creating reality, especially in the perpetuation of structures of domination. He discusses the recent growth of environmental NGOs, national agencies, and transnational institutions concerned with the environment as well as the resulting theoretical trends in Anthropology that critique environmental movements, rhetoric, and representations of indigenous people. He also describes eco-politics, community-based conservation, and environmental racism as other current topics of interest in environmental anthropology.

As Thin (1996) writes, Environmental Anthropology enhances the understanding not only of natural resources, human needs and uses of those resources, but also

of the spatial arrangements by which resources are appropriated and managed. Cross-cultural comparison based on evidence from long-term studies of such locally adapted arrangements may promote better global understanding of the conditions under which resource management remains sustainable or else results in deterioration. Multidisciplinary research teams incorporating high tech resources such as geographical information systems, remote sensing, and satellite data imaging etc.

Activity

What is environmental anthropology and how did it emerge?

1.4 SUMMARY

Anthropology has a long history of exploring many facets of human-environment interaction. Since the beginnings of the discipline in the 19th century and early in the 20th century, scholars have been concerned with the ways in which societies interact with their environment and utilise natural resources, as with the ways in which natural processes are conceptualised and classified. Since, the 1950s and 60s Anthropology has developed approaches to human-environment interactions in Ecological Anthropology. Ecological Anthropology is the study of how people interact with their social and biophysical environments.

Ecological Anthropology was named as such during the 1960s, but it has many ancestors, including Daryll Forde, Alfred Kroeber, and, especially, Julian Steward. Columbia University can be identified as the birthplace of Ecological Anthropology. Early studies of humans and their environment moved from the "Environmental Determinism" of the anthropogeographers, to the "environmental possibilism" of the ethnographers, and to the "Cultural Ecology" of Julian Steward (Michael A. Little, 2009). Steward's cultural ecology influenced the ecological anthropology of Roy Rappaport and Andrew P.Vayda, but the analytic unit shifted from "culture" to the ecological population, which was seen as using culture as a means (the primary means) of adaptation to environments.

The Ecological Anthropology of the 1960s and 70swas known for its functionalism, and systems theory.The studies in the in Ecological Anthropology pointed out that natives did a reasonable job of managing their resources and preserving their ecosystems but those studies, relying on the norm of cultural relativism, generally aimed at being value-neutral. Anthropologists examined the role of cultural practices and beliefs in enabling human populations to optimize their adaptations to their environments and in maintaining undegraded local and regional ecosystems.

By contrast, the new ecological, or environmental, Anthropology blends theory and analysis with political awareness and policy concerns. Accordingly, new subfields have emerged, such as applied Ecological Anthropology and Political ecology (Greenberg and Park,1994).

Environmental Anthropology is a more recent outgrowth of Ecological Anthropology, which can be characterised as the study of the interrelationship between human groups, cultures, and societies and the ecosystems in which they are embedded in all times and all places across planet earth. Scholars have

delineated Environmental Anthropology as becoming more prominent in the 1980s and typically focusing on analysis and application of anthropological knowledge to contemporary environmental issues. Ecological and Environmental Anthropology can most productively be viewed as a single interrelated discipline, with Ecological Anthropology focusing more on basic academic research and Environmental Anthropology being more focused on contemporary environmental issues, problems and having more of an applied, practicing, critical, and/or advocacy approach.

Environmental Anthropology increasingly contributing research of broader relevance to the local, national, international, and global communities in coping with natural resources, hazards, and other environmental problems and issues. In various ways anthropologists have addressed pivotal environmental issues including the population explosion, natural resource depletion such as soil erosion, unsustainable economic development and consumption levels, habitat destruction like deforestation, biodiversity loss, environmental mismanagement, pollution, hazards, environmental problems, conflict zones, and climate change. Environmental Anthropology have developed the foundation, maturity, momentum, and achievements to continue to contribute to our understanding and advancement of human ecology and adaptation from the local to the global levels as long as humanity has a future.

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Sample Questions

1) Distinguish between Ecological and Environmental anthropology?
2) Describe briefly about theoretical perspectives and current approaches in Ecological Anthropology?
3) Define EnvironmentalAnthropology and its scope?
4) Discussthe aspects of anthropological engagements with environmental discourse?
5) How did environmental anthropology emergence explain?

UNIT 2 BASIC CONCEPTS OF ECOLOGY

Contents

Learning Objectives

After reading this unit, you will understand:

- the difference between environment and ecology;
- how does ecosystem develop;
- how community and population understand environmental anthropology;
- the habitat and ecological niche;
- homeostasis of the ecosystem; and
- the ecological succession.

2.1 INTRODUCTION

Understanding ecology is very important to the understanding of man's future. It provides the basis for considerable utilisation of natural resources facilitating in the conservation of habitats and species, and also for the prediction on reflection of man's activities on natural environment. This clearly explains that ecology is concerned with relationships between living organisms: plants, animals, microorganisms and their environment. Ecologists study the way in which organisms, populations, communities and ecosystems function and in doing so encompass many other areas of knowledge.

2.2 WHAT IS ENVIRONMENT AND ECOLOGY?

Before going to know the other fundamental concepts, it is important to first understand the meaning of terms 'Ecology and Environment'. The term ecology or "oekologie" formed by two Greek words *oikos* and *logos* which mean "study of household" was coined by the German Biologist Ernst Haeckel (1866). Ecology in most simple term refers to the branch of science that studies the interactions between organisms and their environment. What is this interaction? It is with

habitat, climate, geology and other aspects of its surroundings. The environment of an organism includes both its physical habitat, which is described as the sum total of all local factors like climate and geology, as well as other organisms which share its habitat. To follow ecology it is imperative to understand the fundamental concepts of biological ecology that the basis of its foundation. The branch of social sciences which is concerned with the study of relationships between human groups and their physical and social environments is referred to as Human Ecology.

Ecology in the most common sense symbolises the dynamic interrelation of the community with its total environment. Adjustments required for successful existence in a particular habitat are adaptations. The term 'Ecology' which has its root in the Greek word, came into use in the latter part of 19th century in the works of biologists to describe the study the ways in which organisms live in. their environments. Haekel coined our modern understanding of ecology in 1870, defining it as "the study of the economy, of the household, of animal organisms. This includes the relationships of animals with the inorganic and organic environments, above all the beneficial and inimical relations Darwin referred to as the conditions for the "struggle of existence" (Netting, 1977). Therefore, an ecosystem concept consists of organisms acting in a bounded environment. Whereas the term 'environment' is derived from the French words 'environ' or environner' meaning 'around', 'round about', 'to surround', "to encompass". In the dictionary sense, 'environment' is the total of things or circumstances around an organism, which include its nature. What do we understand by the environment? Broadly speaking, environment with seamless expanse comprises of surroundings within which the population under consideration functions. Environment in simple terms is multifaceted set of physical, chemical, biological and social factors where a living organism or community exits. Environment plays a significant role in influencing the growth and outlook of people living in it. It also includes the built-in world of human creation to fulfill our need.

Environment is the setting for, or surrounding of all human interactions in society. Environment, according to United Nations (1978) consists of natural and man-made resources available at a given time for the satisfaction of human needs. It is the totality of all external conditions and influences, both natural and cultural influencing the life and development of human beings at any point in time on the earth surface (Olorunfemi & Ajibade, 2000).

Abiotic and biotic form the two primary components of environment in ecosystem. Environment and ecosystem though are at times used interchangeably but are not the same. Environment is the surrounding in which a person lives whereas ecosystem can be compared to a community, functioning with an environment building one big unit. Environment is total surrounding of an organism but that necessarily does not mean any ecological relationship between the members while ecosystem is a definite ecological unit comprising of living and non-living components that functions together as a system.

The abiotic component is the inorganic materials present in the environment i.e. oxygen, nitrogen, sodium, carbon, as well as water and carbon dioxide alongside the physical factors like weather, climate, temperature, radiation, light, geological materials, geography, time, solar radiation and even the cosmos. What are the biotic components? They consist of all materials that are biological in origin:

plants, animals, and microbes, either living or dead. Let's take tree as an example to understand these components; it forms part of the biotic environment, even when dead, fallen or decomposed. Ultimately, when the tree is broken down into its inorganic constituents, it enters the abiotic environment. Any variation in one ecological or environmental factor can simultaneously reflect the dynamic state of the whole ecosystem.

Environment has varied definition based on any number of reasons and operational definitions. Environment too has different conceptual meanings like ecology and to many these expressions also overlap with the concept of nature. Distinguished on the basis of scale, two basic divisions of the biotic environment are biomes and ecozones. Biome is a widened region which is characterised by similar temperature, rainfall, and biology. Anthropologists use this concept as a general descriptive category and as an initial stage for classification and analysis. Whereas ecozone or environmental zone, is a geographic area distinguished by definite biotic communities. Dominant plant communities define the ecozones generally since it is easier to recognize and map them than animals. "Pine belt," is a typical example of ecozones.

An **ecotone** is the geographic intersection of as well as the transition between ecozones. Since ecozone boundaries may also be biome boundaries, ecotones exist between biomes as well. For example ecotone include estuaries (places where freshwater meets saltwater, such as where a river empties into the ocean), shorelines, and areas where forests and grasslands meet. An ecotone is usually a more productive place than either of the individual ecozones because species of both zones intermingle within it. Even in cases where there is less diversity, an ecotone is a good place for an organism to be located as access to both ecozones is easier. This same concept could be applied directly to cultural systems, where the border between two cultures would form a cultural ecotone. This might create a more "culturally productive" place, where ideas and goods could intermingle. Examples of such places would be trading centers, ports, and centers of learning (Mark Q. Sutton and E. N. Anderson, 2010).

Most biomes and ecozones are defined based on the current distribution of plants and animals. Researchers studying past environments also use the ecozone concept but define an ecozone based on past biotic distributions. Occasionally, a remnant of a past biome or ecozone will survive into the present as sort of a living fossil. These areas, and the life within them, are called **refugia** and can be quite valuable in the study of past environments. For example, a number of desert regions once contained different vegetation. If a small pine forest was found on top of a mountain now within a desert, the forest may be a surviving remnant of a larger forest that once covered the area. This refugium could provide clues to the past plant and animal life within the region and provide a starting point for the reconstruction of the ecozone at that time (Mark Q. Sutton and E. N. Anderson, 2010)

2.3 ECOSYSTEM DEVELOPMENT

Ecosystem is noticeably a geographically restricted system where a particular group of organisms interact with both the components of the environment, abiotic and biotic. The magnitude of ecosystems is dependent on how and why it is defined. Presently biosphere occupies the position of largest ecosystem.

It goes to the credit of Odum (1953) who formalised the concept of the ecosystem, and Golley (1993) with the history of the idea. Ecosystems essentially have conceptual component, therefore are defined on context of reference. Say if you are studying tundra region you would define it as an ecosystem and would find it inhabited by a different sort of plants; which would form a community related to one another in an overall symbiotic relationship. Similar would be situation for various species, how they are related to one another, their population cycles, and so on. However, it must be clearly understood that tundra or for that matter any other ecosystem is linked to other things as well, thus being a part of a larger system.

Ecology spans a broad spectrum of interacting levels of organisation right from micro-level (e.g., cells) to planetary scale (e.g., ecosphere) phenomena. Another significant aspect – the time span is undefined in an ecosystem; it can take thousands of years for ecological processes to mature through and until the final successional stages of a forest. The area of an ecosystem can be from very small to very big. While classifying a forest ecosystem a single tree holds no importance but then it is of vital importance to the smaller organisms living in and on it. The nature of associations in ecological communities cannot be elucidated by only having knowing particulars of each species in isolation. This holds significance because the developing pattern is neither discovered nor envisaged unless the ecosystem is studied in totality.

Thus, we realise that ecosystems are defined at a variety of scales for different rationale, but are eventually connected to one another. This creates the division of ecosystems rather random. Interestingly, islands can be designated as "more separate" ecosystem serving as better laboratories to study ecological interaction.

What could be the origin of ecology is quite complex since its interdisciplinary nature has resulted in its multifaceted origin. It is unambiguous that Ancient Greek Philosophers especially Hippocrates and Aristotle were amongst the first ones to have recorded observations on natural history. Interestingly the ancient Greek theorist are of belief that life is an unchanging element, in such a situation there is no question of adaptation which primarily is the basis of contemporary ecological theory.

In 1700s, with the published works of microscopist Antoni van Leeuwenhoek and botanist Richard Bradley, modern concepts such as food chains, population regulation and productivity were developed. Biogeographer Alexander von Humbolt was also one among the early ecological thinkers and was pioneer in recognizing ecological gradients. Ecology was an analytical form of natural history evaluating the interaction of organisms with both their environment and their community, during the early 20th century. Natural historians, including James Hutton and Jean-Baptiste Lamarck, laid the foundation for noteworthy works that placed the foundations of the modern ecological sciences.

The term "ecology" was first coined by the German biologist Ernst Haeckel in his book *Generelle Morphologie der Organismen* (1866). Haeckel was not only a zoologist, but was also an artist, writer, and later in life a professor of comparative anatomy. There has been differing opinions about the founder of modern ecological theory. Some perceived Haeckel's definition as the beginning of modern ecological theory, while others marked that it was Eugenius Warming

from the writing of *Oecology of Plants: An Introduction to the Study of Plant Communities (*1895). Carl Linnaeus' research principals on the economy of nature that matured in the early 18th century may also be noted as the beginning. His works influenced Darwin and in *The Origin of Species* he adopted the usage of Linnaeus' phrase on the *economy or polity of nature*. Linnaeus was the first to frame the balance of Nature to be a testable hypothesis. While Charles Darwin is known for his theories on evolution, he is also credited as one of the founders of soil ecology. In his book *The Origin of Species* Darwin also made note of the first ecological experiment. With the gaining popularity of the theories of evolution, there was scientific paradigm changed in the way researchers approached the ecological sciences.

The modern synthesis of ecology first fascinated considerable formal concern towards the end of the 19th century and became even more popular during the 1960s environmental movement, though many observations, interpretations and discoveries relating to ecology go back to much earlier studies in Natural History.

Aristotle is designated as one of the earliest naturalists who had a prominent role in the philosophical development of ecological sciences. Aristotle and his student, Theophrastus made extensive observations on animal and plant biogeography, migrations, physiology, and their habits what could be similar to the modern ecological niche. Greek philosopher, Hippocrates, has also been recognized with reference to ecological studies in its initial developments.

The first ecological text, *Natural History of Selborne* was suggested to be published in 1789, by Gilbert White. In 1905, the first American ecology book was published by Frederic Clements. His book promoted the idea of plant communities as a super organism, which sprung a debate between ecological holism and individualism that lasted until the 1970s. The Clements super organism concept argued that ecosystems progress through regular and determined stages of serial development that are similar to developmental stages of an organism whose parts function to maintain the integrity of the whole. The Clement concept was challenged by Henry Gleason who reasoned that ecological communities develop from the unique and coincidental association of individual organisms. This conceptual shift placed the focus back onto the life histories of individual organisms and how it relates to the development of community associations.

The notion of food chains was initiated by Charles Elton in his classical book *"Animal Ecology"*. Elton defined ecological relations using concepts of food chains, food size, food cycles, and described numerical relations among various functional groups and their relative abundance. Elton's 'food cycle' was substituted subsequently in ecological text by 'food web'.

It is realised that eecology has spread its wings globally, but the inputs to ecology from other cultures are hindered by language and translation hurdles.

2.4 COMMUNITY AND POPULATION

As we just read earlier that Ecology is the study of the interaction between living things and their environment; and the relationships and interactions among humans- their both aspects biological and cultural, and the physical environments conceptualise human ecology.

Human ecology is thus a study of total ecosystem with a stance specifically from the viewpoint of human factor within the entire system. Humans are found in any habitat be it cold tundra region or hot equatorial belt, consequently qualifies human populations to be polytypic both in the characteristic of the population and their ecological relationship.

It is imperative to study the complex relationship between man and the physical setting in which they live to understand the environment. Man has made immense contributions to environment. What we witness today are results of our scientific and development strategies. Human-made Environment is the environment which has been created by human himself to fulfill his needs and to make his life more convenient and easy. There are many issues related to man made environment. The consequence of poor environment directly affects the habitat resulting in the formation of slums, heap of garbage, congested roads etc. The environment also has pollution component in it. Air pollution, water pollution, noise pollution and all other pollution do have an impact on human beings.

There are number of sources of energy which has an impact on the environment. Solar, wind, hydro and tidal energy- the non- conventional methods of energy sources are environment friendly whereas thermal power stations and nuclear energy have negative environmental impact.

2.5 HABITAT AND ECOLOGICAL NICHE

The geographic setting where a species lives and functions is called its habitat. Niche and habitat have a close relationship and are dependent on each other. Let us take an example: some species of primates eat only fruit, while others only leaves, and still others eat just about anything. Now all three species of primates probably coexist in the same habitat yet occupying three different niches. In a forest, on the same tree two different species may occupy different habitats, one may live in the canopy while others live on the ground.

There have been many definitions of niche since 1917 but G. Evelyn Hutchinson made conceptual developments in 1957 with the presentation of the most extensively accepted definition, "which a species is able to persist and maintain stable population sizes." In the ecology of organisms, ecological niche is a central concept and has been sub-divided into fundamental and realised niche. Fundamental niche denotes the set of environmental conditions under which a species is capable of persisting; where as realised niche signifies the set of environmental plus ecological settings under which a species persists.

Each species have explicit functional traits that are entirely adapted to particular ecological niche. Trait stimuli performance of an organism and is an assessable property, phenotype, or characteristic. In the development and expression of traits, it is the gene which plays a vital role. The appreciation of a species traits and niche necessities are essential in elucidating or foreseeing the bio-geographical patterns and range distributions. Occupant species develop their traits that are tailored to their resident environment, which gives them a competitive advantage and discourages comparable species adaptation from taking an overlapping geographic range. This competitive exclusion principle proposes that two species cannot coexist indefinitely by living off the same restrictive resource. Closer examination into equally adapted species, found to overlap geographically

divulges elusive ecological differences in their habitat or dietary requirements. The ecotope which combines both habitat and the niche is a complete range of environmental and biological variables having an impact on entire species.

Niche is defined by the species activity, what it eats and by how it reproduces whereas habitat is the geographic location of a species in which it lives and operates. Habitat and niche are interrelated and dependent to some extent on each other since the nature of habitat will influence the probable niches there.

Ecosystems contain numerous niches. Even though several organisms may be competing to occupy a niche, it is specific and can be engaged by only one organism in the same geographic place, which would serve as habitat to a large number of species in diverse niches. The same niche may be inhabited by different organisms in different geographically isolated habitats.

What is Niche construction? It has been defined as the process and concept of ecosystem engineering. Ecosystem engineers are defined as "...organisms that directly or indirectly modulate the availability of resources to other species, by causing physical state changes in biotic or abiotic materials. In so doing they modify, maintain and create habitats." Organisms are modifiers of their habitats, though they are also subject to environmental pressures.

The terms niche construction is usually used in reference to the mechanism of natural selection imparting forces on the abiotic niche. Ecosystem engineering concept has motivated a new approval for the degree of influence organisms encompassing on the ecosystem and evolutionary process.

Niches come into reality and go out as systems change. In a young forest, the niche of a high-canopy leaf eater does not occur, so it would not work as habitat to the animal. But as the forest develops, habitat apt for high-canopy leaf eater comes into being, and then the niche survives, which may lead to their movement and settlement into the niche in the new habitat or the niche may even remain unused. On the other hand, an existing species may evolve and adapt to the niche.

Human beings have succeeded in occupying and dominated most of the terrestrial habitats. Through the use of modern technology, humans modify habitat to suit their needs even creating artificial habitats like cities. Adding to adaptability it is the ability of humans to quickly alter their practices and diet. Humans occupy a very broad niche and modern human culture has created a new urban-industrial niche to suit their requirements.

2.6 HOMEOSTASIS OF THE ECOSYSTEM

Homeostasis of the ecosystem is also acknowledged as a biological equilibrium; in other words balance of Nature. Homeostasis is the state when an ecosystem maintains a biological equilibrium between the different components. It continues to change with the time and is not stationary yet it maintains a stability which is sustained by the number of factors including the carrying capacity of the environment and the capacity for recycling of the waste.

The effect of density on the reproductive potential deals with the self regulation. Feedback system plays an important role in the ecosystem in which one component of ecosystem maintains check on the population of the other component. There are positive or negative feedback systems. Positive feedback is the increase in the population of the organisms at the different levels increases the population of organisms at a lower level. For example, when there is an increase in the population of plants it promotes to increase in the population of herbivore animals. Now, it increases the population of frogs and birds. In the same way, the increased population of insectivorous animals predates on the herbivorous insect which is termed as the negative feedback.

2.7 ECOLOGICAL SUCCESSION

Ecological succession is a course of action by which a community gradually transforms itself until a stable community is formed. This is the foundation in ecology, and the alteration that occurs is comparatively expected formation of an ecological community. The genesis of succession lies either by formation of new, unoccupied habitat (e.g., a lava flow or a severe landslide) or by some form of disturbance (e.g. fire, severe wind throw, logging) of an existing community. There are two types of succession: Primary succession and Secondary Succession. Primary succession is the chain of community transformation which takes place on a totally new habitat which has never been colonized earlier e.g. a newly quarried rock face or sand dunes. Whereas secondary succession is the chain of community transformation which take place on a previously colonized, though on disturbed or damaged habitat e.g. subsequent to felling trees in a woodland, land clearance or a fire. Another distinguishing feature is that primary succession begins in areas where no soil is initially present whereas secondary succession begins in areas where soil is already present.

An Ecological succession is the process in which change in the structure of species of an ecological community takes place over a period. This process results at times in some species becoming abundant or appearance of a new species or may some even fade away entirely from an ecosystem. This visible transformation, over a period of time in what is living in a particular ecosystem is “ecological succession”.

Now, the question arises why does this phenomenon of ecological succession happen? We all will agree that every species need certain optimal environmental situation which is complacent for its growth and reproduction. In such a situation in a given ecosystem all those species which are most suited to conditions to grow and reproduce will become abundant. This means if ecosystem’s set of environmental conditions remain unchanged, the species which are the best adapted to those conditions will prosper. The original environment may have quite conducive for first species be it plant or animal, but the modified environment is often conducive for some other species of plant or animal. With the change in the condition of the environment, the earlier dominant species may not prosper and another species may increase.

Another scenario when the ecological succession may occur is when the conditions of an environment unexpectedly and severely change. The conditions like forest fires, wind storms, and human activities like agriculture contribute significantly in modifying the conditions of an environment. These colossal forces

are capable of wiping out of species thereby altering the dynamics of the prompting a rush for dominance among the species still present in the ecological community.

The concept of succession holds importance. There is a very well defined and predictable pattern through different stages of development until the final stage each with differing measure of efficiency and diversity as a community evolves. The stages of succession are concerned with the classification system of a definite group and its use of the environment. For instance some faction of present-day Maya believes that there are six stages of forest regrowth once the land is cleared for agriculture. This becomes significant in appreciating the succession and its allied agricultural implication which are critical to the timing of reuse of the land for agriculture. The processes involved in succession would be the same; however, the actual species involved in the process in a specific area are influenced by Geology and History of the area, the climate, microclimate, weather, soil type and other environmental factors. The time period of succession is not definite and may vary in timescales, ranging from a few days to hundreds of years. It takes hundreds of years for a succession of climax woodland to develop, whereas the succession of invertebrates and fungi within single cow dung may be over within as little as 3 months- the dung would have been changed into humus and nutrients and recycled back into the soil. The holes evidently observable in the cow dung are result of animals which have colonized it.

Is man affected by ecological succession? The answer is in the affirmative.

Ecological succession is not man-made but a power of nature. Ecosystems as we understand are in continuous state of change and restructuring. Let us take an example to appreciate how ecological succession affects humans and realise the unbelievable time and money involved in ecological succession. Imagine a newly ploughed garden plot. The land has been cleared by preparing the soil for new planting has resulted in the disruption and restructuring of the earlier stable ecosystem- this is major external event executed by man. The disturbed ecosystem will without delay begin the progression of ecological succession.

Does ecological succession reach the stage of standstill?

There is a notion in ecological succession termed as the “climax” community. Earlier school of thought was of the opinion that ecological succession finally culminated having a stable end-stage called the climax. This proposal has been discarded by modern ecologists in support of non-equilibrium ideas of how ecosystems function. The climax community characterises a steady end product of the succession sequence. There are certain species in plants that maintain itself for a very long time i.e. their structure and composition would not alter noticeably over an observable time. We can to this extent believe that ecological succession has stopped. But then, it is a known fact that any ecosystem to whatever degree it may be naturally established and constant; is susceptible to substantial external upsetting forces like fires and storms that could reorganize and re-start the succession process. Till these probable calamities exist, it is incorrect to believe that succession has stopped. One point to be appreciated is that over long periods of time there is a change in the climate conditions and other original characteristics of an ecosystem. These changes are not evident in our “ecological” time, but it is certain that their fundamental existence and historical reality is not doubtful. Hence, no ecosystem whether it is past or future will continue living unaffected or fixed over a geological time scale. Let us take concept of climax

vegetation: subsequent to a forest burns; there are different stages of succession which vegetation goes through. They include the grass and herbs, then shrubs and vines, then weedy trees and finally the "climax forest" that grows up under the weedy trees. The climax vegetation goes on until the next fire. However, there is never so simple and static model.

Plant species adapted to the changed soil conditions would dominate the scene. It is mostly the weeds that has significant ecological role and functions, take over. However weeds are vying amid the garden plants for nutrients, water and physical space. The garden would soon be infested with weed that are intensely productive and the garden plants would struggle to strive if left unattended. The only way to combat the situation is weeding the garden which requires lot of time and energy. Now, this energy contribution is directly proportional to the "energy" inherent in the force of ecological succession. Imagine, if this small scale situation is applicable to all the agricultural fields and systems on Earth, then how much load would be there for all of the farmers and gardeners who are growing our food. This gives an idea of the huge cost in terms of time, fuel, herbicides and pesticides that we pay every growing season because of the force of ecological succession.Ecology has spread its wings globally, but the inputs to ecology from other cultures are hindered by language and translation hurdles.

2.8 SUMMARY

Ecology plays a significant role for considerable utilisation of natural resources facilitating in the conservation of habitats and species, and also for the prediction on reflection of man's activities on natural environment. Ecology refers to the branch of science that studies the interactions between organisms and their environment. Ecology in the most common sense symbolises the dynamic interrelation of the community with its total environment. Environments have both abiotic and biotic components in which all organisms interact. Environments can be defined based on any number of criteria, and operational definitions differ depending on the situation. There are two basic divisions of the biotic environment, biomes and ecozones, differentiated based on scale. A biome is a large-scale, broad region of similar temperature, rainfall, and biology. An environmental zone, or ecozone, is a geographic area defined by fairly specific biotic communities within biomes.

An ecosystem is a geographically bounded system within which a defined group of organisms interact with both the abiotic and biotic components of the environment. Each species occupies a niche, the role it plays within its environment, community, or ecosystem. A niche is defined by what the species eats, how it reproduces, and what it does. The geographic location where a species lives and operates is called its habitat. Niche and habitat are interrelated and somewhat dependent on each other as the type of habitat will influence the possible niches present. Adjustments required for successful existence in a particular habitat are adaptation. The magnitude of ecosystems is dependent on how and why it is defined. Presently biosphere occupies the position of largest ecosystem. They are defined at a variety of scales for different rationale, but are eventually connected to one another. Niche and habitat have a close relationship and are dependent on each other. Through the use of modern technology, humans modify habitat to suit their needs even creating artificial habitats like cities. Homeostasis

of the ecosystem is also acknowledged as a biological equilibrium; in other words balance of Nature. Ecological succession is a course of action by which a community gradually transforms itself until a stable community is formed and it is the process in which change in the structure of species of an ecological community takes place over a period. Lots of work has been done all around the world, but the inputs to ecology discipline from other cultures are hindered by language and translation hurdles.

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Sample Questions

1) How ecological developments take place?
2) What is the difference between Habitat and Ecological niche?
3) Define Environment and Ecology.
4) Discuss ecological succession.

UNIT 3 HUMAN BIO-CULTURAL ADAPTATIONS

Contents

Learning Objectives

After going through this unit, you will be able to:

- recognize the basic ways humans adapt to different environments;
- describe the various environmental pressures which shape the primate's behaviour; and evaluate various bio-cultural activities adopted as adaptive strategies by human; and
- apply anthropological perspectives on human evolution and adaptation to theories of human-habitat interaction from Biological and Cultural Ecology.

3.1 INTRODUCTION

Darwin's publication "*On the origin of species*" has crystallised the understanding of the evolutionary process revealing natural selection as the key to evolution. In the struggle for existence the individuals with favorable variations were selected for survival by nature while unfavorable were eliminated. From genetic perspective evolution is defined as change in allele frequency from one generation to the next. The mechanism of evolutionary changes produced by natural selection can be summarized as:

a) A trait must be inherited from parents.

b) Natural selection acts on existing variation within species which is potentially impasse without inheritance of characteristics.

c) Fitness is relative measure that will change as the environment changes. Better adapted individuals generally produce more offspring over generations, thereby the frequency of adaptive trait generally increase in subsequent generations. A new species emerge when changes in trait or geographic barrier result in reproductive isolation of the population.

In the context of 'Modern Evolutionary Theory', evolution may be defined as two stage process:

a) The production and redistribution of variation (inherited differences between individuals). As for speciation, the development and divergence of different species would occur when sub-populations become isolated by geographic barriers or when different subpopulation encountered different climatic conditions or moved into new ecological niches, those environmental isolating process would eventually result in the development of reproductive isolation and new species.

b) Natural Selection acts on these variations whereby inherited differences or variations among individuals differentially affect their ability to reproduce successfully.

The evolutionary factors – mutation, gene flow, genetic drift & recombination interactively affect the gene frequency & produce variation within and between populations. Though these evolutionary changes can occur even in absence of natural selection, directional evolutionary trends have been sustained only by natural selection.

Anthropologists today are concerned with human variation because of its adaptive significance and to elucidate the genetic and related evolutionary factors that act to produce variation. In other words, many traits that typify certain populations are seen as having evolved as biological adaptation or adjustments to local environmental conditions (including infectious diseases). Thus, human presents the contemporary component of vast biological continuum. They share a common ancestry with modern African apes since 6-8 million years ago. Evolutionary approach correlates specific aspects of primate social structure with the elements of their habitats, since all living organisms must adapt behaviourally as well as physically to their environment. By elucidating the various environmental pressures involved and understanding how they have influenced non-human primate behaviour, we can better comprehend the factors that led to human emergence.

3.2 EMERGENCE OF PRIMATES

Primate displays a wide range of behaviours and social organisations that vary from species to species as well as within species under different environmental situations such as predation intensities and population densities (Swindler, 1988). It is generally agreed that the primates may have emerged by the Paleocene, 65 million to 55 million years approximately and perhaps earlier in late Cretaceous climatic changes due to continental drift that had profound effect on the evolution of primates. Expansion and diversification of deciduous trees and flowering plants probably led to mammalian expansion and diversification. Primates evolved from one of these mammalian radiations, probably from the insectivora order of mammals that was is adapted to eating insects.

The traditional view of primate evolution was that arboreal life would have favored many of the common primate features such as dentition, greater reliance on vision over smell, three dimensional binocular vision and grasping hands and feet. Alternatively, Cartmill's visual predation theory (1974) proposes that the distinctive primate character were selectively advantageous for hunting insects on the slender veins and branches that filled the undergrowth of Tropical forests. Robert Sussman's theory, conceal that the basic primate traits have arisen in response to fine visual and tactile discriminate necessary locating flowers, fruits and seed on slender branches in dim light.

3.3 PRIMATE ECOLOGY

Primates occupy all the seven continents – Africa, Asia, South America, Europe, North America Australia, Antarctica and the nearby islands. Although primates occupy only marginal areas of Europe (Gibraltor) and North America (Central and Southern Mexico), they were formally wide spread on both the continents. Within this geographic range, living primates are found in a variety of habitats, ranging from deserts to tropical rain forests. Despite, they are largely restricted to the tropical forested regions of Central and South America, Sub – Saharan Africa, Madagascar and Southern Asia. Each of these bio-geographical regions has a distinctive climate, topography, geology, flora and fauna. In a tropical forest which reaches a height of 80 m; the temperature and humidity, the kind of plant food, shapes of branches, and the type of other animals a species encounters are usually quite different on the ground level where they are subjected to inadequate light and terrestrial predators (Fleagle, 1999). However, in higher canopy horizontally spread branches provide convenient highways for arboreal travel and abundance of leaves and fruits. Still higher in the emergent layer, the canopy become discontinuous and heat from sun may be quite intense and primates are exposed to aerial predators. Primates are gregarious and social animals. However, not all primates are found in larger groups and solitarity in some species is probably related to diet, distribution of resources and predator avoidance.

The nutritional requirements of animal are related to the body size and basal metabolic rate. Smaller animals have high BMR than larger ones and require energy rich diet rich in protein (insects), fat (nuts and seeds), and carbohydrates (fruits and seeds). While larger primates don't depend on high energy diet/food and consume leaves, stems and other types. Insect on the other hand, may be widely scattered and the animals that rely on them usually feed alone and in small groups of 2 or 3. Fruits, nuts and berries in dispersed trees and shrubs occur in clumps. They can most efficiently be exploited by smaller groups of animals, so large groups frequently break up into smaller subunits may consist of one male, multi female group and matrilines (a line of descent in which an individual is considered to belong to the same *descent group* as her or his mother). Species that feed on abundantly distributed resources may also live in one-male, multi female groups and because food is plentiful, these units are able to join with others to form large, stable communities which may appear to be multi male and multi female groups.

In tropical forests attacks by birds of prey, cats, large animals and humans are all potentials cause of mortality. Typically when predation pressure is high, large communities are advantageous and when body size is small, large communities

are advantageous. These may be multi male-multi female groups or congregation of one male group. Most primates are diurnal, but several small bodied Prosimians and New World Monkeys (the owl monkey) are nocturnal. Nocturnal primates tend to forage for food alone or in groups of two or three and many use concealment to avoid predators.

Thus, procurement of food and avoidance of predation are the basic requisites of life as a primate. These as adaptive strategies influences the social structure and behaviour of the species. The complex social organisation has evolved through the process of natural selection. It enhances protection from predators, wider access to mates, better reproductive success and assistance in raising offspring and better access to food resources. They participate in a number of activities to reinforce the integrity of groups which can be summarized as follows:

3.4 PRIMATE BEHAVIOUR AND SOCIAL STRUCTURE

3.4.1 Dominance

As most of the primate lives in groups, they compete with one another from time to time for food and mates. This result in establishment of dominance hierarchy that involves individual differences in behaviour based on size, age, sex, status and kinship. It imposes a certain degree of order within groups by establishing parameters of individual behaviour, thereby reducing causes of intergroup agonistic behaviour (Jurmain et al., 2006). Dominant animal exerts control over aggressive behaviour of other animals by making a dominating, threatening gesture or behaviour. Higher ranking individuals have greater access to preferred food items and mating partners than lower ranking individuals. Dominance hierarchies have sometimes been referred to as "Pecking Orders". Dominance increases the reproductive success of the animal. Higher ranking females have greater access to food than subordinate females and are provided with more energy for offspring production and care (Fedigan, 1983) For instance, offspring of high ranking female chimpanzee at Gombe National Park , Tanzania had significantly higher rates of infant survival. Their daughter matured faster indicating shorter inter-birth interval and consequently produced more offsprings (Pusey et al., 1997).

Males are usually dominant over females. However, in multi female groups associated with one or several adult males, males and females have separate hierarchies. Although very high ranking females can dominate the lowest ranking males and among many species female are dominant sex (lemur) or among species that form monogamous pairs, males and females are co-dominant (eg. Indris, gibbons). An individual's position in the hierarchy is not permanent and changes throughout life. It is influenced by factors including sex, age, level of aggression, amount of time spent in the group, intelligence and sometimes the mother's social position (Jurmain et al., 2006).

3.4.2 Aggressive Behaviour

Primate groups are associated with a home range where they remain permanently. The sizes of the home ranges vary considerably for a variety of ecological and social reasons such as size and proximity of neighbouring troops and the

concentration of food plants. Within the home range is a more restricted area called the core area, which contains the highest concentration of predictable resources, and here the group is most frequently found. Although parts of a group's home range may overlap with the home ranges of other groups, core areas of adjacent groups do not overlap. These area are exclusively used by the group is said to be a group's territory which is defended against intruders and can lead to outright aggressive behaviours. Similarly, conflict within a group frequently develops out of competition for resources, including mating partners or food which often leads to such behaviours. Most intragroup aggression occurs in the form of various signals and displays, frequently within the context of a dominance hierarchy. Therefore, the majority of tense situations are resolved through various submissive and appeasement behaviours. However, all conflicts are not resolved peacefully and frequently results in injury and even death. For instance, male chimpanzees are highly intolerant of unfamiliar chimpanzees, especially other males, and they fiercely defend their territories and resources. Intergroup interactions are almost always characterised by aggressive displays, chasing, and frequently actual fighting.

3.4.3 Affiliative Behaviour

A certain amount of aggression maintains order within groups and protects resources. However, to minimise actual violence and to defuse potentially dangerous situations, there are many behaviours that reinforce bonds between individuals and enhance group stability. These affiliative behaviours include reconciliation, consolation, and simple amicable interactions between friends and relatives (Jurmain et al., 2006).

a) ***Grooming***

Grooming is a tactile activity practiced by all primates from prosimiams to great apes whereupon the groomer inspect the skin of the groomee, picking off piece of dirt, flakes of skins, and any ecto-parasites that might be present. This hygienic behaviour in time has developed into a much more important social behaviour preserving group stability and solidarity. It reduces tension, reinforce social relationship, dominance hierarchy and proximity between the primates. Grooming takes place more often among related than among nonrelated individuals in many primate species and infants usually receive more grooming than older offsprings. Prosimians use their tooth combs (lower incisors and canines) and toilet or grooming claws (on the second digit of the foot) for grooming. They seem to use dental comb when grooming other individuals and generally reserve their grooming claws for cleaning and maintaining their own fur (Swindler, 1988)

b) ***Altruism***

Altruistic act involves some risk or sacrifice to the performer to protect others from attacks by conspecifics or predators. The protection of dependent offspring, is ubiquitous who may or may not be related to the performer. Stelzner and Strier (1981) witnessed a female baboon chasing a hyena that was in pursuit of a young adult male baboon. Adoption of orphans has been reported for macaques, baboons, and gorillas, and it is common in chimpanzees. When chimpanzee youngsters are orphaned, they are almost always adopted, usually by older siblings who are solicitous and highly

protective. Empathy, or the ability to identify with the feelings and thoughts of another individual, is required for altruistic behaviour. Evolutionary explanations of altruism are usually based on one of two premises: First, individuals perform acts that benefit others because they share genes with the recipient; thus, by helping a relative, the performer is helping to ensure the survival of the genes they have in common. The second explanation, sometimes called "reciprocal altruism," is that one individual helps another to increase the chances that, at a future date, the recipient might return the favor (Jurmain et al. 2006).

3.4.4 Communication

Communication in primates refers to scents and unintentional, autonomic responses and behaviours that convey meaning. These include a wide variety of gestures, facial expressions, and vocalisations.

a) Olfactory: The odors of pheromones secreted by the scent glands in various areas of the body eg armpit, along forearm or near the base of tail are generally used for sexual interaction. In many species the males smell the anoperineal region of the female or even examine her vagina to monitor her reproductive status. At height of estrus there may be several males following one female. Other than sexual attraction, many primates use scent markings to establish territories, as alarm mechanisms and in aggressive encounters.

b) Visual signals include body postures, gestures, facial expressions and different positions of tail. These ritualised visual behaviours stimulate both friendly and competitive interactions. The social relationships are manipulated by reducing tension within a group and maintaining cohesion by preventing fights. For instance, during a series of displays by dominant male macaque, the subordinate animal can terminate the action by performing a conciliatory gesture such as presenting its rear end to the dominant male. Rhesus monkey display dominance by holding the tail high above the body with a slight S-curve near the end, while a lower rank male carries his tail low below the level of his back while walking. Facial expressions such as yawn is a threat signal particularly when the upper canines are exposed (eg. baboons). Lip smacking often accompanied by tongue thrusting is an invitation to approach. The play-face is often a friendly gesture in which an animal looks towards another animal with open mouth but don't stare while staring makes it a threat gesture.

   'Sting-fight' among lemur presents an interesting illustration of both olfactory and visual communication. The males rub their chests and forearm scent glands together stimulating the flow of pheromones, and then rub their tails through their forearms and across theirs chest, after which they quiver and shake their tails at their adversary, who receives an odiferous blast from the waving tail. This results into withdrawal of troops to favorable positions and escape from the enemy (Swindler, 1988).

c) Auditory: With evolution, enhanced visual communication along with vocalisation among diurnal primates has replaced the varied olfactory signals of the nocturnal Prosimians. The warning calls of the arboreal species alert the members of the group of impending danger from a bird or snake eg. Vervet monkeys. Chimpanzee makes pant-hoots vocalisation during feeding,

when groups meet or when they begin to nest in the evening. Howler monkeys probably have 15-20 separate vocal patters in their repertoire. It includes hoarse clucks that initiate troop movements, gurgling sounds made only by males as defensive vocalisation and the wailing sounds made by a mother when her infant has fallen or otherwise been removed from her. The 'great call' among gibbon serves to identify the boundaries among gibbon territories and is unique for each species. As they approach near another group, the two groups engage in a vocal battle that becomes louder and faster until one group moves away thus lessening the chances of actual physical contact (Swindler, 1988).

3.4.5 Tools and Culture

Many animals were known to use unmodified objects as tools but fabricating tools was the unique activity of the genus Homo. However, chimpanzees have been found to make and use tools as probes for termite fishing. These tools have usually been modified by stripping off the leaves or breaking the twigs into different shapes for later use at termite mounds. The termites attach to the stick inserted into the hole and when it is removed, the chimpanzee licks off the termites. In addition to termite fishing, the repertoire of chimpanzee cultural behaviours include nest building, hunting and throwing sticks and stones as offensive weapons. Tools use has been reported occasionally among the wild orangutans such as waving sticks to ward off wasps or to scratch one's back. Washing of sweet potatoes in nearby sea portray the cultural behaviours among the primates (macaques). The sweet potatoes were not only cleaned by the washing but the monkeys preferred the added taste of salt.

3.5 HUMAN BIO-CULTURAL ADAPTATION

Humans have occupied a wide range of habitats because of their ability to intervene environment- the living and inanimate, for their purposes. This approach is largely based on a notion of adaptability, which regards individuals as being equipped with a set of biological traits that provide means of survival within certain limits. It involves physiological, structural, behavioural or cultural changes aimed at improving the organism's functional performance in the face of environmental stress. These adjustment can either be temporary or permanent, acquired either through short term or lifetime processes. Thereby expressed in terms of phenotype variation of continuous trait, physiological acclimatisation and learned behaviour. There seems to be few situations in which human population develop genetic adaption to specific environment expressed in terms of phenotypic variation which eventually leads to differences in allele frequency between populations. On the other hand, decades of research affirm that biological plasticity or physiological acclimatisation is species wide adaptive mechanisms which enable individuals to maintain internal constancy or homeostasis. These adaptive strategies represent the continuum and elaboration of adaptive patterns which characterise primate.

Within the broader content of Human Evolution coping with ecological constrains include culturally coded survival strategies. Culture is a complex entity of technological inventiveness, social institutions, belief systems and idiosyncratic amalgamation with our evolutionary biological and behavioural heritage. It includes technology which range from computers, subsistence pattern ranging

from hunting and gathering to agri-business on a global scale, housing type from thatched huts to skyscrapers and clothing from animal skin to high tech synthetic fibres (Jurmain et al., 2006).

> "*the use of human population in ecological analyses preserves a view of humanity as a part of nature at the same time that it recognizes the uniqueness conferred upon the species by culture. As such it preserves the terms defining the condition of a creature that can live only in terms of meanings, largely culturally constituted, in a world to which law is intrinsic but meaning is not." (Rappaport, 1990)*

Culture is learned and passed on from one generation to the other. It shapes people's perception of external environment in particular way that distinguishes one culture from another. It is, however, important to emphasise that culture is not genetically determined and the human predisposition to assimilate culture and function within is influenced by biological factors. Indeed, over the past several million years of human evolution, biology and culture have interacted in such a manner that human are said to be the product of bio-cultural evolution. Thus the aspect of human variation includes the bio-cultural response of population to different kinds of environmentally induced stress i.e high attitude, cold and heat.

3.5.1 Response to Heat

Human maintain a relatively constant internal body temperature independent of environmental temperature through a complex mechanism of heat gain and heat loss. In hot climate, the fundamental response of human exposed to heat stress is heat dissipation. The process of heat transference between the body and environment includes radiation, conduction, convection and evaporation. It has been observed in all human to an almost equal degree, with the average number of sweat glands per individuals (approx 1.6 million) being fairly constant. However, the non-acclimatized individual, on exposure to heat stress exhibits significantly increased perspiration rates (Frisancho, 1993). Further, the effectiveness of the heat removal process depends, on the gradient of heat between the body core and the external environment which involves three factors:

1) The magnitude of heat gradient between the environment and body core.
2) The rate of heat exchange between the interior and skin surface.
3) The rate at which metabolic heat is produced.

> People from the hottest regions (South Asia, Africa, India and Australia) had the largest surface area to body mass ratios. Such a morphological configuration is ideally suited to the more energy-efficient dry heat exchanges, and to a reduced reliance upon evaporative cooling (Taylor, 2006).

Another adaptive mechanism involves vasodilation, whereby blood capillaries near the skin surface widen to permit increased flow to the skin and hence enhanced peripheral heat conductance.

Skin color is another adaptive mechanism to the distinct climatic conditions. Melanin pigment produced by melanocytes present beneath the epidermis provides protection from overexposure to ultra violet radiation which can cause genetic mutation in skin cell leading to skin cancer.

Thereby, natural selection has favored dark skinned individuals in area near the equator where exposure to UV radiations is the most. Biotopes with high densites of UV radiation are also characterised by high temperature. In such biotopes a dark skin color would actually be disadvantageous, as it causes a strong heating of body surface, due to relatively low reflectance. This is explained by differences in numbers and function of the sweat glands among dark skinned individuals. The African groups have been able to maintain a lower body and skin temperature as compared to European light skinned people as a consequence of lower suppression of sweat rate than Europeans (Walter, 1971). Thus darkening of skin is of prime biological importance so not only in Negroid, but a functionally effective melanisation is present in South Indians and other ethnic groups also (Weiner, 1964).

Cultural adaptation

It pertains to the creation and maintenance of favorable environmental conditions near the individual - microclimate, different from those in the general area. The ideal microclimate involves lowered skin temperature, a vapour pressure gradient favoring evaporative heat loss, and protection from conductive, convective and radiation heat gain.It is within the extrasomatic zone that behavioural and social adaptations play a major role by maintaining a favorable microclimate within a larger and more stressful macroenvironment. (Hanna, 1983).

Material Culture as habitations and clothing establish a favorable microclimate while behavioural adaptation centre's largely upon avoidance. Houses are constructed of high heat capacity materials such as adobe and stone, to delay entry of heat. These materials absorb large amount of heat before passing it into the interior and the stored heat is lost at night by radiation and convection. The net effect is to dampen temperature fluctuation so that interior temperature remains moderate. Pueblo Indians, Middle Eastern communities construct their house several meters beneath the surfaces as the mean temperature of subsoil is more comfortable that the surface with its extreme variation. In habitation above the ground, compact geometry minimizing surface area to internal volume reduces solar heat gain as well as convention heat gain from desert winds.

Clothing, another aspect of material culture reduces abrasions, prevents sunburn and reduces solar heat gain. This in turn reduces level of perspiration required to maintain equilibrium. It has been proposed that well-acclimatized individual wearing clothes perspire 30% less than unclothed men at rest which reduces the heat load of about 165 kcal/hr. (Henschel and Hanson, 1959)

Chaamba Arabs, tribal population of Sahara Desert wear clothing that minimises conductive and radiant heat gains from the environment. The insulative effects of trapped air reduce heat transmission to the skin surface. However, clothing is less advantageous at work than at rest as it hinders the loss of internally generated heat and loose fitting, baggy clothing is desirable. Such cases, favors ventilation and evaporates from the skin surface. Furthermore, a light-colored external garment may reflect radiation reducing heat gain.

3.5.2 Response to Cold

Human physiological responses to cold combine factors that increase heat retention with those that enhance heat production (Jurmain et al., 2006). On exposure to cold stress vasoconstriction limits the flow of warm blood from

core to the skin thereby lowering the skin temperature. Consequently reduction of temperature gradient between the skin surface and environment reduces the rate of heat loss. The reduction in heat conductance of the blood is also caused by deviation of the blood in the extremities from superficial vein to the deep veins. The countercurrent heat exchange between arteries and vein lower the heat conductance to the periphery.

In addition, subcutaneous fat layer provides an insulator layer throughout the body. When vasoregulatory mechanisms are not sufficient to counteract heat loss, the organism adjusts by increasing the rate of heat production. Shivering augments the thermeogenesis of the muscle mass and the temperature of muscle is raised to approach that of the core, thus eliminating the temperature gradient heat loss (Frisancho, 1993) shivering also increase the metabolic rate to two three times the basal value which consequently release energy in the form of heat. In general, people exposed to chronic cold maintain higher metabolic rate than those living in warmer climates. The Eskimo living in the Arctic maintain rates between 13-45% higher that observed in non-Inuit.

Himalayan population of India wear several layers of cloth to combat cold, but extremities remain exposed to cold stress. However, they are characterised by elevated resting metabolic rate and high level of blood flow to the extremity to maintain warm surface temperature during local exposure to cold (Little et al, 1977).

Body size and proportions are also important in regulating body temperature. In general, within a species, body size increase with the distance from the equator. Two rules that pertain to such relationship between body size, body proportion and climate are:

1) Bergman rule

   In mammalian species, body size tends to be greater in population inhabiting colder climates. Increased mass, thereby decreased surface area allows greater heat retention and reduced heat loss eg. Arctic region

2) Allen's Rule

   In colder climates, shorter appendages, with increased mass-to-surface ratios are effective at preventive heat loss. Conversely longer appendages with increased surface area relative to mass permit heat loss eg. Sub Saharan Africans.

Cultural adaptation

The diurnal-nocturnal variation in the temperature exposes the Aborigines of Australia to heat stress during day and moderate cold stress during night. As they wore no clothing and did not built shelters, the heat against the cold stress is provided by sleeping fires. They also experience continuous vasoconstriction throughout the night which prevents them from excessive internal heat loss with no threat of frostbite.

The Bushman of Kalahari Desert, like the Australian Aborigines are exposed to moderate chronic cold stress during night. They have been able to create a microclimate around their bodies that is close to the thermoneutral temperature of 25°C through efficient use of fires and skin cloaks during cold nights

(Frisancho, 1993). They sleep in a group of three or four in families or in single sex groups. The heat made up of grass and boughs are placed in a half-circle as wind breakers.

Eskimos occupy the northwestern coast of North America and across the Bering Strait into Asia. They have well insulated housing known as 'Igloo'. Their wall made of whole rib rafters are covered with a double layer of seal skin attired with moss. They place the source of heat usually an oil, blubber or coal lamp at a lower level than the main floor; where by cold air is warmed before it reaches the area where people live. The housing structure permits trapping of air which in turn further provides insulation. Such an efficient heat exchange system maintains between 10ºC to 21ºC for coastal Eskimos despite subzero environmental temperature. Their clothing is made of caribou which provides higher insulation as compared to seal skin. Coribou fur of 1½ and 3 inches thickness provide insulation equivalent to 7 to 12 clo units (Scholander et al., 1950) Although Eskimo wear snowshoes and short skin mittens at times, during their daily activities such as fishing, their hands and feets are continuously subject to cold stress. They experience intermittent periods of vasoconstriction and vasodilation which prevent frost bite in below freezing temperatures. At the same time, because vasodilation is intermittent, energy loss is restricted, with more heat retained at body's core. The high peripheral temperatures of extremities and high tolerance to cold of Eskimos and highland Quenchas appear to reflect the influence of developmental acclimatisation. Traditionally they have the highest animal protein and fat diet than any other human population. Such a diet, necessitated by the available resources base, served to maintain the high metabolic rates required by exposures to chronic cold.

The highland Quenchua population from the Peruvian Andes and other mountain areas of South America are exposed to a variety of stresses including hypoxia cold, low humidity and high levels of solar radiations. Thus, interpretation of cold adaptation of the highland population requires a synergic interpretation of all these stresses. The success of the Quenchua population in preventing severe body cold stress reflects the effectiveness of their technological adaptations, which includes housing, bedding and clothing. The housing of the highland natives differs with the variation in altitude and subsistence pattern. Population living below 4000m has mixed economy owing to individual or community ownship of land. They have permanent houses built of Abode which maintain the indoor temperature more than 10ºC above the outdoor temperature. On the other hand, housing at elevation above 4300m are temporary is a consequence of pastoral economy requiring high mobility. However, these houses constructed of piled stones and roofed with straw have inadequate insulative effectiveness with the average indoor-outdoor differential temperature of 3.7ºC. They sleep within the woolen sleeping bags providing adequate protection against cold stress. Clothing results in 4ºC increase in temperature of the skin under clothing.

3.5.3 Response to High Altitude

A high attitude environment exerts multiple stresses on human which include hypoxia, more intense solar radiation, cold, low humidity, wind, a reduced nutritional base and rough terrain. Of these, hypoxia exerts greater degree of stress on physiological functions and is not easily modified by cultural behavioural practices or responses. Hypoxia results from a decrease in partial pressure of

oxygen in atmosphere proportionally to increase in the attitude which consequently leads to reduction in O_2 Heamoglobin saturation. It interferes with the oxygen acquisition at the cardiopulmonary level and utilisation by the cells. Hypoxia induced anorexia and dehydration due to increased ventilation and low humidity at high attitude leading to weight loss. The multifaceted effect of hypoxia also manifests through increased rates of infant mortality, miscarriage and prematurity among people residing at higher elevation. Decreased foetal growth due to impaired maternal foetal oxygen transportation also results into birth of low birth weight babies.

Thus, acclimatisation to high attitude hypoxia is a complex phenomenon that develops through the modification and synchronized interdependence of the respiratory, circulatory and cardio vascular system to improve oxygen delivery and utilisation. On exposure to high attitude low landers, acquire short term modifications or partial acclimatisation in response to hypoxia which include increase in respiration rate, heart rate, and production of RBC which contain oxygen-transporting protein heamoglobin while high attitude dwellers adapt to hypoxia during their lifetime, as they mature. During growth and development environmental factors constantly condition and modify the expression of inherited potentials. The environmental influences felt by the organisms depend on the type of stress imposed and especially on the age at which the individual is subjected to the stress. The respective contribution of genetic and environmental factors varies with the development stage of the organism, in general (Frisancho, 1993).

The earlier the age or the longer the duration of stay at high altitude, the greater the environmental influence on body dimensions and respiratory functions. For instance, the altitude natives Anedean Indians have larger chests and greater lung capacity as well as more surface areas in the capillaries of lungs which facilitate the transfer of oxygen to the blood. Consistent with a presumed environmental effect, the children of high attitude Peruvians who grow up in low lands don't develop larger chests. Peruvian who were born at sea level but grew at up at high attitude developed the same amount of being capacity as people who spent their entire lives at high attitudes (Ember & Ember, 2008).

Thereby larger chests among Andeans which was considered to be a genetic adaptation, infact, presents acclimatisation which develops early in childhood and persists for the lifetime of an individual. The Spitians who inhabit high altitudes in the North West Himalayas showed large chest size in relation to stature indicating developmental adaptation to low oxygen pressure of high altitude (Singh et al. 1986). The larger chest circumference of the Bods of Ladakh as compared to lowland Indians also suggests a structural response to the greater lung function capacity and adaptation to high altitude hypoxia (Kapoor & Kapoor, 2005; Bhasin et al. 2008;). Rajis, a hunter-gatherer tribal population of Uttaranchal showed lower chest circumferences comparable to the mid-altitude population but lung functions comparable to those of other high-altitude populations. This leads to the conclusion that indigenous high-altitude populations may possess different genetic potential for thorax growth compared to low-altitude populations, possible related to ethnic differences in the rate of growth of thorax related to stature at high (Kapoor et al., 2009).

Altitude

Cultural adaptation

Acclimatisation to high altitude also concerns with the utilisation of glucose, a critical O_2 efficient source of energy for brain. There is an apparent dependency on blood glucose under both resting and exercise conditions and increases with the length of exposure to high altitude.

3.6 SUMMARY

As non- human primates are our closest living relatives, the identification of underlying factors related to social behaviour, communication, infant care, reproductive behaviour and so on aid in developing a better understanding of the natural forces that have shaped so many aspects of human behaviour (Jurmain et al, 2006). Since Homo sapiens evolved, populations have dispersed across the planet, inhabiting niches that span the spectrum of available terrestrial habitats. Many of these populations survived for millennia in extreme environments, developing adaptations which have contributed significantly to the phenotypic and to some extent genotypic variation found among present day people (James, 2010). So, in evaluating adaptations of 'indigenous' human populations living in various extreme environments, the focus is really on how these populations evolved so as to survive and reproduce under conditions that would seem to be unfavourable (James, 2010). The study of many of these biological aspects of humankind including adaptation and evolution could certainly be the purview of human biologists. However, when such research also considers, the role of cultural factors, it is placed within the discipline of Anthropology.

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Sample Questions

1) Define adaptation and the bio-cultural strategies adopted by human for their survival in cold climate.
2) Describe the influence of altitude environment on Human Physiology and its consequences.
3) Elaborate the relation of Primate Ecology with their behaviour and social structure.
4) Comment on 'Human as biological continuum of primate'.

UNIT 4 POTENTIAL ENVIRONMENTAL STRESSES

Contents

Learning Objectives

At the end of this unit, you will be able to:

- understand about the potential environmental stressors that affects human being;
- comprehend how human being by the process of their in-built biological mechanism or by adopting some cultural practices make an effort to minimise the effect of stress on their body; and
- know that the responses of human to these potential stressors are not the same and there is variation in the response levels that exist in human population.

4.1 INTRODUCTION

Human population inhabits almost all the parts of the world. Take for example the Arctic dwellers like, Eskimos. These people are the original inhabitants of the arctic regions. They have developed certain common adaptive features for their survival in that environment. But, let us think of an individual or a group of individuals who have migrated to the Arctic region from the tropical or temperate region, what may happen to them? Since these tropical people do not have the adaptive features like the Arctic dwellers, can they survive? The answer is yes. This demonstrates the plasticity of human phenotypes in their capacity to adjust to a wide range of environmental stress.

Human being has the capacity to endure various environmental stresses. Stressors are conditions that threaten to disturb normal biological function or homeostasis. Heat, cold, hypoxia, disease and malnutrition are some of the potential environmental stressors that disturb homeostasis or increase the strain on human being. The coping strategy of human beings with these environmental stressors may be biological and/or cultural. Every individual with its own set of biological potentiality tries to reduce strain or enhance the endurance of strain tolerance- a

phenomenon defined as A*cclimatisation*. Although physiological and epidemiological responses of individuals to a particular environment are representative of a species, yet the concept that all population within a species would respond in the same way was challenged. But remember that A*daptation* and A*cclimatisation* cannot be used synonymously. Adaptation is a genetically fixed condition of a species or subspecies or of a specific group of organism, which favours survival in a particular environment. In other words, adaptation is something which has genetic endowment and the characters are transmitted generation after generation. On the other hand acclimatisation is a temporary biological response to environmental stress, and the response is withdrawn once the stress is removed.

4.2 POTENTIAL ENVIRONMENTAL STRESSORS

4.2.1 Heat and Cold Stress

Our body is divided into two parts (a) the core: inside which all the vital organs are present and work and (b) the periphery or shell (or the extremities, like hands and feet). The main heat reserve and production cite (because of metabolic activities) of our body is the core. The core body temperature is 98.6° F (37° C). But, this core body temperature varies between an acceptable range- 85°F or 29.4°C and 105°F or 40.6°C. However, the rise and fall of core body temperature beyond this acceptable limit disturb the balance or homeostasis of the body. If the core body temperature falls below 85°F or 29.4°C, an individual suffers from hypothermia; and if it goes beyond 105°F or 40.6°C an individual suffers from hyperthermia. The heat produced in the core is transmitted throughout the body. On the other hand, the temperature of the periphery or shell is strongly influenced by the environment and is not regulated within narrow limits like in the core.

Heat transfer in the body Although heat is produced inside the body, it is lost only through the tissues which are in contact with the external environment (mostly through skin). Within the body, heat is transported by two means- *conduction* through tissues and *convection* through blood. Heat flow by conduction is proportional to the thermal conductivity of the tissues (like muscle and adipose tissues), the change of temperature with distance in the direction of heat flow and the area through which the heat flows. Heat flow by convection depends on the rate of blood flow and the temperature difference between the tissue and the blood supplying the tissue. Here, blood capillaries have a major role to play. The blood capillaries have thin walls and together they form capillary bed across a large surface area in various tissues. The heat is exchanged through the thin walls of the capillaries between the tissues and blood.

When is the homeostasis of our body disturbed? During an endogenous heat stress (or cold stress), when the ambient temperature remains below the skin temperature, this heat flux may be enhanced by convective heat exchange between circulatory blood and adjacent tissues with the circulatory blood carrying the warmth from the central core to the peripheral tissues. During periods of exogenous heat stress (or heat stress), when ambient temperature surpasses skin temperature, the rate of sweating and the ability to move heat from the core to the skin's surface to facilitate evaporative heat loss. Both heat and cold stress disturb the homeostasis of the body.

Cold stress

Homo Sapiens is a species and thus its tolerance to cold stress is low. If you carefully follow the record, you will observe that in India, the number of death that takes place during cold season is higher than the hot season. A lesser extreme condition that may develop out of cold stress is numbness and loss of mental alertness.

When the ambient temperature falls much below the normal, the skin looses heat (because of the development of thermal gradient). Under this condition, our body tries to put a check to this heat loss by restricting the flow of blood to the skin. This physiological response of the body to cold is called *Vasoconstriction*. In this process the lumen of the blood vessels becomes narrow because of contraction of muscular walls of the blood vessels, in response to the fall of ambient temperature. The decrease in size of the lumen of the blood vessels reduces the flow of the blood to the skin and hence, heat loss from the body is reduced. However, prolonged absence of blood flow to the skin may affect energy and oxygen supply to the tissues and may contribute to the etiology of cold injury and in extreme situation may lead to frost bite. Here, another physiological response to that is cold, 'Cold induced vasodilation' (CIVD) modulates the effect of vasoconstriction. The response is termed as '*hunting reaction'* or *'Lewis wave'*. Let me give an example. If we put our finger tips in cold water we get a chilling sensation for some time and later numbness develops that region because of vasoconstriction. After some time, we regain sense in the fingers because of the effect of CIVD. This suggests that a periodic oscillation of skin temperature follows the initial decline in skin temperature during prolonged cold exposure. But, the time interval of this periodic switching over from vasoconstriction to vasodilation varies widely. For example, people who are habitual to this situation (workers of ice factory or cold water fisher men) experience a less time interval as compared to those who are not exposed to this situation regularly.

Activity

Take some ice cubes in a container and dip your fingers in it. Initially you will feel a chilling sensation; this chilling sensation will subside after sometime and your fingers will become numb. Gradually, you will regain sense in your fingers.

Shivering thermogenesis is another way by which human population responds to cold stress. Shivering is an involuntary pattern of repetitive, rhythmic muscle contractions. This is often referred as a 'Quasiexercising' state, since the muscles contract but do no external work. Shivering increases whole body oxygen uptake (V_{O2}) and thereby increasing the cardiac output. Since shivering is a muscular activity, metabolic activity increases and thereby more energy produced.

The tolerance level to cold depends on various factors- individual's familiarity with cold exposure, age, physical fitness, type of body armour, intensity of wind speed and duration of exposure. A lean individual, having a larger surface area to body mass is more likely to suffer from cold stress since heat loss from the body surface will be of higher degree. Young adult will be more tolerant to cold because of their ability to generate adequate heat through physical activity. Again, adult women, generally having shorter extremities and greater body weight compared to men are more tolerant to cold stress. Greater body mass to body surface area

means more heat production and greater average subcutaneous fat deposition and thereby heat is restored. Wind speed expedites the heat loss from the body and thereby reduces the heat tolerance.

Behavioural responses, such as taking shelter from the cold and wearing adequate protective clothing, can greatly reduce the physiological strain of cold exposure and obviate the need for nutritional interventions.

Heat stress

Similarly, during heat stress, i.e. when the external or ambient temperature becomes higher than the peripheral or skin temperature, the heat load on the individual rises. Extreme heat stress may lead to fatal heat stroke. In response to this stress, the lumen of the blood vessel becomes wider in order to allow more blood to flow through it (cardiac output increases) and thus more heat is released from the core to the environment via the shell or periphery. This physiological response is called *Vasodilation*. Since vasodilation increases the pressure of the blood down the vessels, cardiovascular strain also increases.

If the heat load still remains high, sweating through eccrine glands begins which releases further heat from the body. Evaporation of 1 liter of sweat takes away 580 kcal of heat and humans can sweat up to 4 liters an hour at the extreme. But the rate of sweating depends on the number of sweat glands that are active. Studies show that people who live in high heat load regions have more number of active sweat glands than their counter parts in cold regions. However, sweating doesn't remain as an effective cooling mechanism if the water vapour content in the atmosphere is high.

The response to heat stress is not uniform. For example, if a person who is a native dweller of cold climatic region visits Delhi during summer, the discomfort level of that individual will be high. The person will sweat profusely, experience cardiovascular strain (because of high level of vasodilatation) and may decide to stay inside the room and take rest. Contrary to this, an individual who is a habitual dweller of Delhi, will not face this discomfort level in a similar situation. Again, all the people who are habitual dwellers of Delhi, will not respond similarly because of their differential plasticity levels. Moreover, an individual who gets the first exposure of heat load in the day will find a high level of discomfort level but, will gradually feel stable as time passes.

Activity

If you start for your office from your home on a day in the hot summer season, for the first 5-10 minutes you will sweat profusely, experience tremendous heat load and cardiovascular strain. However, after some time this discomforts will go, sweating rate will be reduced and cardiovascular strain minimised.

The morphological factors impacting on thermal regulation in humans vary substantially across the population. The impact of these morphological factors becomes more pronounced when one examines the divergent subsets within a population. Individuals differing in body size and composition appear to respond differentially to variations in both ambient and core temperatures. Weight of an individual has a significantly positive relationship with sweat loss. The size of the skin surface also contributes positively towards effective cooling. If an

individual has a larger skin surface compared to mass, then the tolerance level of that individual will be high. A large skin surface means a wider surface area through which heat is released by the process of vasodilation and sweating.

Apart from biological responses, people also adopt certain behavioural adjustment and cultural practices to cope with heat stress. These include their clothing types, structure of houses, building materials used to construct houses, time of activity and food habits.

4.2.2 High Altitude Stress

High altitude environment is signified by decrease in air pressure, decrease in water vapour pressure and increase in radiant energy penetration. Out of these three, decrease in air pressure is crucial for human population. Now let us try to understand with an example how the air pressure decreases with the increase in altitude. Pile up books one above the other. Place your palm below the topmost book and observe the pressure you are experiencing. Similarly place your palm below the last book from the top and experience the pressure. I am sure that the pressures will not be the same; the pressure in the latter case will be higher. Similarly, air in the atmosphere appears to be like layers. Thus, at the sea level the pressure of the air will be the highest and will gradually decrease as you move above the sea level (towards higher altitude). The decrease in air pressure at high altitude also signifies a decrease in oxygen pressure, since oxygen is a component in the air. Breathing is a mechanical process. In this process we voluntarily (subconsciously) develop a low pressure inside the chest cavity by expanding the chest. In the way a pressure gradient develops between the atmosphere (high pressure) and the chest cavity (low pressure) and air gushes inside the lung. Now, if the air pressure in the atmosphere remains low, less amount of air can enter inside the lung and thereby a less intake of oxygen. This phenomenon is called *Hypoxia*. We all know that the red blood corpuscles (RBC) of our body contain haemoglobin, which binds the oxygen that enters with the air inside the lung. At sea level, the oxygen content of the inhaled air is high and haemoglobin becomes 97% saturated with oxygen. But, with increase in altitude level (around 4000m above the sea level), the oxygen pressure decreases and so also the saturation level of the haemoglobin decreases.

An individual freshly exposed to high altitude will experience a low level of oxygen intake, and will response to this stress by increasing the breathing and heart beat rates in order to maintain comfortable supply of oxygen to the body. This condition leads to certain health problems to the new comers of high altitude like, fatigue, nausea, increase in breathing and heart beat rates, difficulty in sleep, a reduction in aerobic capacity. It has been found that their aerobic capacity is lost by 20-30 per cent compared to their capacity at sea level. However, aerobic capacity is restored once they return to their native place (low altitude). The natives of high altitude probably manage to cope with this stress by increasing the count of their RBC, which in turn increases the oxygen saturation level of haemoglobin. But, their work capacity is not improved if they (native high altitude dwellers) go down to low altitude.

4.2.3 Nutritional Stress

Nutritional stress occurs when people fail to fulfill their nutritional requirement. This may be caused by (i) non availability of particular nutrient(s) in an ecological setup and (ii) unbalanced energy flow.

i) The study of diet and nutrition has been a central component of much research in human biology because it represents a critical interface between biology, culture and the environment. It has been argued that the increasing ability of our species to control and utilise energy was the key to understanding cultural development over the history and prehistory of cultural change. Patterns of nutritional and metabolic variation among human populations provide additional insight into the influence of environmental and cultural factors on evolution of nutrition in our species. It was commonly thought that our early ancestors were heavily dependent on meat diet. The variety in stone tool types and the depiction made by prehistoric human being in the form of cave art can be cited as supportive evidence behind this perception. In evolutionary framework, if one goes with this perception, then it becomes difficult to exemplify why the structure of digestive system of modern human signifies the requirement of some other nutrient for our body. A comparative analysis of dietary practices between two contemporary human groups, the Inuits (who are solely hunters) and Kung San (who are hunters and gatherers) will help you to understand this thesis. Inuit diet is largely dependent on meat or other animal body parts (like liver), since their habitat (arctic region) is not conducive for faunal resource. On the other hand, the! Kung San group lives in the jungles of South Africa, with plant and animal dietary resources in abundance. Their dietary practice is more dependent on diversified plant products, rather than meat. It has been observed that the Inuits probably have a lower life expectancy and face more problems related to mastication compared to their South African counterpart because of excessive dependence on meat diet.

We all know that carbohydrate, protein and fat are the major sources of nutrients in our body. Apart from these, vitamins and mineral salts also act as nutrients for our body. Carbohydrate is the principal source of energy for our body. Although fat produces more energy than carbohydrate, yet it is less consumed by the people compared to carbohydrate because of difficulty in digestion. However, there are regions in the earth, like the a Arctic, where people consume animal fat more than carbohydrate for energy because of the easy availability of the former. Again, if we look at some Polynesian communities, we will see that fat is the major source of energy and it is derived from coconut. This demonstrates that people derive their nutrients for their body from the available sources in that ecology. Protein is an important nutrient and is essential for formation of all amino acids present in our body. Human population, being omnivorous, derives this nutrient both from animal and/or plant products. But, there are people who do not consume animal products because of cultural proscriptions or dislike. Thus, these people are totally dependent on plants to obtain protein. It has been found that plants cannot supply variety of amino acids, like the animal products. An inappropriate intake of these three nutrients causes certain disorders among the human population. *Kwashiorkor* and *marasmus* are two advanced forms of protein-calorie malnutrition. They are not two different diseases with different dietary aetiology but two facets of the same disease. It is suggested that marasmus, characterised by severe growth retardation but remarkably well-preserved metabolic processes, represents a state of good adaptation to the stress of protein-calorie malnutrition. The response of the adrenal cortex may be crucial for this adaptation, a normal

increase in plasma-cortisol helping in adequate mobilisation of muscle protein and in maintenance of metabolic integrity. The failure of the adrenal cortex to respond adequately may represent the crucial step in breakdown of adaptation, resulting in the characteristic biochemical and clinical picture of kwashiorkor. The representation of this nutritional disorder comes from the countries like India, Africa, South East Asia, Caribbean and Mexico. The common symptoms of this disorder are: changes in skin pigmentation, decreased muscle mass, fatigue, large belly that sticks out and swelling.

Let me give some examples of other nutritional stress experienced by the people of the world. (a) Water is a nutrient which acts as a medium of transport and regulates the concentration of urine. In hot humid climate, water is used up in the form of sweating as a mechanism of releasing body heat. Again, in desert areas shortage of water in the environment leads to fewer intakes. In both the situation, insufficient retention of water in the body increases the chance of calculi (kidney stone formation). (b) Our body has a high level of salinity and this is critical for many physiological functions. People living in hot and humid climate lose a good amount of salt from their body in the form of sweat. This loss of salt is supplemented through selective dietary practices (plant and animal products). Human beings probably have developed this practice in course of evolution, owing to their origin in tropical regions of the world; may be by increased dependency on meat diet, which is a good source of salt. (c) There are peoples in this world (highland South Americans and Mesoamerican Indians) who lack calcium in their diets. They supplement this deficiency by using burnt limestone as spice in child's food; the adults mix this burnt limestone with coca leaves and chew. The staple food of Mesoamerican Indians is maize. These people prepare maize by soaking it in lime water. This enhances their calcium content of the body. (d) There are communities who consume leafy vegetables, meat and iron rich organs of animals (heart and spleen) to supplement iron deficiency. Use of iron cooking pots, as practiced in rural India and some parts of Africa helps to remove iron deficiency in the body. Again, over dependence of diet on meat and other blood rich organs (as found among the Inuits) or continuous use of iron cooking pots might lead to liver problems. (e) The importance of vitamins as a nutrient and its supplementation through specific diets was understood during the first half of the twentieth century. For example, people who take polished rice are likely to be affected with thiamin deficiency as the rice husk contains thiamin. Raw fish contains antithiamine compound called thiamase. Thus, the practice of consuming raw fish (as practiced by coastal Japanese people) may lead to thiamine deficiency. However, cooking of fish put an end to the action of antithiamine substance and improves thiamine absorption.

ii) The energy requirement of our body varies with body size, levels of physical activity and age. The minimum energy required by an individual when totally inactive and in thermally neutral condition is called basal or resting metabolism. Basal metabolism varies with other factors held constant according to body size. Living in extreme climatic conditions generates energy requirements. For example, living in hot climate leads to additional requirement of energy, since high amount of heat loss takes place through sweating and physical activity. Body size is another factor which varies with energy requirements. A large body size requires greater energy. Some

countries have their own energy requirement recommendations, specific to body size. We perform various physical activities in our daily life. Some of these activity types may be categorized as 'heavy', 'medium' and 'light'. Again, the duration of these activities also differ. For example, the energy requirement of a person who is tailor by profession and the one who works as an agricultural labour will not be the same. It has been found that a fit young adult of 70 kg weight can spend four times more energy than its basal metabolism for a period of 8 hours; but, the result for aged people and children will be different from this estimate.

4.2.4 Infectious Disease

Infectious diseases are also called as communicable disease and are spread from one individual to another through some *pathogens*. Pathogens are organisms that cause infectious disease like, malaria, diarrhoea, AIDS, tuberculosis and chicken pox. Pathogens may be micro (bacteria, protozoa, and virus) or macro (helminthes) in nature. The time period between infection and development of symptoms is called *incubation period* and it varies with the infection type of the pathogen. The length of time between infection and the ability to infect somebody else is called *latent period.*

Infectious diseases are a major cause of human mortality especially for the tropical countries. In fact, the tropical environment is conducive for the growth and survival of pathogens. The reasons are as follows: tropical region has a hot and humid climate; it offers tremendous floral and faunal biodiversity and has high human population density. Human beings are essentially warmth loving, and if you look at the evolutionary discourse, you will find their distribution mostly in the tropical regions, rather than in the temperate. The two most populous continents of the world that come under this region are Asia and Africa. High population density of these two regions leads to the spatial expansion of human settlement and thereby more exploitation of natural resources. For example, large scale denudation of forest took place at the cost of secured food supply and expansion of human base started with the introduction of agriculture in the society. This affected the biodiversity of this region. The pathogens that used to survive on the nutrients of plants and animals are quickly shifting their hosts and finding human as substitute. In this way many diseases which were once believed to have affected non-humans are now becoming human specific. The unicellular pathogens, with their simple cell structure, ability to modify their genotypes and multiply fast are quickly adapting in the body of the new host (human). In the process, human beings are becoming victims to emerging diseases (resulting from new mutations) and are causing more severe stress, compared to the existing ones. With the development of technology, people from the old world started moving to the new world, i.e. North and South America and the Pacific islands. In this way, the aborigines of the new world became victims to some new types of infectious diseases (like small pox, measles and influenza) that are typical of the old world. One may find this to be one of the reasons of dwindling number of aborigines from the new world.

There are two kinds of immune responses to infectious diseases- antibody mediated and cell mediated. Antibodies are proteins (also called immunoglobulin) that appear in serum following exposure to antigen (foreign substance). Repeated exposure to the same antigen elevates the immune response or the level of that

antigen-specific antibody. The second kind of immune response is cell-mediated. If a foreign body enters a cell, the infected cell is destroyed by special killer cells like, lymphocyte and neutrophil through cell mediated immunity. However, human immune system exhibits a complex set of responses to infectious agents that varies with differential biological plasticity. As a result, some of us are more susceptible to certain infections than others. Again, within human population, stress caused by a particular infectious disease is not uniform. Communities that get frequently exposed to a disease or have a historical episode of exposure to a disease are likely to develop an immune system in their body. This immunological adaptation causes less stress to its members than the ones who are newly exposed. Travellers are recommended to protect from illnesses present in other parts of the world and to prevent the importation of infectious diseases across international borders. Which vaccinations you need depends on a number of factors including your destination, whether you will be spending time in rural areas, the season of the year you are traveling, your age, health status, and previous immunisations. For example, there are some recommended vaccines for travel to India. One such is anti-malarial vaccine. The Indians do not administer this vaccine, since the disease is endemic.

An interacting complex between disease, vectors and its hosts should work together for their co-evolution. For example, a disease can be considered as fit (fit in the sense of the survival of the pathogen in the population), when (a) causes less disturbance for host and vector, (b) survives on multiple host and (c) gets adequate replacement of hosts. Pathogenic organisms use various strategies, called modes of transmission, to spread from one host to another. The wide variety of pathogens, vectors and transmission modes involved and the creative intelligence of humans have all contributed to the incredible diversity of strategies humans and other pathogens have evolved in order to survive. Modes of transmission can broadly be divided into two types- direct and indirect. The transmission of causal organisms for measles, influenza, HIV and so on takes place directly from the body of an infected person to another by various means like, sexual or simple body contact, through respiratory and fecal-oral transmission. In case of diseases like malaria, plague and dengue fever, the causal organisms are transmitted via intermediate hosts. Diseases like cholera, hepatitis B and hook worm spread through any medium, may be soil/water/food. If you take a close look at the different modes of transmission of these diseases, you will find that human behaviour and activities like, high population density, unhygienic sanitation and toilet practices, food habit, migration, agricultural practices and construction of dams for irrigation and other purposes are significantly responsible for the growth of pathogens and vectors and transmission of diseases. Let me present few examples. (1) The causal organism(s) of diseases like, measles, mumps and influenza, are found in the droplet of moisture released from the body of an infected person. Thus, the chance of rapid spread of this disease is high among the dwellers of slum and squatter and some areas of old cities, owing to their close living situation. (2) The causal organism(s) of some gastrointestinal illness (like worm infestation) are spread through fecal-oral transmission. The infectious agents get excreted in feces of affected humans and other animals. The susceptible humans come into direct contact with feces and inadvertently introduce the infectious organisms into their mouths and in turn cause illness.

4.3 SUMMARY

Let us sum-up about what we learned in this module. We started our discussion with heat and cold stress. Here we learned the various ways by which our body maintains the heat balance between core and periphery. We further learned how our body morphology is important in maintaining heat balance. *Hypoxia* is the major stress related to high altitude, and people respond differentially to this situation. Nutrition related stress is experienced by people all over the world. This type of stress may occur because of the non-availability of macro or micro nutrients in the ecology or unbalanced energy flow. It is interesting to learn how different groups cope with these various types of nutritional stress with their cultural practices. Human activities and in-activities are responsible for the spread of infectious diseases in human population. But the differential immunological response in human body makes some people more susceptible to infectious diseases than others.

Thus, we learnt about some environmental stress and how these stresses disturb homeostasis. We also learned how human population with their biological plasticity and also by adoption of some cultural practices tries to minimise these environmental stresses or increases their strain tolerance. It is also evident from this discourse that the responses of human to these potential stressors are not the same; there exist intra and inter group variations in response levels. In Anthropology, it is important to studying the variation in the response levels to different environmental stressors.

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Sample Questions

1) What is homeostasis?
2) What is hypoxia?
3) What are the ways by which human responses to cold stress?
4) How heat is transferred in our body?
5) Why tropical environment is conducive for the spread of infectious diseases?
6) When an infectious disease breaks, why the effect is not uniform in human population?
7) What do you understand by co-evolution of disease and host?