Community ecology vs Species diversity : An important aspect of Ecology

Human beings in the onward march of human civilization have been living in the Age of Ecology , and a revolution has taken place over the last 30years centering on the relationships between humans and their environment .The understanding of ecology as being the interrelationships among the organisms are used to unravel the mysteries behind the functioning of the natural worlds. The development of ecology during the century has followed the lines developed by the naturalists during the last century The study of ecology is viewed from three points if view---descriptive, functional or evolutionary. The descriptive point of view is mainly natural history and proceedsby describing the vegetation groups of the world--the functional point of view, on the other hand, is oriented more towards dynamics and relationships and seeks to identify and analyze general problems common to a;; of the different areas. Functional studies deal with populations and communities as they exist and can be measured now.Functional ecology studies proximate causes --the dynamic responses of populations and communities to immediate factors of the environment. Evolutionary ecology studies ultimate causes ---the historical reasons why natural selection has favored the particular adaptations we now see. The evolutionary point out of view considers organisms and relationships between organisms as historical products of evolution.The evolutionary ecologist must work with the functional ecologist to understand ecological systems (Pianka, 1988).The environment of an organism contains all the selective forces that shape its evolution , so ecology and evolution are two viewpoints of the same reality.

the basic problem of ecology is to determine the causes of the distribution and abundance of organisms. Every organism lives in a matrix of space and time. Consequently, the two ideas of distribution and abundance are closely related , although at first glance they may seem quite distinct.In ecology, three levels of integration operate. On one side, ecology overlaps with environmental physiology and behavior in studies of individual organisms, and on the other side, ecology fades into meteorology, geology , and geochemistry when we consider biosphere , the whole -earth ecosystem.

Each level of integration involves a separate and distinct series of attributes and problems.For example, a population has a densitywhereas a community has a species diversity. Some ecologists consider --the biotic community and its abiotic environment --is the basic unit of ecology(Tansley, 1935).

Recognization of communities of living organisms in nature is very old, but specific recognization of the interelations of the organisms in a community is relatively recent.With the recognition of the broad problems of populations and communities, ecology was by 1900 on the road to becoming a science.Its roots lay in the natural history, human demodraphy, biometry and applied problems of agriculture and medicines.

The life of every organism is influenced by its interactions with the environment and with other organisms with which it shares its time and space. an organism brings to these interactions a set of genetically based physical, physiological , and behavioral features that shape their outcome. The patterj of evolutionary relationships among species or other taxonomic groups is called phylogeny which demands special attention to develop deep understanding of its ecological relationships.The ecological studies focussing on the causes and adaptability of ecological interaction with the environment is referred to as ecophysiology which explains the physiological adjustments of the organisms with the changing ecnvironment..In an ecosystem dynamics of energy transformation within and between organisms and the physical environment.

The organisms of the same species living in the same place and time are said to constitute an ecological population. These suits of interacting populations are called ecological communities.The term community provides a variety of meannings to the ecologists.Like population communities are characterised by a number of unique properties, which are reffered to as community structure and community which refer to involve suites of interracting process rather to delineate single community processes or features. The species richness, the number of species, types of species present and their relative abundances, the physical characteristics of the species assemblages, the trophic relationships among the interacting populations in the community are attributes of community structure. Rates of energy flow, properties of community resiliences to perturbations and productivity are the examples of community function

Community structure and function are manifested by a complex array of interactions directly or indirectly trying all members of the community together into the food web. The influence of a population extends to ecologically distanct parts of the community through its competeters,predators and prey.

Natural unit at the community level of ecological organization :

One of the issues that perplexed and polarized the community ecologists was the issue of unity of the community. Whether or not the populations that make up a community interact with one another in the same complex and mutually dependent way that organs of human body interact with one another. That is, is the community a super organism whose function and organization can be appreciated only by considering its place in nature as a whole or does community structure and function simply express the interactions of the individual species constituting the local association without organization, purposeful or otherwise, above the species level ?

The community is a group of plant and animal species that inhabit a given area. As such, understanding the biological structure of the community depends on understanding the distribution and abundance of species. Thus far we have examined a wide variety of topics addressing this
broad question, including the adaptation of organisms to the physical environment, the evolution of life history characteristics and their infl uence on population demography, and the interactions among different species. Integration of the adaptation of organisms to the physical environment involving the species interactions texplain the processes that control community structure in a wide variety of communities .

The Fundamental Niche Constrains Community Structure

All living organisms have a range of environmental conditions under which they can successfully survive, grow, and reproduce. This range of environmental conditions is not the same for all organisms. The conditions under which an organism can function successfully are the consequence of a wide
variety of physiological, morphological, and behavioral adaptations. As well as allowing an organism to function under a specifi c range of environmental conditions, these same adaptations

also limit its ability to do equally well under different conditions. For examples, many plants adapted to high-light environments exhibit characteristics that preclude them from being equally successful under low-light conditions . Animals that regulate body temperature through ectothermy (cold-blooded animals—poikilotherms) are able to reduce energy requirements during periods of resource shortage. Dependence on external sources of energy, however, limits diurnal and seasonal periods of activity as well as the geographic distribution of poikilotherms. The number of offspring produced at any one time constrains the nature of parental care . Each set of adaptations reflects a solution to a set of environmental conditions and, conversely, restricts or precludes adaptation to another. Such adaptations defi ne the fundamental niche of a species.

Environmental conditions vary in both time and space . This observation, when combined with inherent

differences in the fundamental niches of species, provides a starting point for exploring the processes that structure communities. We can represent the fundamental niches of various species with bell-shaped curves along an environmental gradient, such as availability of water or light for plants . The response of each species is defined in terms of its population density or abundance. Although the fundamental niches overlap, each species has limits beyond which it cannot survive. The distribution of fundamental niches along the environmental gradient represents a primary constraint on the structure of communities. For any given range of environmental conditions, only a subset of species can survive, grow, and reproduce. As environmental conditions change from location to location, the possible distribution and abundance of species will change—in turn changing the community's structure.

For example, a framework for comparing the actual interaction patterns as observed within the community is the basis for comparisons in the experiments, which examined in which the interactions between two species (competition, predation, parasitism, and mutualism) are explored by physically removing

one species and examining the population response of the other . If the population of the remaining species does not differ from that observed previously in the presence of the removed species, we could assume that the apparent interspecific interaction has no infl uence on the remaining species'

abundance within the community.

A great deal of evidence, however, indicates that species interactions do influence both the presence and abundance of species within a wide variety of communities. Asit is observed that the, species interactions modify the fundamental niche of both species involved, influencing their relative abundance and, in some cases, their distribution . The process of interspecifi c competition can reduce the abundance of or even exclude some species from a community, while positive interactions such as facilitation and mutualism can enhance the presence of a species or even extend a species' distribution beyond that defi ned by its fundamental niche (Sally Hacker). Because studies that examine species interactions typically focus on only two (or at best a small subset) of the species found within a community, such studies most likely
underestimate the importance of species interactions on the structure and dynamics of communities.

Diffused Species Interactions : As evident from the case study of Norma Fowler

One reason such experiments tend to underestimate the importance of species interactions in communities is that such interactions are often diffuse, involving a number of species . The work of Norma Fowler at the University of Texas provides an example. She examined competitive interactions within an old-field community by selectively removing species of plants from experimental
plots and assessing the growth responses of remaining species. Her results showed that competitive interactions within the community tended to be rather weak and diffuse because removing a single species had relatively little effect. The response to removing groups of species, however, tended to be much stronger, suggesting that individual species compete with several other species for essential
resources within the community. In diffuse competition, the direct interactions between any two species may be weak, making it difficult to determine the effect of any given species on another. Collectively, however, competition may be an important factor limiting the abundance of all species involved.

Diffuse interactions, where one species may be influenced by interactions with many different species, is not limited to competition. In the example of predator–prey cycles, a variety of predator species (including the lynx, coyote, and horned owl) are responsible for periodic cycles observed in the snowshoe hare population . Examples of diffuse mutualisms relating to both pollination and seed dispersal were where a single plant species may depend on a variety of animal species for successful reproduction

Although food webs present only a limited view of species interactions within a community, they are an excellent means of illustrating the diffuse nature of species interactions

Species Diversity Hypothesis : Manifestation of species richness

Species diversity is the diversity of species in an area which includes due allowance for the relative abundance of different species present . It provides a more usefull measure of community characterstics when it is combined with an assessment of the relative abundance of the species present. diversity within ecosystem has been equated with stability and climax communities,

Evolutionary Time Hypothesis (Fischer 1960; Simpson, 1964); It proposes that diversity relates to the age of the community. Old communities (in an evolutionary sense) hold a greater diversity than young communities. Tropical communities are older and diversify faster than temperate and arctic community. Considering a shorter time scale, the ecological time hypothesis is based on the time needed for a species to disperse into unoccupied areas of suitable habitats. Because not enough time has passed since the glacial period for many species to move to temperate zones, these areas are unsaturated by the species they now support Many cannot move until barriers to dispersal are broken: others are moving out to tropics into temperate zones.

The Spatial hetergeneity hypothesis (simpson , 1964) Holds that more complex and heterogenous the physical environment, the complex will its flora and fauna be.The greater the variation in topographic relief , the more types of habitats the community contains(BITA diversity); the more complex the vertical structure of vegetation(ALPHa diversity); the more kinds of species it hold. The fact that communities with marked vertical structure hold more species of birds supports this theory(MacArther, 1972; Person 1971).

Several hypothesis relate to climate

1) **The climate stability hypothesis**(Fischer, 1960 ; Connel and Orias,1964) states that because a stable climate, one does not change much with the seasons, provides a more favorable environment, the species richness will be high. Organisms living in a constant bening climate, typical of tropical regions, would not require the broad tolerance limits needed by species living in a more variable climate. Constant environment would favor specialization in feeding niches and microhabitats. Such specialization would increase species diversity, typical of the tropics.

2) The climate predictability hypothesis relates species diversity in temperate and polar regions to a variable but predictable climate. In such climates organisms have evolved some dependence on regularly occurring changes and specialize on conditions that recur every year. Migratory birds respond to seasonal climate changes by arriving at the most favorable periods for nesting and leaving before adverse climate changes return. These responses result in the temporal diversity in the region.

3)The energy hypothesis , originally advanced by J. Brown 1981, predicts that in regions of roughly equal area, energy flux per unit area should be the major determinant of species diversity (Currie 1991) . for trees primary production represents realized capture of solar energy , the best indicator of which is actual evapotranspiration. Among, vertebrates, the regulation of body temperature is closely linked to atmospheric energy. It is best correlated with latitude and variability in solar radiation.

Sanders (1968) modified the climatic stability hypothesis assumes that two contrasting types of communities exist : the physically controlled and the biologically controlled. In physically controlled communities organisms are subjected to physiological stress, which increases the probability of low reproductive success and srvival. These condition result in low diverslty. In biologically controlled communities , physical conditions are relatively uniform over long periods of time and are not critical in controlling species. Evolution proceeds in the lines of interspecific competition, one species adapting to the presence of other species and sharing resources with it. The environment is more predictable, the physiological tolerances are low and diversity is high. However, no community is wholely physically controlled or biologically controlled.

4) Productivity hypothesis relating to climate stability (Connel and Orias , 1964) proposes that the level of a community is determined by the amount of energy flowing through the food web. The rate of energy flow is influenced by the limitation of the ecosystem and by the degree of stability of the environment. The productivity hypothesis also states that the more nutrients available and greater the productivity , the greater the diversity.

5) A competition hypothesis, originally proposed by Dobshanky (1951) and C.B.Williams (1964) contains some elements of the climate stability hypothesis . In tropical regions, where the climate is benign and stable, populations of species reach near maximal size. As a result both interspecific and intraspecific competion are high. Under selection pressures, selection favors specialization in foods and microhabitats. Species occupy narrow niches , which makes for high diversity. In temperate and polar regions, where the climate is benign and more variable , populations rarely reach their maximum size. Because competition for resources is relatively low and tolerance limits are broad., the species are not strongly specialized. As a result , niches are broad and the species diversity is relatively low. In such regions, selection is controlled largely by physical habitats.

6) A **predation hypothesis** also has been proposed to account for species diversity, particularly on a local and regional basis (Paine, 1966). The hypothesis propose a higher species diversity in those communities in which predators reduce prey species to a numerical level where interspecific competition among them is greatly reduced. The reduction in competition allows the coexistence of number of prey species.

7) A **dynamic equilibrium hypothesis** as proposed by Huston(1979) was based on the differences in the rates at which populations of competitive species reach competitive equilibrium. The major determinant of diversity in nonequilibrium situations is the population growth rate of the competitors. Most communities fail to achieve equilibrium because of a fluctuating environment and periodic reductions in populations. In the absence of disturbance, an increase in the population growth of major competitors results in low diversity.

8) The **random niche model (MacArthur** , 1960) views abundance as a random partitioning of resources distributed along a continuum. The model assume that species in the community use the critical resource with no overlap between species.

9) The **niche preemption hypothesis** supposes that the most successful or dominant species preempts the most space. The next most successful claims the next largest share of space, and the least successful occupies what little space is left. This model produces the highest dominance and lowest evennes of the three models. Such a distribution is achieved by a few plant communities containing few species and occupying severe environments such as a desert. in most plant and animal communities, species overlap in the use of space and resources.

10) The log -normal hypothesis (Preston, 1962) supposes that niche space occupied by a species is determined by a number of conditions, such as food, space , micro-climate and other variables that affect the success of one species in competition with another. The log-normal distribution most closely approximates the distribution of importance values obtained from communities rich in species. It is most useful in summarizing observed abundance relationships within and major communities. all these distributions describe species abundances, but they are of little value in determining the underlying causes for the observed abundance relationships.