7. SPECIES DIVERSITY.

The data most basic to the understanding of community structure are the number of species present and their relative abundance. In nature, we find that some communities are rich in the number of species (like perrrenial forests of tropics, oceanic environment etc) while certain others (like estuaries) are relatively poor in this respect. Ecologists agree that there is a general increase in the number of species from higher latitudes towards the tropics. However, the reasons for variations are far from clear. Several theories with respect to this have been suggested, but no single explanation is sufficiently cogent to pinpoint the variations.

Within the tropical aquatic environment itself we find that there is a decreasing gradient in diversity from oceanic to neritic and to estuarine habitats. Mac Arthur (1965) stated that "the number of species within a habitat can be expected to increase with productivity (sometimes), with structural complexity of the habitat, lack of seasonality in resources and

the degree of specialisation". Various theories involving time (older communities have more numbers of species), spatial heterogenity (more heterogenous physical environment supports more species), competition (leads to narrow niches), predation (reduces competition and allows more prey species), environmental stability (more species in stabler environments) and productivity (greater production results in greater diversity) have been put forward. However these theories, apart from lack of general stability of the environment do not explain the lower diversity in the estuaries.

Ecologists argue that negative feed back in ecosystems damps perturbations and the stability or the resilience of the environment contributes to higher diversity. The idea that ecosystems possess such stability was introduced by Mac Arthur (1955). Ecologists' subsequent efforts to verify this hypothesis became complicated by attempts to define stability and diversity in operational ways (Patten and Odum, 1981). "Increased stability with increased species is difficult to demonstrate.... Models reduce the intricate beauty and awesome complexity of a piece of living nature to what is by comparison

a flat pallid image of reality. An ecosystem model, no matter how sophisticated or difficult to produce is but a shadow of its prototype" (Patten et al., 1975).

Environmental conditions in tropical estuaries are highly fluctuating unlike marine environment. A more or less stable condition in estuaries is attained only during the saline premonsoon months and zooplankton species are more diverse during this period compared to other seasons.

Two indices, 'D' (Margalef, 1968) and 'E' (Heip, 1974) were used to evaluate the diversity of zooplankton in the estuaries. The formula used for the index 'D' was,

$D = \frac{S-1}{\log_e N}$, where S is the number of species and N is the number of individuals of all species and for E was

$E = \frac{e^H - 1}{S-1}$, where S is the number of species.

The index 'D' is relatively stable compared to α (Fisher et al., 1943) but this index also possess the drawback that it is affected by the sample size. The evenness index is the ratio between

the actual diversity and the maximum possible diversity which occurs when all species are equally abundant and ranges from 0 to 1. In short it gives the evenness in distribution of species within the sample. Evenness is the inverse of dominance.

The number of species and the indices 'E' and 'D' for the eight estuaries are given in Table 9. Diversity value, 'D', was higher during the salinity regime and lowest during the peak monsoon months. At Neendakara the values remained high throughout the year. In ranged between 3.2 and 7.0. Salinity was also high at the mouth of this estuary in most months. In the Cochin backwaters these values ranged between 2.2 and 5.3 comparatively higher values being observed during the time when salinity recovery started. Both marine and true estuarine forms occur at the mouth during this period. The values were comparatively lower in the Korapuzha estuary.

The index 'E' was highest at Thottappilly lake and to some extent at Veli also. In the other estuaries higher values were observed in certain months especially when the species number and zooplankton population were low. Thus during this period although the number of species was less, their distribution within the total numbers was more or less even.

The number of species which occurred showed more or less a direct correlation with salinity when the distribution in the upstream areas of Cochin backwaters was analysed (Fig. 31). There was a progressive decrease in the number of species along the salinity gradient towards the upper reaches. During July when the system was practically fresh water, only very few organisms tolerating low saline conditions thrived in the estuaries.

In almost all the estuaries, the greatest diversity occurs near the mouth where a wide range of neritic species also appear. Some of the higher values (D values) observed in some estuaries especially at Neendakara (7.0 in April, 6.1 in September) are because of stray occurrences of some of the coastal and neritic species. Thus if the estuarine and euryhaline species which are common in the estuaries only are taken into account and the less tolerant neritic species omited, the indices would be still low.

Species diversity in estuarine zooplankton was low compared to coastal or oceanic waters. The average diversity index 'D' ranged between 1.5 and 5.5 in these estuaries. It ranged from 3.1 to 7.7 in a nearshore environment (Haridas et al., 1980) from 8.2 to 12.9 in

the coastal and oceanic waters of the Bay of Bengal (Nair et al., 1981) and from 3.2 to 8.1 in the Andaman Sea (Madhupratap et al., 1981). Thus there is a progressive gradient in the zooplankton diversity from estuarine environment to open ocean. A similar trend was observed for the tropical benthic communities by Sanders (1969). He maintains that estuaries are in principle physically controlled environment, unlike the open ocean which is more stable and develop biologically accommodated communities. The number of species present diminish continuously along the stress gradient from a stable environment to habitats where conditions are fluctuating and finally when the stress conditions become greater than the adaptive abilities of the organisms, an abiotic condition is reached.

Diversification has several important implications for the community. Ricklefs (1973) says that many species can exploit different kinds of resources more efficiently because the evolutionary independence of reproductively isolated populations allows specialisation. Further, diversity creates heterogenity in the environment which provides the basis for increased diversification of life forms. Whether species exploit more ecological roles in areas of high diversity in view of

the greater variety of ecological opportunities or because species diversity to avoid competition, or both, is still open to question.

Productivity or spatial heterogenity are certainly not the factors affecting the species diversity in the estuaries. Analogous situations where diversity tend to decrease with higher standing population have been reported (Deevey, 1971; Nair et al., 1981). Phytoplankton diversity has been found to be high in oligotrophic areas compared to eutrophic areas (Peterson, 1975). It can only be speculated that lack of stability or time to diversify (only the intermonsoon period allows some diversification) and the constant physical changes of the environment lead to a lesser diversity in the estuaries.

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