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A COMPARATIVE STUDY ON SPECIES DIVERSITY, DISTRIBUTION AND ECOLOGY OF THE DINOPHYCEAE FROM VELLAR ESTUARY AND NEARBY BAY OF BENGAL

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ABSTRACT

A detailed study of the Dinophyceae was carried out for a period of two years. Of the 103 species recorded and described about 20 are oceanic elements. Some of them such as *Ornithocercus* (5 spp.), *Ceratocorys horrida, Ceratium praelongum, C. ranipes, C. teres* and *Dinophysis cuneus* are indicators of upwelling. Species diversity index with related parameters namely, species richness and evenness showed maximum values during summer seasons. An inverse relationship between species diversity and dominance was noticed. Intermediate salinity values were found to be favourable to dinoflagellates. Species belonging to other major geographical regions have been recorded.

INTRODUCTION

PHYTOPLANKTON are of great biological and ecological significance. Among them the Dinophyta (dino flagellates) are second only to diatoms (the Bacillariophyta) in abundance and at times even surpass them. These microalgae are of diverse assemblage having either autotrophic or auxotrophic or parasitic modes of nutrition. Some of them are phagotrophic grazers too. They form symbiotic consortia as well. It is believed that sometimes their contribution to primary production would be more than that of the diatoms (Blasco, 1975). At the same time the blooms of toxic dinoflagellates (e.g. *Gonyaulax catenella, Ptychodiscus breve*) causing also red tides may result in mass mortality of aquatic animals and thereby affecting the marine economy. The study of plankton and the limiting factors of their production form fundamental aspects. Such studies involving the Dinophyceae are rather limited particularly from the Indian waters.

There is a corpus of literature on their taxonomy (Subrahmanyan, 1968, 1971 ; Krishnamurthy *et al.*, 1977, 1978, 1980). Aiyer (1936) and Prasad (1953) from the east coast and, Bhimachar and George (1950) and Prakash and Sarma (1964) from the west coast described the red tides caused by dinoflagellates and their impact on fishery. Qasim *et al.* (1972) studied the influence of salinity on the abundance of phytoplankton including two dinoflagellates. Devanesan (1942), Prasad and Jayaraman (1954) and Prasad (1958) from the east coast reported on the feeding habit of *Noctiluca* and its effect on plankton community and relationships with hydrological conditions. Krishnamurthy *et al.* (1978) reported the presence of four indicator species of dinoflagellates from Porto Novo Coast. From the foregoing account it is evident that detailed studies on floristics, biomass, species diversity

and ecology exclusively on dinoflagellates of Indian waters are scanty. Hence, the present study was planned.

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Material and Methods

Phytoplankton samples were collected fortnightly for a period of two years from April 1978 to March 1980 from two stations. Station I (Neritic) is situated on the 10 m line in the nearshore water of the Bay of Bengal at Porto Novo (11° 29'N ; 79° 46'E). Station II (Estuarine) is situated in the marine zone of the Vellar Estuary which is influenced by both the neritic waters of the Bay and the freshwater flow of the River Vellar. The backwater also joins here. The methods of collection, preservation enumeration of standing crop, etc. are described elsewhere (Ilangovan and Krishnamurthy, 1983). The methods of determining the cell carbon content from plasma volume for computing the biomass of dinoflagellates are available in another communication (Ilangovan and Krishnamurthy, 1985). Species diversity index was calculated based on Shannon-Wiener function (Shannon and Weaver, 1963). Species richness was worked out using Gleason's (1922) formula. Evenness was computed using the formula of Edden (1971). Dominance index based on cell count and carbon content was calculated using the formula of McNaughton (1967).

Results and Discussion

In the present study a total of 103 species of the Dinophyceae belonging to 19 genera was recorded (Ilangovan, 1981). Of them only 27 were recorded exclusively from the neritic station. Thus, approximately three fourths were recorded from the estuarine station also, revealing its richness in species composition.

Species diversity is an important parameter of an ecosystem (Mac Arthur, 1965 ; Margalef, 1968). The community structure could be understood by a study of species diversity index, which helps in summarising a large body of data. In the estuarine station during 1978 the species diversity index (H') ranged from 0.55 to 3.30 (October and May 1978 respectively) and from 0.93 (April) to 3.77 (August) during 1979 and between 2.26 and 3.98 (February and March 1980 respectively) (Fig. 1). In the neritic station

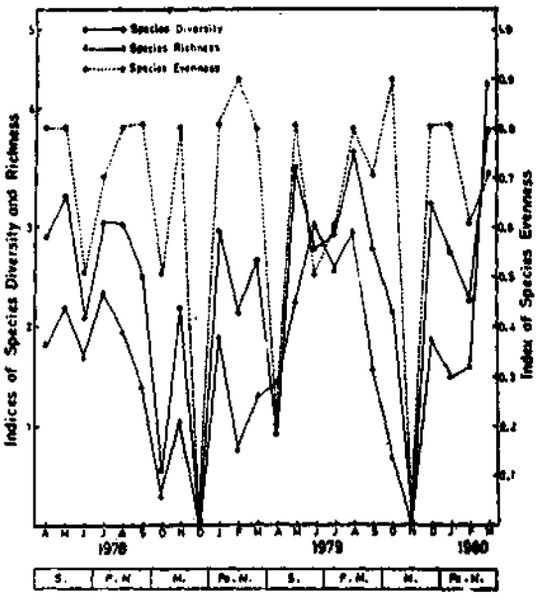

Fig. 1. Variations in the species diversity, richness and evenness at the estuarine station.

(Fig. 2) it ranged from 1.97 (September 1979) to 3.75 (May 1979). The maximum values observed for the two year period were 3.48 (May, 1978), 3.75 (May, 1979) and 3.71 (March, 1980). Lower values were observed from

September to November in 1978 and January, March and September 1979.

The species diversity showed a good relationship with species composition (richness). The maximum diversity value generally coincided with the presence of maximum number of species and the minimum species diversity index values with less number of species in both the stations. Kricher (1972), De Jong (1975) and Eloranta (1976) have also reported about increase in diversity as the number of species increased. However, in some months, increase in number of species did not cause increase in diversity. This was due to uneven distribution of individuals among species. It has been observed that in such cases, where only a few species remain dominant followed by rapidly decreasing numbers of other species, diversity would be low (Sager and Hasler, 1969 ; Margalef, 1978).

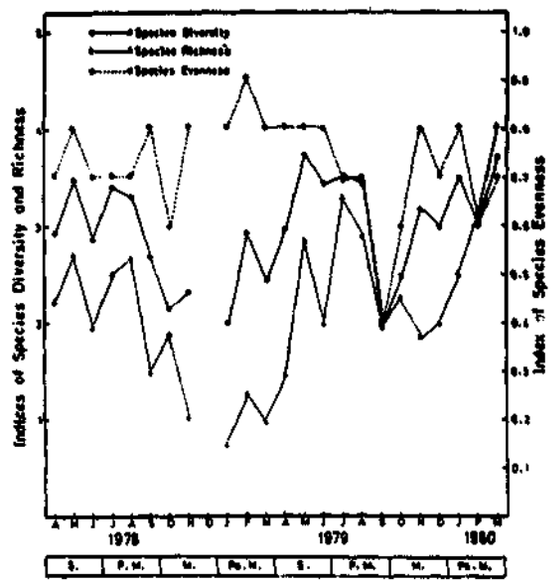

Fig. 2. Variations in the species diversity, richness and evenness at the neritic station.

It was interesting to note that at both the stations the maximum diversity values were observed during the summer month of May in both 1978 and 1979. This could be attributed to the prevailing stable environmental conditions during the summer season. High values of species diversity during July and August (Premonsoon season) of 1978 and 1979 were accomplished by intermediate salinity values (Fig. 3), favourable for the growth of many neritic and estuarine dinoflagellates (Braarud and Rossavik, 1951 ; Nordli, 1957 ; Qasim *et al.*, 1972). A general trend registering lowering values of diversity index during Monsoon season (October-December) could be ascribed to turbidity caused by northeast monsoon rainfall causing flood. An unusual low value of species diversity during September 1978 and 1979 could also be due to the same reason, because of the unprecedented heavy rains in that month in both the years (Fig. 4). Margalef (1968), Eloranta (1976) and Wilhm *et al.* (1978) observed low values of diversity in turbid conditions. The increase in diversity index from the Monsoon to the Postmonsoon season (January to March) could be due to an accumulation of nutrients then (Kannan, 1980).

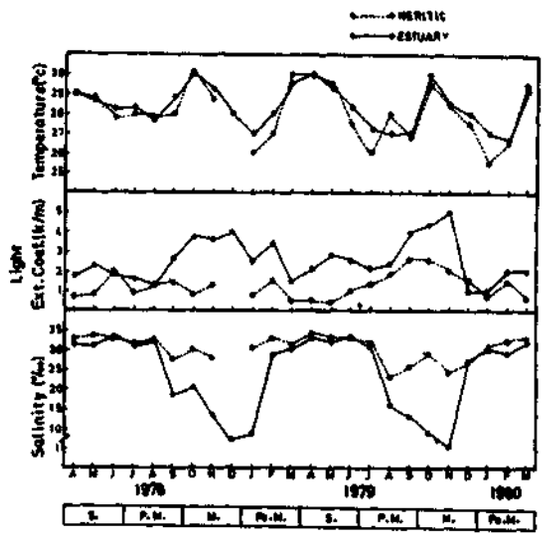

Fig. 3. Variations in the hydrographical parameters at both the stations.

Evenness index ranged between 0.49 and 0.98 in the neritic station and between 0 and 0.93 in the estuarine station. The maximum evenness values generally coincided with the maximum species diversity indices. De Jong (1975) and Eloranta (1976) observed that evenness and diversity were interlinked.

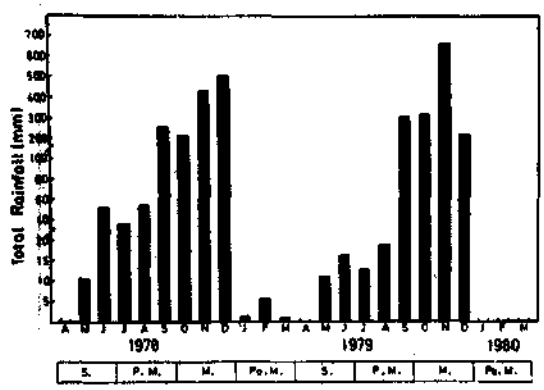

Fig. 4. Total monthly rainfall at Porto Novo during the study period.

The organisational structure of a biotic community could be inferred also using dominance index together with diversity index (Hulburt, 1963; Whittaker, 1965; McNaughton and Wolf, 1970). Dominance and diversity are inversely related (McNaughton, 1967). In the present study also statistically, a negative correlation between species diversity and dominance indices was found both in the estuarine ($r = -0.95$) and neritic ($r = -0.74$) stations, thus lending further support to their findings.

In the present study species belonging to other major geographical regions have been recorded in Table 1.

TABLE 1

Major biogeographical province	Dinoflagellate taxa	
	Number	Percentage
Cosmopolitan	10	10.30
Temperate-tropical	47	48.43
Tropical	33	34.00
Indo-Pacific	2	2.07
Indian Ocean	1	1.05
Others	4	4.15

The Table shows the predominance of temperate-tropical and tropical forms. In a sense this shows a wide mix up of species belonging to various biogeographical realms. It was interesting to observe that the number of Indo-Pacific representatives were very poor as also observed earlier by Krishnamurthy *et al.* (1978).

Of the 103 species recorded and described (Ilangovan, 1981) about 20 are considered as belonging to oceanic realm and as indicators of presence of oceanic elements in plankton (Wood, 1969). They were (with the species recorded here in paranthesis): *Amphisolenia* spp. (*A. bidentata A. thrinax*, *Amphisolenia* sp.), *Ceratium carriense*, *C. karstenii*, *C. teres*, *Ceratocorys armata*, *Dinophysis cuneus*, *D. hastata*, *Gonyaulax scrippsae*, *Heteraulacus polyedricus*, *ornithocercus* spp. (*O. magnificus*, *O. quadratus*, *O. splendidus*, *O. steinii*, *O. thumii*), *Protoperidinium claudicans*, *P. elegans*, *P. okamurai*, *Podolampas* spp. (*P. palmipes*) and *Pyrocystis robusta*. This could be due to southwest drift current and the counter current flowing along this coastline (Krishnamurthy *et al.*, 1978).

It is noted here that in Porto Novo coastal waters many upwelling indicator species of dinoflagellates were also observed in the present study. They were: *Ceratium declinatum*, *C. geniculatum*, *C. praelongum*, *C. ranipes*, *C. teres*, *C. horridum* var. *tenue* (= *C. tenue*), *Dinophysis cuneus*, *D. hastata*, *Protoperidinium elegans* and *Ornithocercus* sp. Most of these were encountered only once (September 1978). These have been considered as 'shade' species (Graham and Bronikovsky, 1944; Balech, 1967; Wood, 1969). The particular

presence of *Ornithocercus* spp. has been characterised as a clear case of upwelling by Wood (1969). The upwelling is indicated in varying degrees in the Bay of Bengal (Krishnamurthy *et al.*, 1978). Usually upwelling occurred during July (La Fond, 1957; Murty and Varadachari, 1968). It may show slight annual variation. Upwelling along the Andhra Coast off Waltair is well known for this region. Weak upwelling has been reported off the Karaikal Coast (Murty and Varadachari, 1968). In the nearshore waters of Porto Novo Coast, the trend of upwelling is indicated by different hydrographical features and by the presence of upwelling indicator dinoflagellates.

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