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ABUNDANCE AND DISTRIBUTION OF INTERTIDAL POLYCHAETES IN THE VASISHTA GODAVARI ESTUARY

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ABSTRACT

The abundance and distribution of polychaetes in 270 samples collected from the intertidal zones of the lower 16 km stretch of Vasishta Godavari estuary is discussed in relation to temperature, salinity, dissolved oxygen, substratum, composition and organic matter content in the sediment.

Salinity in the estuary varied from near zero during July to 35‰ in May. The organic matter content of the sediment ranged from 0.11 to 4.2%. The polychaete abundance which was high during the summer period (March–June) reduced markedly during the annual freshwater flood period (July–September). The numbers gradually increased again during the recovery period (October–February) when the 'seasonal migrants' started entering and settling in the estuary in progressive stages depending upon their capacities to tolerate fluctuating salinities and differences in the composition of substratum. The estuary exhibited high polychaete diversity.

Key-words : Distribution, intertidal, polychaetes, estuary.

INTRODUCTION

Studies on the benthic fauna inhabiting the coastal water bodies has gained importance in the context of assessing the brackishwater and estuarine production. In addition to the estuarine bottom the extensive mudflats formed in the lower reaches of the estuaries are also known to contribute significantly to the total productivity of the estuaries by harbouring a great variety of micro- and macro-organisms.

Although the work on the brackishwater and estuarine organisms started in the early 20th century in India, it mainly dealt with the systematics of different groups. Due to the abundance and variety, the polychaetes received considerable attention. The estuarine research carried out in India is well documented by National Institute of Oceanography (1981).

This paper presents the distribution and abundance of polychaetes at various tidal levels on the muddy beaches at different selected localities in the lower reaches of the Vasishta Godavari estuary, in relation to the physical factors including the substratum composition and the organic matter content in the substratum.

MATERIALS AND METHODS

River Godavari, the second largest in India, divides into two branches namely the Vasishta Godavari and Gautami Godavari. The Vasishta Godavari open into Bay of Bengal at Antervedi 16°18′N and 81°42′E). The tidal influence generally occurs upto 25 km in the estuary and the tidal range in the estuary varied from 1 to 1.5 m. However, only a 16 km stretch of the lower reaches of the Vasishta Godavari estuary extending between the confluence at Antervedi to about 2 km beyond Narsapur town was investigated. Six stations were fixed along the bank of the estuary against permanent land marks for regular sampling (Fig. 1).

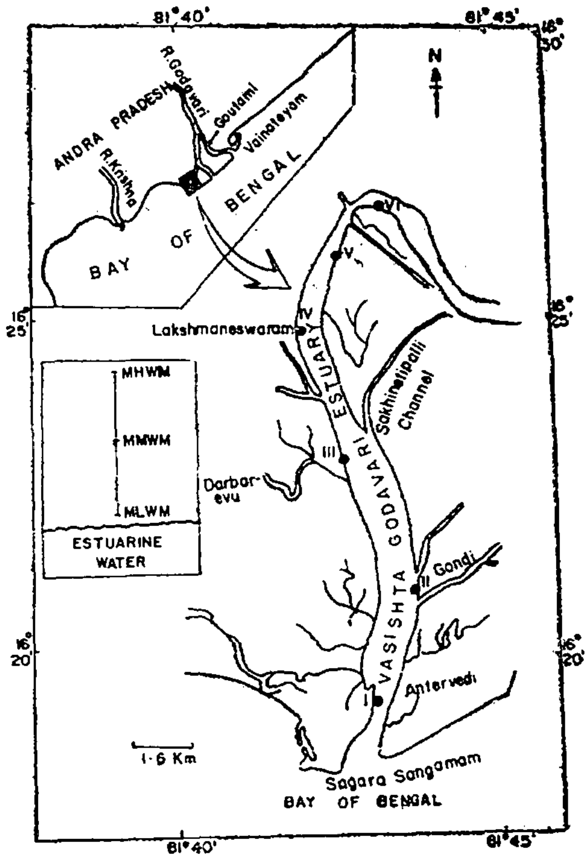

Fig. 1. Station location map.

At each station collections were made systematically at monthly intervals at three tidal levels viz., mean high water mark (MHWM), mean mid water mark (MMWM) and mean low water mark (MLWM).

Temperature was measured using a thermometer of 0.1°C sensitivity. For estimating salinity and dissolved oxygen, water samples were collected from a small hole made in the mud where water seeped in. Sediment was collected by pushing a PVC corer into the sediment. Faunal collections were made employing a metallic frame of 20 x 20 x 15cm. The sediment was initially sieved in the field itself by using a 0.5 mm mesh sieve. Polychaetes were narcotised using magnesium sulphate and preserved in 5% formalin. Further details of analysis are given in earlier publications (Srinivasa Rao, 1980; Srinivasa Rao and Rama Sarma, 1980, 1981). Analysis of water was made following standard methods. Sand, silt and clay fractions were separated in suspension following the pipette method of Krumbein and Pettijohn (1938). Organic matter in the sediment was estimated following the method suggested by Gaudette, Wilson, Toner and David (1974).

Altogether 270 samples were collected during September 1976–January 1978, covering all the stations uniformly.

RESULTS AND DISCUSSION

Monthly changes in hydrographical parameters at six stations are presented in Figs. 2–7.

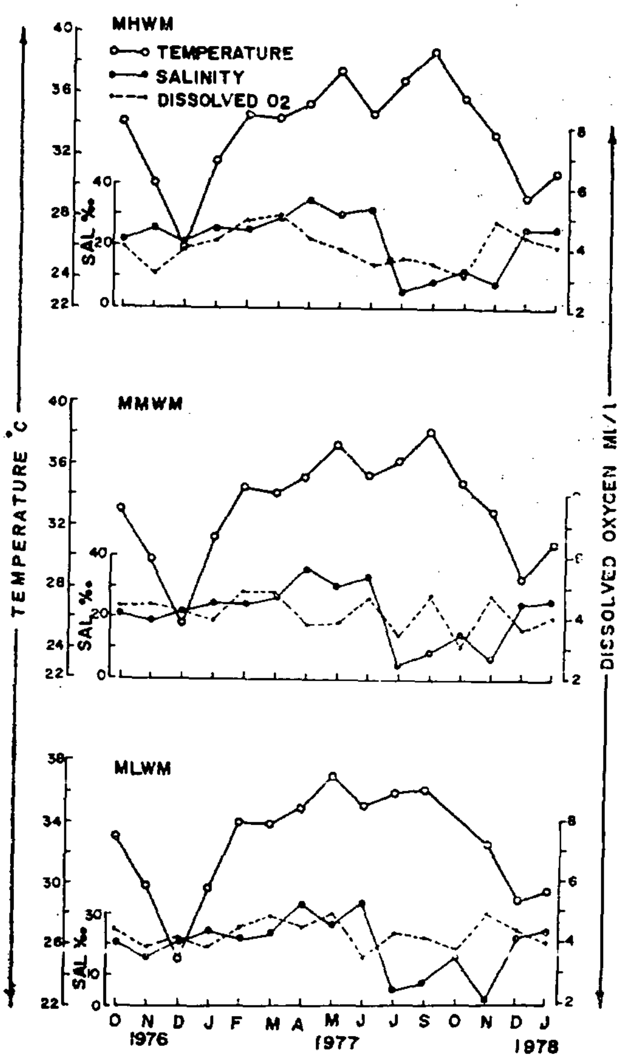

Fig. 2. Monthly variations in temperature, salinity and dissolved oxygen of interstitial water at three tidal levels at Station I.

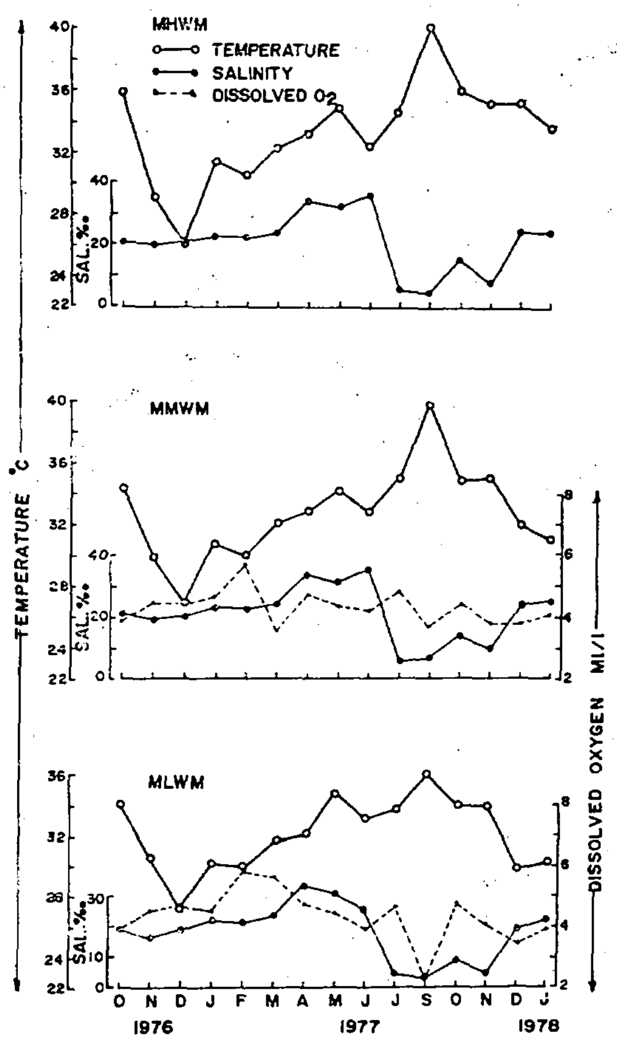

Fig. 3. Monthly variations in temperature, salinity and dissolved oxygen of interstitial water at three tidal levels at Station II.

Temperature of the sediment ranged from 22 to 40.2 °C and generally followed changes in atmospheric temperature exhibiting a bimodal curve. At all stations, because of differences in the duration of exposure during the low tide phase, the temperature was high at the MHWM and gradually decreased to MLWM. The differences in the temperature of the exposed sediment at MHWM and MMWM ranged from 0 to 1.1 °C for the entire period of study. Similarly, the differences between MHWM and MLWM ranged from 1.2 to 4.4 °C. Maximum temperature difference between the surface and that at 10 cm depth of the sediment was 1.5 °C.

Interstitial water salinity ranged from near zero to 37‰. However, the minimum and maximum salinity values varied from station to station.

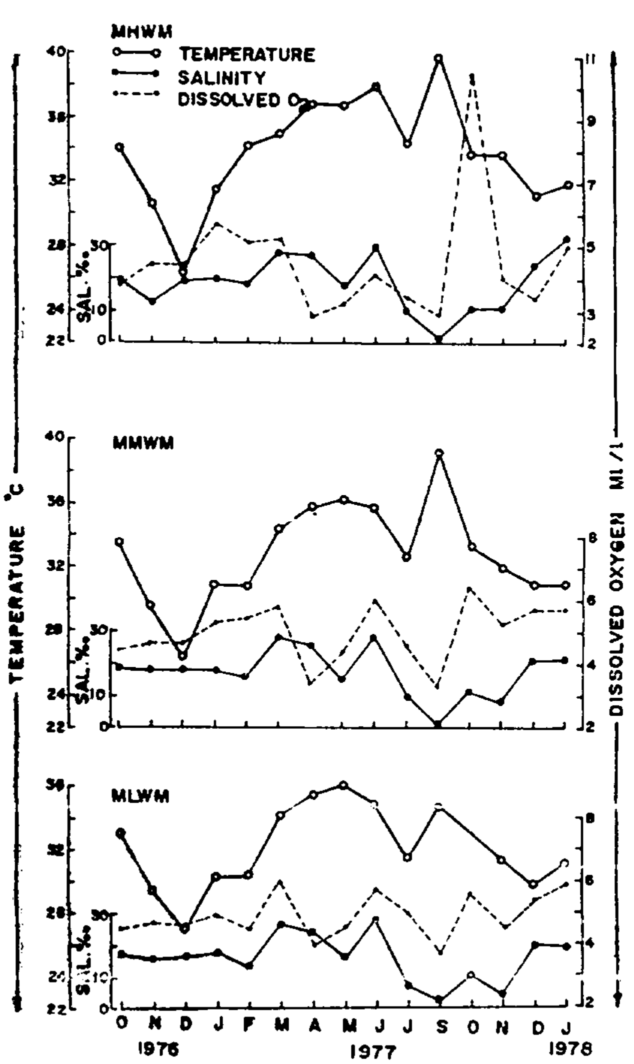

Fig. 4. Monthly variations in temperature, salinity and dissolved oxygen of interstitial water at three tidal levels at Station III.

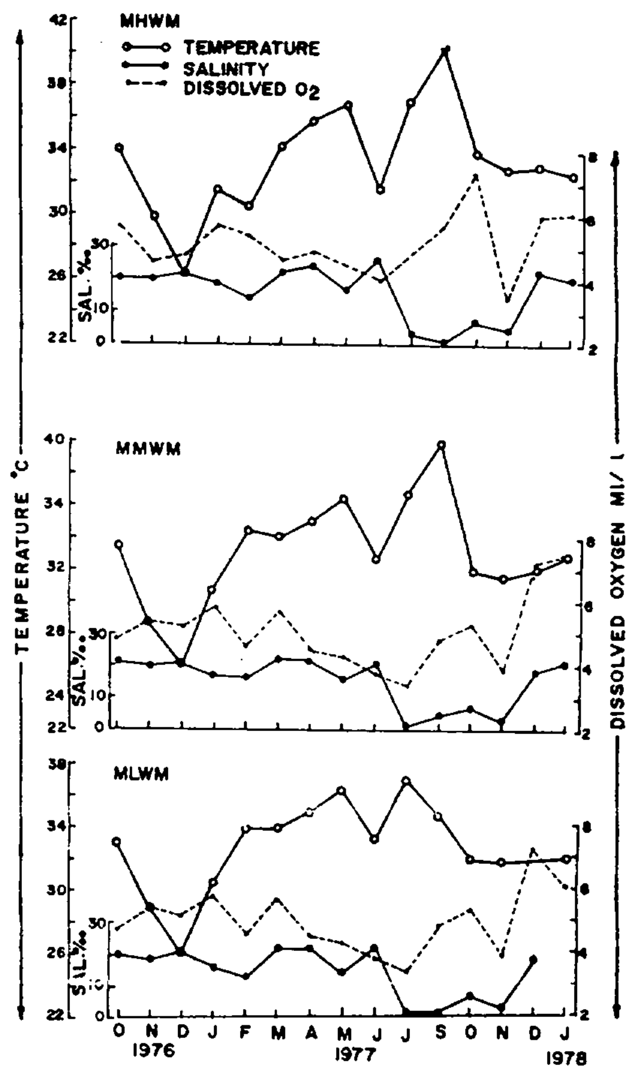

Fig. 5. Monthly variations in temperature, salinit and dissolved oxygen of interstitial wate at three tidal levels at Station IV.

Highest salinity was recorded in April and lowest in July. Salinity at MHWM was higher than that at MMWM where the salinity was always higher than at MLWM. Salinity at MLWM was similar to that of adjoining estuarine water with reversed trend occasionally noticed because of let off of the irrigation water from nearby paddy fields.

Depending upon the annual salinity data obtained in the estuary, three distinct salinity periods were distinguished. The annual freshwater flood period (July–September) when the entire estuary was filled with freshwater discharge (salinity near 0‰). The recovery period (October–January) marked by the receding floods and the incursion of neretic water (salinity 10–16‰) and the summer period (February–June) dominated by the neretic waters (salinity 25–35‰).

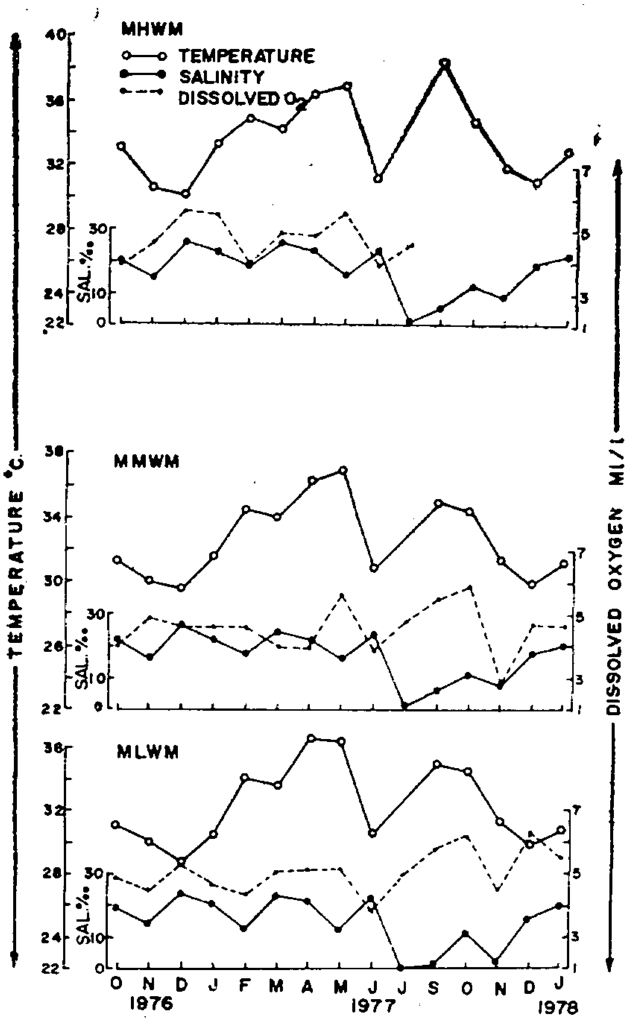

Fig. 6. Monthly variations in temperature, salinity and dissolved oxygen of interstitial water at three tidal levels at Station V.

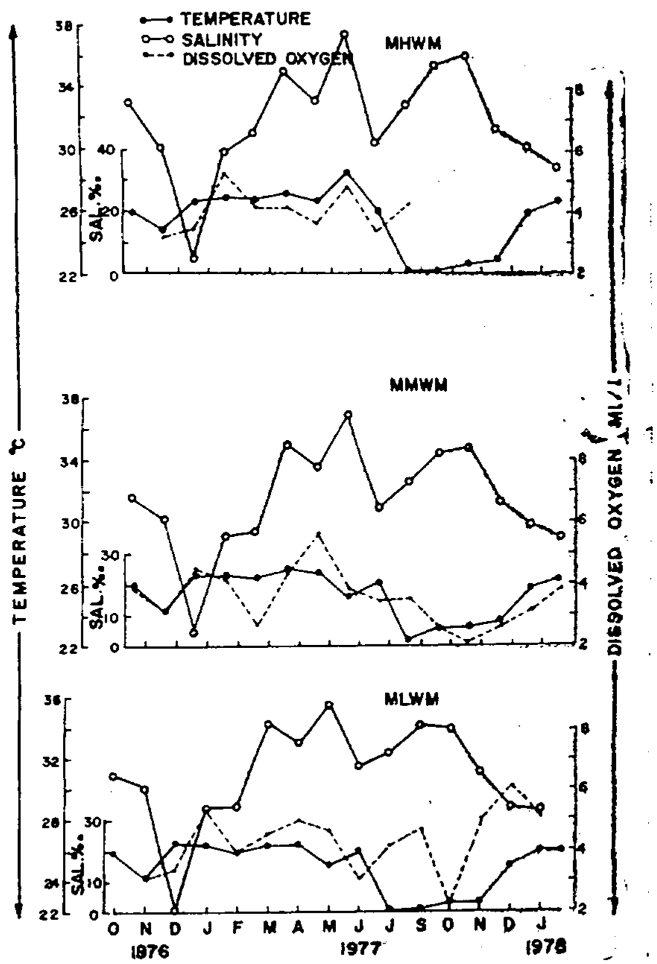

Fig. 7. Monthly variations in temperature, salinity and dissolved oxygen of interstitial water at three tidal levels at Station VI.

Dissolved oxygen varied between 2.2 and 10.4ml/l. The highest value was obtained only once and reasons for such high value in the estuary remains unexplanable. A pronounced oxygen gradient was observed along the transect, with steady decrease from MLWM to MHWM. The low oxygen value obtained on certain occasions may be due to the utilisation of oxygen by decomposing organic matter of aquatic and terrestrial origin. This was evident by the presence of black coloured sediment which emitted foul smell owing to the putrefaction of organic matter in the sediment.

The sediment was predominantly sandy near the river mouth (stations I and II), as this area is influenced by neretic waters. The silt-clay fraction increased with increasing distance from the river mouth (stations III-VI) under the influence of the river. The sediment distribution showed variation along the transects at various stations. The silt-clay fraction increased down the transect.

The sediments of the estuary are classified following Folk (1968) and their composition during the pre-flood (April–June) and post-flood period (September–November) is given in Table I. The minimum, maximum and average organic matter content in the sediment is presented in Table II.

Organic matter was generally low at the river mouth and increased upstream with increasing distance. The low organic matter at the seaward stations I and II may be due to the sandy nature of the substratum and sufficient aeration. The high silt clay and the compact nature of the sediments

Table I. Sand, silt and clay percentages in the sediments at three tidal levels at different stations during pre-flood and post-flood periods.

Station	Tidal level	Pre-flood			Post-flood		
		Sand	Silt	Clay	Sand	Silt	Clay
I	MHWM	91.92	0.46	7.62	80.92	8.08	2.00
I	MMWM	45.02	38.08	16.10	87.92	6.16	5.92
I	MLWM	51.22	35.22	12.56	82.92	10.16	6.92
II	MHWM	60.22	17.38	22.40	64.70	13.40	21.90
II	MMWM	57.80	29.66	12.54	89.28	5.80	4.92
II	MLWM	26.68	60.82	12.50	32.78	47.32	19.90
III	MHWM	29.40	52.34	18.26	23.12	63.38	13.50
III	MMWM	39.72	59.72	0.56	71.96	17.50	10.54
III	MLWM	17.02	72.02	10.96	33.52	26.78	39.70
IV	MHWM	17.68	24.02	58.30	30.84	58.38	10.78
IV	MMWM	16.01	21.68	62.31	9.72	67.86	22.42
IV	MLWM	14.22	51.77	34.11	32.98	44.26	22.72
V	MHWM	44.90	44.32	12.78	56.60	24.24	19.16
V	MMWM	24.70	50.26	25.04	65.36	21.74	12.90
V	MLWM	18.00	70.86	11.14	28.02	46.30	25.18
VI	MHWM	43.82	40.30	15.88	51.82	39.21	9.97
VI	MMWM	51.82	39.21	9.97	71.44	22.90	5.76
VI	MLWM	29.08	35.88	35.04	25.22	45.36	29.42

Table II. Minimum, maximum and average organic matter in the sediments at the three tidal levels at six stations during 1977.

Station	Tidal level	Minimum(%)	Maximum(%)	Average(%)
I	MHWM	0.11	1.20	0.61
I	MMWM	0.16	2.49	1.53
I	MLWM	1.04	2.64	1.71
II	MHWM	0.17	1.73	0.86
II	MMWM	0.66	3.20	1.85
II	MLWM	0.94	3.52	1.81
III	MHWM	0.39	2.64	1.98
III	MMWM	0.62	3.66	2.25
III	MLWM	0.72	3.20	2.11
IV	MHWM	0.16	3.20	1.99
IV	MMWM	0.97	3.84	2.15
IV	MLWM	0.80	2.62	1.83
V	MHWM	0.27	2.14	1.31
V	MMWM	0.39	2.49	1.73
V	MLWM	0.15	2.57	1.77
VI	MHWM	0.41	3.85	2.34
VI	MMWM	0.38	3.32	2.43
VI	MLWM	0.17	3.74	2.39

Table III. Minimum, maximum, total and average polychaete fauna (no/m^2) at six stations during the period of study.

Stations	Minimum	Maximum	Total	Average
I	0	6424	29912	487
II	0	3266	18318	407
III	20	1716	18826	418
IV	0	3882	31903	709
V	0	1647	17518	389
VI	0	915	13059	290

may be the factor for high organic matter content at stations III–VI. The organic matter content showed variation along the transect also.

A total number of 1,21,137 polychaete specimens belonging to 16 families, 32 genera and 42 species were collected during the entire period of study with an average density of 499/m^2 for the area. The highest observed density was 6424/m^2 at MMWM of station I in March 1977. The minimum, maximum and average density of polychaetes at all the six stations are given in Table III.

Out of the 42 species collected *Polydontes melanonotus, Panthalis oerstidi, Leocrates claperedi, Poecilochaetus serpens, P. johnsoni, Trochochaeta* sp., *Marphysa sunguina* and *Isolda pulchella* are considered rare to this estuary as they occurred only once or twice during the period of study. *Phyllodoce tenussima, Mystides southerni, Namalycastis indica, Diopatra neapolitana, Lum-*

brinereis sp. and *Glycinde oligodon* may be regarded occasional as they occurred 5 or 6 times in the collections.

Forms like *Ancistrosyllis parva*, *Magelona cincta*, *Prionospio pinnata*, *Polydora kempi* are regarded as seasonal migrants of the estuarine system. These species were encountered only during November to June when the salinity was high and disappeared completely from the habitat during July–October when the estuary was flooded for a prolonged period with freshwater from surface to bottom. The fourth group of species are the typical estuarine forms which include *Nephthys oligobranchia*, *Heteromastus similis*, *Dendronereis arborifera*, *Indonereis* sp. etc. They occurred in the estuary throughout the period of study.

The percentage occurrence of these species out of the 45 samples collected at each station was calculated and presented in Fig. 8. The percentage

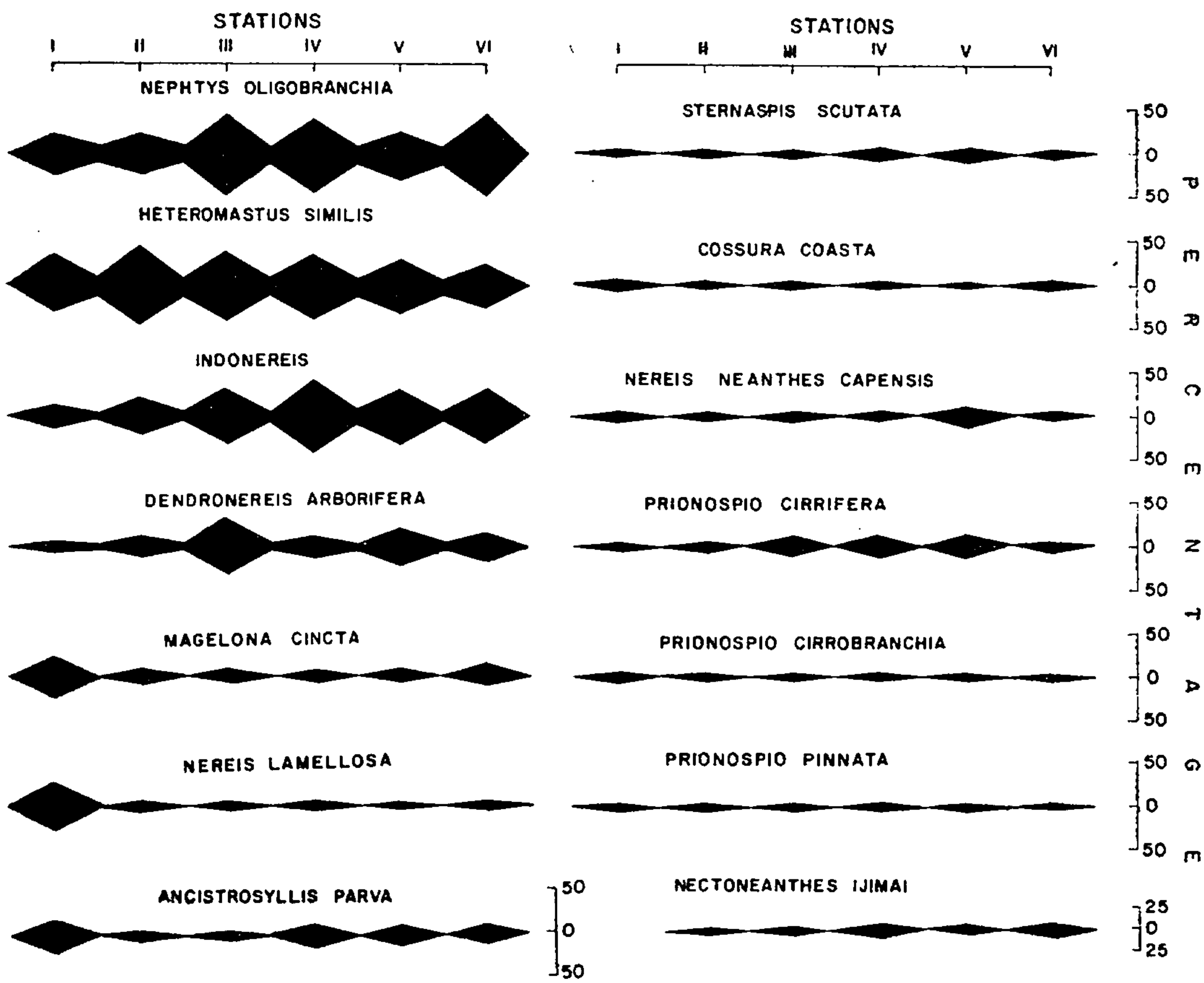

Fig. 8. Relative percentages of dominant polychaete species at each station over the period of study.

occurrence of each species at different tidal levels covering all the six stations was calculated and presented in Fig. 9.

The maximum abundance of dominant polychaete species varied seasonally, high in summer period and low during annual flood period. Out of the 14 dominant species, half of them showed their maximum density at MMWM, 4 species occurred in maximum abundance at MLWM, while the remaining 3 species occurred in high abundance at MHWM.

The outstanding feature of the polychaete distribution is the unimodal pattern, i.e., highest at MMWM and nearly equal numbers at MHWM and MLWM. This was true of some other areas also (Travellion, Ansell, Sivadas and Narayanan, 1970). In summer the polychaete population was high at MHWM. This may be because of least interstitial salinity changes as observed by Sanders, Mangelsdorf and Hampson (1965) for Pocasset river estuary. The burrowing polychaetes are also known to escape the effect of temperature by moving down the substratum. The occurrence of polychaetes in lesser number at MLWM may be due to the greater interstitial salinity changes at the lower tidal mark during a tidal cycle (Milne, 1940), in addition to the constant agitation of the substratum by the incoming tide. The polychaetes inhabiting the MLWM were mostly juveniles which are known to tolerate wide fluctuations in salinity (Gunter, 1961).

With the advent of freshwater influx, the entire fauna except the true estuarine organisms are washed away. The true estuarine polychaetes may be surviving by their high osmoregulatory capacity or by some protective secretion around their body as suggested by Kinne (1964). With the abatement of freshwater influx, the polychaete larvae are obviously transported into the estuary along with tidal flow from the adjoining neritic waters.

For the true estuarine species, the tidal levels appear to be no barriers (Srinivasa Rao, 1980, Srinivasa Rao and Rama Sarma, 1980, 1981). On the other hand, the seasonal migrants always restricted themselves to the lower tidal levels (Fig. 9). However, the possibility of occurrence of these forms at MHWM because of the rising tide cannot be ruled out. Such occasional occurrence of forms at higher levels though their natural preference to low water was earlier reported by Wieser (1959).

Wooden (1974) and Santos and Simon (1974) state that dissolved oxygen content restrict polychaetes to the upper 6 and 10 cm layer in Mitchell Bay and South Florida estuary respectively. But in Vasishta Godavari estuary, the polychaetes were found even at 20 cm depth. The suggested methods like circulating water during high tide (Gordon, 1960; Brafield, 1964), outflow of ground water (Janson, 1966), wave action (Johnson, 1967) and diffusion from the air may be replenishing the oxygen in the sediments.

In estuaries the sediment is a factor of paramount importance influencing the life in general and the benthic fauna in particular. The works of

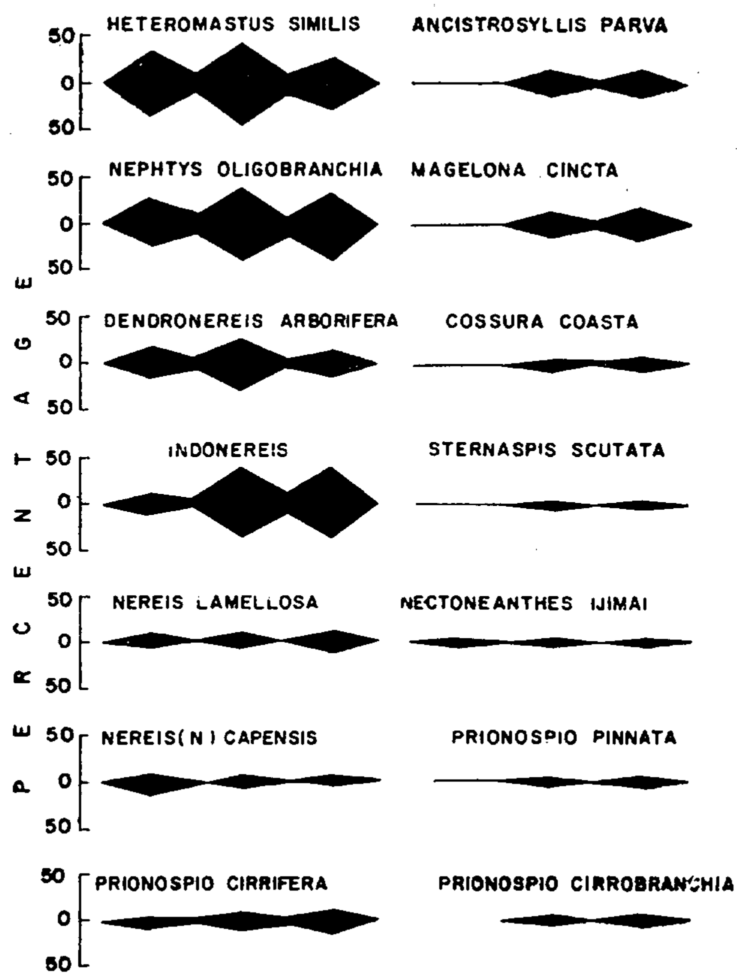

Fig. 9. Relative percentages of dominant polychaete species at three tidal levels over the period of study.

Sanders (1956), McNulty, Work and Moore (1962) and Brett (1963) show that a close relationship prevails between the feeding habits of the infauna, gross organic matter content and the texture of the sediment. Though the food and feeding habits of the polychaetes inhabiting this estuary was not worked out, the observations made on the morphological features suggests that most of them are detritus feeders.

Members of the genus *Glycers*, Eunicids, *Diopatra neapolitana* and *Lumbrinereis heteropoda* which are known carnivores restricted themselves to the sandy substrata, while the detritus feeders were able to invade the substrate containing sand, though their preference is muddy ones. This may be due to the possible clogging of feeding apparatus of the sandy inhabitants when they try to invade muddy areas (Johnson, 1971). The importance of organic matter within the substratum during settlement and consequent growth is well documented (Wilson, 1962; Buchanan, 1963). Capitellid *Heteromastus similis*, *Dendronereis arborifera*, *Magelona cincta*, *Sternaspis scutata* and *Cossura coasta*, prefer muddy areas where the organic matter content is high. *Nereis lamellosa* occurred in good numbers at station I where grass was present which not only provides stability to the substratum but also keeps the temperature low, in addition to providing food material in the form of detritus. The importance of grass in the distribution and food patterns of intertidal organisms was shown by MacGinite (1939).

Percentage affinity among stations during different salinity periods is calculated separately following Sanders (1960) and presented in trellis diagram (Fig. 10). Such distinct groupings formed because each species is influenced

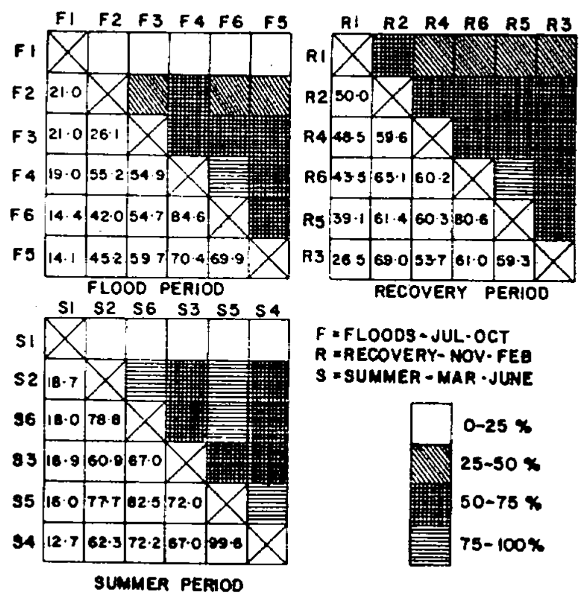

Fig. 10. Trellis diagrams showing faunal similarity among six stations during different seasons.

somewhat differently by the polyfactorial gradient changes in environmental conditions in addition to the biological interaction. The faunal affinity in the Vasishta Godavari estuary was dealt with in greater detail earlier (Srinivasa Rao and Rama Sarma, 1981).

Rarefaction method suggested by Sanders (1968) is adopted to arrive at diversity of intertidal polychaete fauna of this estuary (Fig. 11). The total number of species occurring at each station, their percentage composition and cumulative percentages are given by Srinivasa Rao and Rama Sarma (1981).

Sanders (1969) distinguished two hypothetical and extreme types of communities, while postulating his stability-time hypothesis, namely physically controlled and biologically accommodated communities. Because of wide

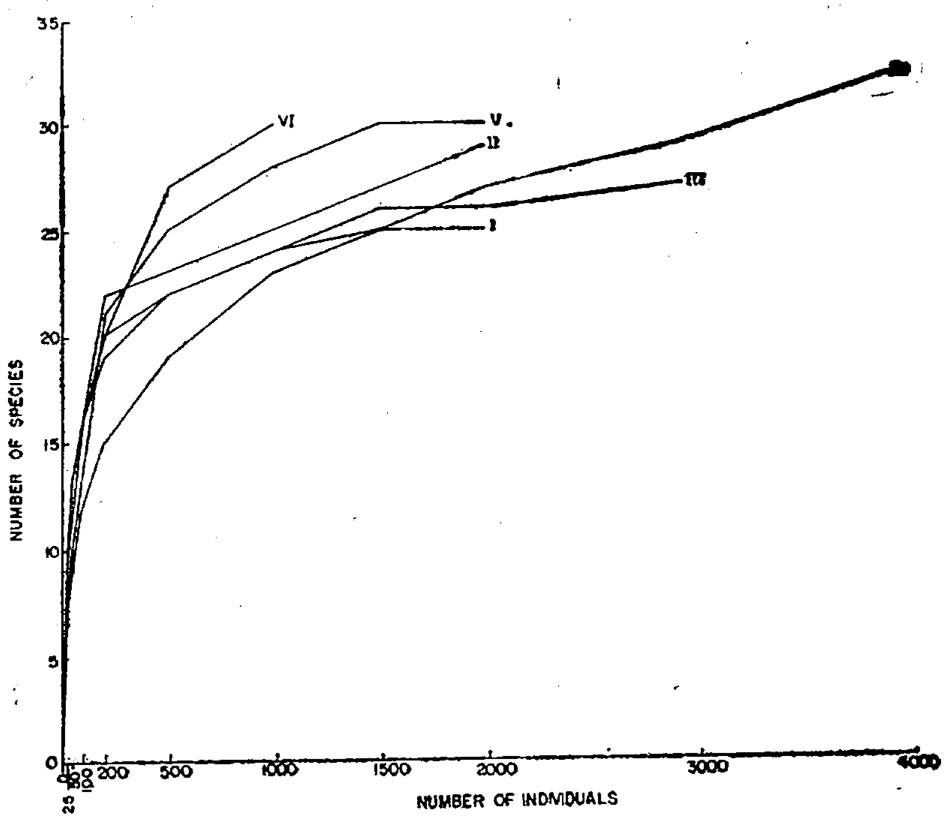

Fig. 11. Arithmetical plot of the number of species at different population levels using the rarefaction methodology for stations I to VI.

fluctuations in salinity, sediment composition etc., Vasishta Godavari estuary is expected to be the physically controlled area and hence to exhibit a low diversity. On the contrary it exhibits high diversity (Fig. 11) as is the case with other tropical estuaries like Vellar estuary and Kakinada Bay (Sanders, 1968) which experiences similar physical stresses (Jacob and Rangarajan, 1959; Rama Sarma and Ganapati, 1968).

From the information available, the chief factors attributed to the high diversity of this estuary is its location in the tropics and the adaptability of several polychaete species to the physical stresses prevailing in the estuary.

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