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A Study on Mangrove Ecology and Impact in Kakinada Bay

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The southern shores of Kakinada Bay (Lat 82°15'—82°22' E and Long, 16°51—17°N) is a region of mudflats interspersed with creeks and rivers that traverse through dense mangrove forests. These forests extend south eastwards to the mouths of the Godavari estuarine system

The species comprising these are the larger tree varieties in dense formations about 10 trees/10 m^2, *viz.*, *Avicennia* sp, *Rhizophora* sp. and a few small shrubs these latter extend towards the Bay-side fringe. The beds get submerged to root level in the diurnal high tide and spring tides (tidal range 1—1.8 m with very little wave action). These areas contribute to a continuous, shallow, mud-covered, submerged nutrient zone which forms a nursery for a number of brackishwater fish and prawn species. The mangrove forests also contribute to heavy leaf-litter-detritus load to the Kakinada Bay through the creeks/rivers; The data indicates a medium-energy system.

Three rivers/creeks *viz.*, Matlapalem. Coringa and Garderu are sampled at their mouths very adjacent to mudflats (the intertidal zone) to study the chemistry of soils and waters, biological productivity (of plankton, benthic fauna and larger molluscan beds) and impact on Kakinada Bay.

The rivers also transport sugar mill effluents and contribute to adverse impacts on intertidal zone covering the mangrove based vegetation, fauna and the mud flats.

The southern fringes of the Kakinada Bay are predominantly mud-flats interrupted by creeks/rivers which traverse, at the bayward end, through dense forests of mangrove as mentioned by Ramasarma and Ganapathi (1968) in their study on the Bay hydrography. The larger trees are located at a height of 0 3 m in relation to creek river low water level but in high tide and spring tides major parts are innundated. A part of the system forms a fringe along the eroding creek/river banks with roots in the water but on the bay-ward side the trees are succeeded by vascular plants. the shrubs and grasses on the mudflats due, probably, to show encroachment and reclamation for human habitation and paddyfields, especially in Matlapalem creek (Rajyalakshmi, 1975). However, the creeks are highly saline in non-monsoonal seasons, deep with a directional flow towards the Bay.

The hydrobiological characteristics of this important ecological zone

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towards its lower reaches on Bay are studied with a view towards assessing their impact and contribution to the Bay productivity, particularly the food web, as a buffering zone at the intertidal region and its contribution as a juvenile nursery ground and molluscan fishery.

The major problem here is that the creeks and rivers are used, unauthorisedly, as effluent release grounds for sugar factory located about 30 km upstream. The periodical releases blacken the surface areas, particularly of Coringa river and if coinciding with high tide, the entire mangrove bed is covered over. It emanates noxious odour and fish kills extend into the Bay.

Earlier studies contributing to the ecology and species distribution of the Indian mangrove systems are those of Dwivedi (1973) and Dwivedi *et al* (1975) Untawale *et al* (1973 and 1977; Lakshmana Reddy and Rao 1986) among others. The present study, in addition to presenting the ecology of the region, is also an emphasis on environmental impact which formed a part of major study on environmental impact in Kakinada Bay (Rajyalakshmi *et al* 1985).

CLIMATOLOGICAL AND TIDAL FACTORS :

The climatological features of the Kakinada Bay- Godavari estuarine complex ranges from hot summer temperatures (35°C on an average) and humidity to declining temperature, of an order of 6-8° C. and heavy rainfall (South-west monsoon) from July to September and flooding of rivers, followed by post-monsoon recovery in salinity but further decline in temperature to around 22°C, from October to February. The average annual rainfall is 118 cm. Strong winds prevail in April-May.

The tides in the Bay are diurnal ; but two periods of highest high tides occur in the annual cycle, once in early May and another time, in November. The spring tides have a maximum tide of 1.8 m and minimum neap tide at -0.18 m.

No long-shore currents are present in this region but monsoon flood emanating from the rivers Gaderu and Coringa connected to Godavari, cause heavy churning action and bring in high sediment loads (Ramasarma and Ganapathi, 1968).

MATERIALS AND METHODS

Three sampling stations are established at the mouths i.e., in low shoreline of mangrove forests of the three major rivers and one major creek *viz*, Matlapalem creek (St. I), the R. Coringa (St II) and R. Gaderu St. III). The rivers are offshoot from R. Godavari. All three traverse through dense mangrove forests and shrub vegetation, the latter particularly in Matlapalem creek

(Rajyalakshmi, 1975). The sampling was conducted monthly for two years 1981-82 and 1982-83.

The water and soil samples were analysed for temperature, salinity, pH, EC, Dissolved oxygen and nurients using Standard methods (APHA. 1965). A 30 cm dia. Sechi disc was used for estimating transparency of waters. Plankton samles were obtained with a half meter tow net, towed for 10 minutes using a boat with outboard motor. Bottom soil samples for benthic fauna was obtained with Eckman's dredge (9052 cm^2 area). The samples were washed, settled volume is measured and numerical counts were made of the fauna. Larger fauna were obtained by a iron rake attached to a 1 m length mesh bag.

The mangrove density was estimated as 10 trees/ 10 m^2. The bed area itself was not covered in this study. The leaf-litter contribution is taken as approximate estimations in two estimations only, as 10 kg/m^2.

RESULTS AND DISCUSSION

The mangrove forest extends right upto the high tide end of the tidal mudflats at the mouths of the three rivers/creeks. The average depth ranged from 1.0 to 1.9 m. The water salinity was highly variable governed by the large inputs of freshwater from the two rivers particularly during July-September, when the salinity declined to 4.7 to 12 ppt. The post-monsoon recovery was sharp and rose to 32 ppt and occassionally upto 47.5 ppt due to capillary action from sediments. All the three stations showed alkaline ranges of pH, the total alkalinity at 60 (minimum) to 153 mg (maximum). The general temperature range was 26.6—30.5°C. The water transparency followed the pattern of floods, declining to 72 cm (monsoon) and rising sharply to to 300 cm (summer). The dissolved oxygen remained high in all the seasons at 6.4 to 14.8 ppm. The soil pH was in alkaline range 7.9—8.3 and EC at 1.6 to 6.1 mmhos/cm. The organic carbon was at 0.37—0 60 representing medium values for production. The phosphorus content was very high at 3.00—9.75 ppm reflecting high loadings, probably both from decompositions from mangrove beds and inputs from paddy field drainage. $CaCO_3$ was quite high.

At the three stations 5 species of phytoplankton *viz.*, *Chaetoceros* (3.7%), *Coscinodiscus* sp., (3.7%), *Fragilaria* sp. (0.76%), *Noctiluca* sp. (3%), Oikopleura (1.7—13%) were recorded. among others. Among zooplankton, copepods (72.7—78.6%) were predominant followed by mysids (2—10.4%, decapod larvae 6.8-9.4% polychaete larvae (1.7-2.3%), gastropod larvae(1%) and fish eggs and By others, all indicating chacteristic composition of saline dominant waters.

volume, plankton constituted 2.5 to 14.0 ml per operation. A biomodal distribution was evident with a major peak during March-May and minor one during October-November. Benthic macrofauna constitutel 2-9 no m^2, constituted by bivalves (20%), polychaetes (60 %), Isopods 20%). Occassionally decapods also occured. The general density was observed to be not high.

The data presented herein indicates that the mangrove forests here are of medium energy system controlled by the water levels, (diurnal tides and monsoonal floods) but weak wave action. This is the reason perhaps for the high tree populations as explained by Dwivedi *et al* (1975) for Orda swamp at Goa. But the presence of larger benthic molluscan beds indicates that the system is of medium energy resulting from stronger currents flowing in from the connections to R. Godavari.

Higher vascular plants such as *Eichhornia crassipes* entered the creek water and transported to the intertidal zone during monsoon floods.

Sediment analysis was reported earlier (Rajyalakshmi *et al*, 1985) wherein the presence of heavy metal and above normal concentrations of cadmium and chromium were shown. Similary a preliminary analysis of tissues of the mollusc, the blood clam *Anadora granosa* also recorded presence of higher concentrations of cadmium.

About a hundred yards away from mouths the mudflats merge into shallow fish grounds. The species composition being of *Modiolus* sp. *Anadara granosa* and the window pane oyster, *Placenta placenta* The last two are relatively lower in abundance being probably at the tail end of their distributional range (Rajyalakshmi 1985 a).

The sedimentation and nutrients flowing from the mangroves and the low to medium tidal effect from the Bay mouth seem to have resulted in suitable conditions for the formation of these beds which are commercially exploited for lime kilns. Further, suitable plankton feed has also resulted for these filter feeder from this nutrient load carried in by the tidal flows from the forests. While no detailed sampling and estimate has been made of the leaf-litter, an estimated amount of 10 kg/m^2 (dry matter) seem to be available. Untawale *et al.* (1977) reported deposits of organic detritus to the tune of 10 t/ha/yr, in muddy mangrove wet lands.

The increasing presence of *Modiolus* sp. beds might reflect also conditions of eutrophication in these areas due to high nutrient loads transported not only from mangroves but also the increasing number of paddy fields along the banks of the river. The presence of heavy metals is another hazard which might affect the mangroves also. Natarajan and Ghosh (1985) have reported concentrations of uranium in mangrove leaves. Similar adverse effect might

already be occurring by the sugar-mill effluent released from the upstream, which cover the mangrove roots during high tides, This leads oxygen depletion, among other effects and juvenile fish kills. Rajyalakshmi (1985), Ganapathi and Sabrahmanyam (1966) have all reported on the importance of this ecosystem as a nursery ground. This will ultimately adversely affect the commercial fishery of the Bay itself.

As a foremost step at conservation of this important ecosystem: (1) The organised reclamation of the zone for paddy fields brackishwater aquaculture and other uses must be prevented. Major effect of removal of mangrove forest would be on their action as buffer zones between land and water usages and the sea and preventing entry of unhindered sediment loads to the Bay (2) Replanting of natural seedlings in some of the existing bare patches preventing other uses (such as lime kilns) here. (3) Total prevention of releases of sugar mill and other industrial effluents. (4) Further detailed studies in the upper and middle zones of the main mangrove forest area must be conducted.

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