

Suitability of Mangrove Swamps of Goa for Aquaculture

S.C. GOSWAMI

USHA GOSWAMI

National Institute of Oceanography,

Donu Paula, Goa 403004

Materials and Methods

Abstract

Occurrence of mangrove swamps in the intertidal regions is characteristic of the tropical coastline. The mangrove, a dynamic ecosystem, is a transitional area between the terrestrial and marine biotopes. The Mandovi-Zuari estuarine complex of Goa is endowed with mangrove swamps of varying intensities. The environmental parameters such as ambient water temperature, salinity, dissolved oxygen and pH fluctuated with tides and seasons and the annual variations of these parameters ranged from 24.0°C to 32.50°C, 0.1 to 34.3 ppt, 3.4 to 5.6 ml/l and 6.8 to 7.9, respectively. The mangrove swamps of Goa serve as nursery ground for several finfish and shellfish including penaeid shrimps (*Penaeus merguensis*, *Metapenaeus dobsoni*, *M. monocerros* and *M. affinis*), nonpenaeid shrimps (*Macrobrachium* sp.), fishes (*Chanos chanos*, *Mugil cephalus*, *Etroplus suratensis*, *Lates calcarifer*) and crabs (*Scylla serrata*). During low tide, juveniles of these species could be collected in large numbers for stocking in pond culture.

Introduction

The State of Goa is situated along the central west coast of India and has a coastline of 110 km. There are seven major rivers and several minor riverine systems along the coast. Among them, the Mandovi and Zuari rivers with the interconnecting Cumbarjua canal forms the largest estuarine system. The mangrove vegetation is usually present in the middle and upper reaches of the estuaries. It is estimated that about 2000 ha area is occupied by mangroves along the Goa coast (Untawale *et al.* 1982). Most of the investigations on the mangrove habitats of Goa pertain to the flora (Jagtap and Untawale, 1981; Jagtap, 1985 a and b). It is only recently that the importance of mangrove fauna has been realised. Achuthankutty and Sreekumaran Nair (1980) gave an account of shrimp fry resource in a mangrove swamp of Goa. Goswami (1992) described zooplankton ecology of mangrove habitats of Goa. The present paper deals with the suitability of mangrove swamps of Goa for coastal aquaculture with particular reference to the larval stages of penaeid shrimps.

The material for the present study was collected at two stations located in the Mandovi and Zuari estuaries (Fig 1). Monthly sampling was done from January to December, 1983. Two types of collections were made: (1) for qualitative and quantitative studies of larval stages by operating a modified HT net (mouth area 0.25 m² and mesh size 0.330 mm) during high tide and (2) for quantitative estimation by towing a small hand net with coarse mesh (5 mm size) during low tide. The samples were preserved in 5% formaldehyde. The larvae of penaeid shrimps were sorted out as protozoa, mysis and post-larval stages and identified. The total length (tip of rostrum to tip of telson) of juvenile shrimps was measured. Surface and bottom (2-3m depth) water samples were also taken for studying the prevailing physico-chemical conditions and estimations were done as per standard procedures (Strickland and Parsons, 1968).

Results and Discussion

Mangrove swamps are complex and dynamic ecosystems, occurring in thick fringes in the intertidal zone along tropical and subtropical coastlines. Their distribution and zonation depend upon several factors such as tidal movements, physico-chemical features of water and soil, soil drainage, ground water level and frequency of inundation (Chapman, 1975; 1978). The magnitude of variability of most of the environmental parameters was quite pronounced (Fig. 2). The pH values of surface and bottom waters at station 1 fluctuated from 6.8 to 7.8 and from 6.8 to 7.7. The corresponding values at station 2 ranged from 6.9 to 7.9 in the surface and bottom layers. The annual water temperature variations were in order of 7 °C with higher values (32.5°C) during dry pre-monsoon season. With the advent of Southwest monsoon, there was lowering of water temperature with the lowest value (24°C) being recorded at station 2 during August. The salinity variations were drastic from almost freshwater to marine conditions (0.1 to 34.7 ppt).

The variability in salinity was mainly due to the retention of salts by the substratum apart from sudden showers which reduced salinity considerably. The dissolved oxygen content was not high (3.4 to 5.1 ml/l) in the water column. The high oxidizable matter originating from mangrove litter might have resulted in the low oxygen. Occasionally anoxic conditions were observed in the mangrove swamps due to higher organic load and microbial population. The range of seasonal variations of environmental parameters recorded agree with the earlier observations from the mangroves of Goa (Dwivedi *et al.* 1974; Untawale and Parulekar, 1976; Pant *et al.*, 1980).

The faunal components of the mangrove swamps are distributed in the contiguous terrestrial and aquatic biotopes in addition to a few indigenous plant and animal species. The mangrove communities function as a solar-powered, tidal subsidised and pulse stabilized ecosystem (Odum, 1974). The epibenthic forms and the organisms living in the water column are transported from the adjoining habitat by the tidal currents. These animals may recede to the original biotope along with the ebb tide or establish themselves permanently in the mangroves if the prevailing hydrographical conditions are congenial for their survival, growth and perpetuation. The larval stages of the commercially important species were present in the plankton collections taken from both the stations. The distribution of larvae of penaeid shrimps was studied and their percentage occurrence was tabulated (Tables 1 and 2). Four species viz, *Penaeus merguensis* De Man, *Metapenaeus dobsoni* (Miers), *M. affinis* (H. Milne Edwards) and *M. monoceros* (Fabricius) were present in surface and bottom samples, and the larvae and postlarvae of *M. dobsoni* were dominant. Occurrence of larvae and postlarvae of eight commercially important species in the surface and bottom zooplankton samples in the Mandovi estuary was reported earlier (Goswami and Goswami, 1992). Seven species of penaeid and one species of nonpenaeid shrimps occurred in Pichavaram mangrove on the east coast (Sambasivam, 1985). Most of the shrimp larvae were confined near to the mouth of an estuary and only a few could adapt to the changing environmental conditions prevalent in the middle and upper reaches of the estuaries. Among the mysis stages, highest and the lowest population densities were recorded for mysis I and mysis II, respectively (Tables 1 and 2). The poor occurrence of mysis III stage could be due to the fact that the larvae sink to the bottom when they reach this stage to take up the benthic mode of life. The mysis stages of *M. dobsoni* were common.

The juveniles (10-27mm) of *P. merguensis*, *M. dobsoni* and *M. monoceros* constituted penaeid shrimp population in the samples taken near the bottom of mangrove swamps. The mangrove substratum was stated to be of fine silt and mud (Dwivedi *et al.* 1974) with high organic content. The organic matter in the sediment was reported to be 52.92 mg/g (Parulekar, 1985). The decaying mangrove foliage and debris resulted in the formation of high organic matter pools in the sediments of mangrove swamps. The abundance of food and relatively lesser number of predators and other harmful animals perhaps form the congenial conditions for growth of organisms. *M. dobsoni* grows to 50-60 mm length within 5-6 months; *M. monoceros* attains 70-80 mm in 7-8 months and *P. merguensis* reaches 80-90 mm in 6-7 months (Achuthankutty and Sreekumaran Nair, 1980). The availability of penaeid shrimp juvenile resource was influenced by places of collection and seasons. Maximum population density was observed during dry pre-monsoon period. The temperature variations do not show appreciable difference in the numerical abundance of juvenile populations. However, salinity fluctuations were important. The intensity of precipitation and its seasonal break influenced the shrimp catch which observed to be poor during the monsoon seasons. Any change in the inflow of water during monsoon would have drastic effect on the nursery areas changing their ecological balance and set up (Rajyalakshmi, 1972).

The population density of juveniles was low during early post-monsoon and it increased by late post-monsoon with a peak during pre-monsoon months. The peak breeding periods of the commercially important penaeid shrimp species in the coastal waters of Goa appeared to be during the pre-monsoon season, especially in the month of January-February and April-May, varying with the species (George and Goswami, 1977). The period and intensity of spawning activities of penaeid shrimp can be evaluated on the basis of juvenile abundance in the estuarine and mangrove swamp biotopes. The present study has shown that in addition to juveniles of penaeid shrimps, enormous fish seed resources (*Chanos chanos*, *Mugil cephalus*, *Etiopis suratensis*, *Lates calcarifer*) and crabs (*Scylla serrata*) were also available which should be judiciously exploited for aquaculture. Any ecosystem would remain viable and continue to flourish if left undisturbed. Unfortunately human interferences in the form of reclamation for aquaculture, indiscriminate destruction of vegetation for fire wood, building material, charcoal production, extraction of tannin and dyes, dredging, channelising and mining have put mangrove swamp ecosystems under stress.

It is imperative to maintain mangrove swamps of Goa for long term benefits on a sustainable basis.

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Table 1. Percentage occurrence of larval stages of four species of penaeid shrimps in surface and bottom plankton collections at Station I

Type of haul	Species	Larval Stages *						
		PI	PII	PIII	MI	MII	MIII	PL
Surface	<i>Penaeus merguensis</i>	1.40	1.59	0.95	6.26	1.54	0.0	0.25
	<i>Metapenaeus dobsoni</i>	5.91	4.69	9.47	14.07	5.88	1.07	3.93
	<i>M.affinis</i>	1.01	0.73	4.10	12.70	5.46	1.75	3.80
	<i>M.monoceros</i>	1.07	0.68	2.80	4.10	1.21	0.0	3.58
Bottom	<i>Penaeus merguensis</i>	1.29	1.92	1.18	2.69	0.37	0.0	1.19
	<i>Metapenaeus dobsoni</i>	4.67	2.51	8.50	8.99	4.54	2.87	13.53
	<i>M.affinis</i>	3.10	0.08	3.82	7.22	4.70	1.57	7.53
	<i>M.monoceros</i>	0.03	1.62	1.98	3.13	1.83	0.0	9.14

*PI - III = 3 protozoa stages; MI - MIII = 3 mysis stages and PL = postlarva.

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Table 2. Percentage occurrence of larval stages of four species of penaeid shrimps in surface and bottom plankton collections at Station 2.

Types of haul	Species	Larval stages *						
		PI	PII	PIII	MI	MII	MIII	PL
Surface	<i>Penaeus merguensis</i>	1.62	1.89	2.01	4.30	2.23	0.75	0.66
	<i>Metapenaeus dobsoni</i>	5.32	2.89	10.71	15.89	8.49	2.57	4.67
	<i>M.affinis</i>	1.61	0.90	3.00	5.55	0.73	0.00	1.53
	<i>M.monoceros</i>	2.30	1.32	4.33	7.31	1.90	0.98	4.52
Bottom	<i>Penaeus merguensis</i>	0.29	1.20	0.62	3.69	0.71	0.00	1.13
	<i>Metapenaeus dobsoni</i>	4.71	2.82	12.21	14.32	7.11	4.29	9.30
	<i>M.affinis</i>	0.47	2.16	2.76	4.83	0.19	0.00	5.38
	<i>M.monoceros</i>	1.87	0.96	2.73	5.66	2.13	0.24	8.22

* PI - III = 3 protozoa stages; MI - MIII = 3 mysis stages and PL = Postlarva.