

SEASONAL VARIABILITY IN PENAEID PRAWN LARVAL ABUNDANCE IN THE MANDOVI AND ZUARI ESTUARIES, GOA.

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ABSTRACT

Seasonal variations in the occurrence and abundance of penaeid prawn larvae in the Mandovi and Zuari estuaries of Goa were studied. Larvae and postlarvae of commercially important species viz. *Metapenaeus dobsoni* (Miers), *M. affinis* (H. Milne Edwards), *M. monoceros* (Fabricius), *Penaeus merguensis* de Man and *Parapenaeopsis stylifera* (H. Milne Edwards) were recorded in that order of abundance. Protozoa and mysis stages were dominant in surface zooplankton collections while the postlarvae were more in the bottom samples. Based on larval density, *M. dobsoni* appeared to be a continuous breeder. The active spawning periods in other species were during the late postmonsoon and premonsoon seasons varying with the species. Peak recruitment of postlarvae in the estuaries was observed mostly during southwest monsoon months (June to September). Penaeid prawn larval ingressions were more in the Zuari estuary compared to the Mandovi estuary. Their numerical abundance gradually decreased towards the upstream areas. The feasibility of large scale collection of penaeid prawn larvae for aquaculture is indicated.

INTRODUCTION

Prawns of the family Penaeidae constitute a suitable group for aquaculture and adequate availability of quality seed in space and time is one of the pre-requisites for proper management of their culture as also capture. Although some progress has been made on the hatching and rearing of penaeid larvae under controlled conditions, a major portion of the seed required for culture purposes are obtained from nature. It is well known that penaeid larvae utilize the estuaries and brackishwater systems as nursery grounds. These habitats could be useful source of collection of prawn larvae. Earlier studies (Gopalakrishnan and Rao, 1968; Subramanyam and Ganapati, 1971; Kuttyamma, 1975; and Ramamurthy, 1982) pertained mainly to the immigration of the postlarvae and juveniles into the estuaries and backwaters along the Indian coast. Information is not available on the seasonal variability and relative abundance of different protozoa and mysis stages which constitute an important component of penaeid larval population in the estuarine environment. The present communication deals with these aspects

along with the postlarval distribution in the Mandovi and Zuari estuaries of Goa along the west coast of India.

MATERIAL AND METHODS

Fortnightly surface and bottom zooplankton samples were collected for a period of one year (June 1982 to May 1983) from three stations (Stns. 1 to 3), located in the lower, middle and upper reaches of both Mandovi and Zuari estuaries (Fig. 1), during high tide with a modified III net (mouth area 0.25 m²; mesh width of 330 µm) fitted with a calibrated flowmeter. Larval stages of penaeid prawns were separated from 25 to 100% of the samples and further sorted into 3 protozoa, 3 mysis and postlarval stages and identified (Raje and Ranade, 1972 a & b and Mohamed *et al.* 1968). Their numerical abundance was raised to total and given as per 100 m³. Water samples from surface and bottom (5m) were also collected for determination of water temperature, salinity and dissolved oxygen following standard procedures (Strickland and Parsons, 1968).

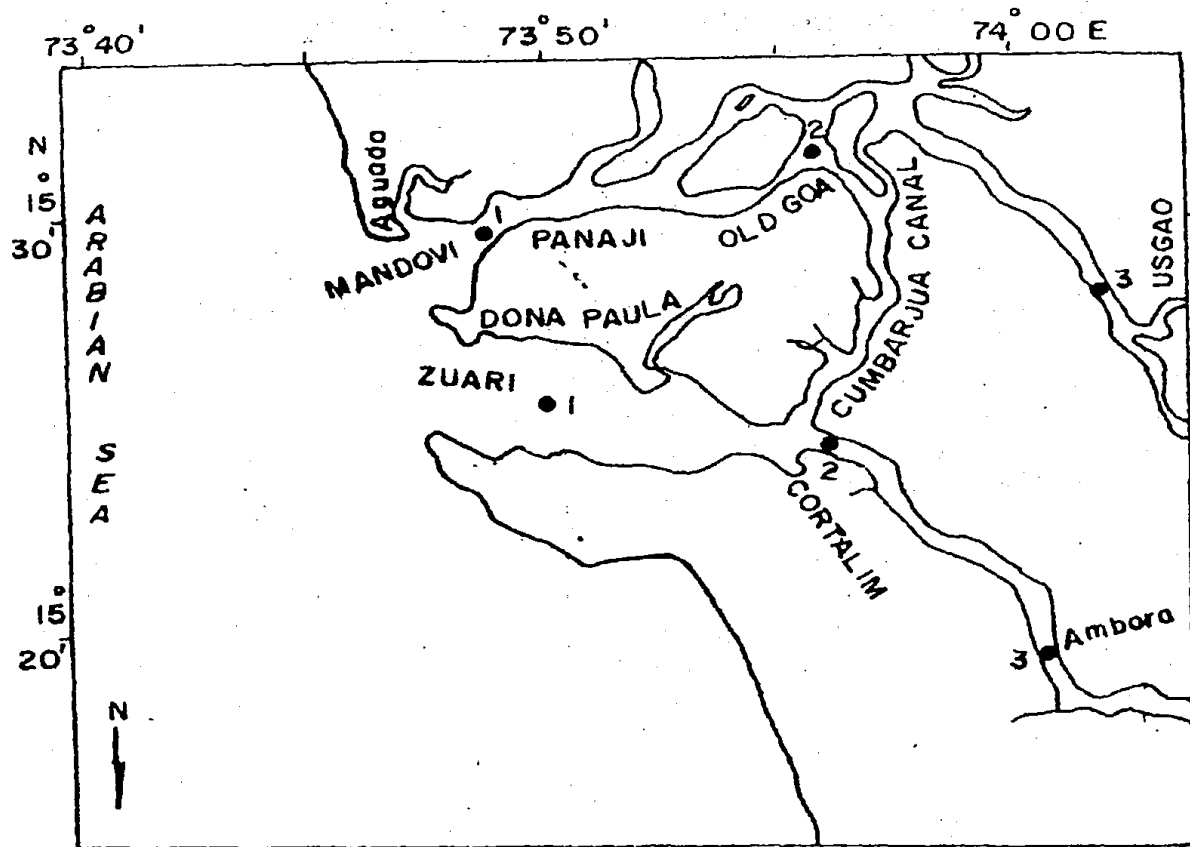


Fig. 1 Station positions

RESULTS AND DISCUSSION

In a tropical estuarine environment, fluctuations in water temperature are minor. The annual variations in temperature in surface and bottom waters and between stations were within the range of 7°C . However, salinity difference were drastic due to heavy precipitation during southwest monsoon and land runoff. Almost limnetic conditions prevailed during the period in the middle and upper reaches of the estuaries. Stratification was observed in the lower reaches due to density differences. Salinity values varied from 0.0 to 34.54 ‰ and from 0.12 to 35.52 ‰ in the Mandovi and Zuari estuaries respectively. The dissolved oxygen content ranged between 3.0 to 5.5 ml/l. These parameters did not influence the occurrence of prawn larvae. Achuthankutty *et al.* (1977) observed that salinity alone did not have an important role in penaeid larval distribution in the estuaries. The total larval abundance was

influenced by tidal and lunar phases in the Mandovi estuary (Goswami and Goswami, 1992). The Protozoa (PI-III), mysis (MY I-III) and postlarval (PL) stages of 5 commercially important penaeid prawn species were encountered. Larvae and postlarvae of *Metapenaeus dobsoni* were dominant (40.59%) followed by *M. affinis* (21.78%), *M. monoceros* (17.15%), *Penaeus merguensis* (13.02%) and *Parapenaeopsis styliifera* (7.46%). The early larval stages (protozoa and mysis) were abundant in surface samples (72.27%) while postlarvae were more in the bottom zooplankton hauls. Higher numbers of the larvae were recorded at stations in the Zuari estuary (58.11%) than those in the Mandovi estuary (41.89%) as had been reported earlier also by Achuthankutty *et al.*, 1977. However, the maximum and minimum numbers were obtained respectively at the lower and upper reaches of both estuaries (Table 1). Mysis stages were the common larvae and these ingressed till the upstream regions except for

Table 1 Occurrence of penaeid prawn larvae (No/100m³) in surface and bottom zooplankton samples at stations located in different areas of Mandovi and Zuari estuaries (nos. in parantheses are of bottom samples).

Species	Mandovi estuary			Zuari estuary		
	Lower reaches	Middle reaches	Upper reaches	Lower reaches	Middle reaches	Upper reaches
<i>Metapenaeus dobsoni</i>	1779 (868)	757 (379)	238 (90)	2607 (1289)	1007 (491)	172 (81)
<i>M. affinis</i>	1202 (584)	502 (238)	0 (0)	1578 (711)	267 (141)	6 (1)
<i>M. monoceros</i>	694 (375)	221 (149)	26 (22)	1332 (611)	455 (194)	32 (9)
<i>Penaeus merguensis</i>	777 (290)	203 (72)	5 (0)	1036 (395)	270 (68)	11 (0)
<i>Parapeneopsis stylifera</i>	439 (152)	3 (0)	0 (0)	716 (242)	179 (59)	0 (0)

those of *M. affinis* and *P. stylifera* in the Mandovi estuary (Table 3). Abundance of mysis stages of 8 species of prawns over the tidal cycle in the Mandovi was described by Goswami and Goswami (1992). Interestingly during the present study, mysis II of *P. stylifera* was observed to penetrate till the middle reaches of both the estuaries. *P. stylifera* was reported to be a marine species (Menon, 1953) and the larvae were not recorded earlier from the brackishwater system (Rao, 1970). The mysis II of *M. dobsoni*, *M. affinis*, *M. monoceros* and *P. merguensis* could ingress upto the upper reaches of the Zuari estuary. In the Mandovi estuary their distribution was restricted till the middle reaches except for *M. dobsoni* (Table 2). The mysis III of individual species occurred in small numbers in both estuaries, may be due to the fact that at this stage, they take up a benthic mode of life. Among the protozoa stages, protozoa III were common (49.19%) followed by protozoa I and protozoa II. These stages were recorded till the middle reaches of the estuaries except *M. dobsoni* in the Mandovi estuary (Table 2) and *M. dobsoni*, *M. monoceros* and *P. merguensis* in the Zuari estuary (Table 3). No information is available

for comparison on the seasonal occurrences and abundance of different protozoa stages in the estuaries and backwaters along the Indian coast. The postlarvae of *M. dobsoni*, *M. monoceros*, *M. affinis* and *P. merguensis* were obtained in that order of abundance and corroborate the earlier results from the Cochin backwaters (Kuttyamma, 1975) and the Kasaragod, Mangalore and Mulki estuaries along the Karnataka coast (Ramamurthy, 1982). According to George and Suseelan (1982), the postlarvae and juveniles of *M. dobsoni* were dominant in the backwaters of the southwest and southeast coastal regions. Higher abundance of postlarvae and juveniles of *P. indicus* was reported from the Vellar estuarine system, Porto Novo (Sambandam *et al.* 1982) and in the Marakanam estuary in South Arcot District, Tamil Nadu, on the east coast (Bose and Venkatesan, 1982). Higher population density of postlarvae was recorded in the Zuari estuary (52.63%) whereas it was reported earlier from the Mandovi estuary by Achuthankutty *et al.* (1977). The distribution pattern of postlarvae of prawn species was observed to be different in the two estuaries. The postlarvae of *M. affinis* were common in the Mandovi estuary while

Table 4 : Seasonal variations in the occurrence of larval stages at stations located at the lower reaches of Mandovi and Zuari estuaries
(Data of surface and bottom samples combined; nos. in parentheses are of Zuari estuary).

Months	Species														
	<i>M. dobsoni</i>			<i>M. affinis</i>			<i>M. monoceros</i>			<i>P. merguensis</i>			<i>P. stylifera</i>		
	PI-III	MyI-III	PL	PI-III	MyI-III	PL	PI-III	MyI-III	PL	PI-III	MyI-III	PL	PI-III	MyI-III	PL
June '82	21 (2)	16 (28)	3 (16)	22 (155)	72 (174)	14 (46)	0 (6)	4 (9)	8 (0)	0 (0)	28 (23)	0 (0)	0 (0)	0 (0)	0 (14)
July	21 (4)	14 (29)	3 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (33)	119 (97)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
August	27 (5)	22 (34)	4 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (66)	57 (74)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
September	34 (48)	14 (44)	13 (14)	0 (5)	0 (0)	0 (0)	0 (14)	0 (37)	0 (40)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)
October	165 (178)	29 (40)	30 (31)	8 (22)	4 (22)	7 (7)	0 (38)	0 (57)	0 (31)	0 (11)	16 (11)	0 (0)	0 (0)	0 (18)	0 (0)
November	172 (336)	145 (587)	27 (76)	61 (112)	104 (123)	12 (29)	25 (164)	18 (176)	0 (76)	55 (167)	1 (95)	9 (28)	7 (61)	0 (170)	0 (0)
December	123 (229)	396 (448)	58 (55)	107 (156)	144 (173)	33 (46)	119 (102)	131 (46)	24 (18)	87 (62)	8 (105)	1 (25)	55 (24)	18 (61)	0 (0)
January '83	106 (223)	424 (339)	80 (256)	138 (186)	253 (360)	57 (42)	36 (86)	28 (83)	19 (53)	36 (39)	44 (139)	12 (28)	66 (58)	34 (78)	0 (0)
February	85 (43)	83 (79)	49 (34)	12 (47)	34 (64)	55 (23)	37 (77)	28 (63)	20 (22)	99 (135)	218 (203)	43 (27)	21 (10)	5 (16)	0 (0)
March	169 (135)	59 (207)	74 (57)	17 (53)	81 (40)	38 (8)	57 (73)	75 (103)	39 (22)	8 (57)	64 (62)	35 (5)	66 (52)	39 (76)	0 (0)
April	80 (106)	27 (146)	28 (51)	27 (135)	148 (143)	39 (29)	106 (75)	62 (108)	19 (19)	5 (53)	154 (66)	18 (26)	88 (61)	44 (88)	0 (0)
May	13 (37)	13 (71)	20 (43)	55 (25)	196 (31)	48 (33)	16 (18)	10 (44)	8 (10)	3 (45)	105 (108)	17 (22)	60 (105)	88 (66)	0 (0)

Table 5 : Seasonal variations in occurrence of penaeid larval stages at stations located in middle reaches of Mandovi and Zuari estuaries
(Data of bottom and surface samples combined, nos. in parentheses are of Zuari estuary).

Months	Species																				
	<i>M. dobsoni</i>		<i>M. affinis</i>		<i>M. monoceros</i>		<i>P. merguensis</i>		<i>P. stylifera</i>												
	PI-III	MyI-III	PL	PI-III	MyI-III	PL	PI-III	MyI-III	PL	PI-III	MyI-III	PL									
June	2 (0)	9 (12)	2 (8)	3 (43)	14 (30)	8 (26)	0 (3)	0 (9)	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
July	1 (0)	4 (12)	3 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	45 (13)	0 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
August	0 (12)	8 (20)	0 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	18 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
September	18 (29)	9 (23)	2 (8)	0 (0)	0 (0)	0 (0)	0 (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
October	74 (83)	11 (19)	8 (8)	0 (0)	1 (0)	0 (0)	0 (15)	0 (0)	0 (0)	0 (0)	0 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)
November	75 (118)	55 (152)	18 (21)	34 (11)	59 (31)	6 (0)	9 (77)	0 (62)	0 (42)	0 (0)	0 (0)	0 (4)	9 (9)	1 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
December	152 (99)	188 (171)	25 (3)	26 (29)	69 (30)	17 (19)	21 (24)	24 (12)	31 (15)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
January	57 (66)	43 (83)	9 (33)	20 (32)	31 (33)	28 (20)	10 (21)	6 (32)	0 (24)	0 (0)	0 (0)	0 (0)	7 (19)	25 (30)	2 (10)	0 (0)	0 (6)	0 (0)	0 (0)	0 (0)	0 (0)
February	37 (18)	76 (39)	31 (1)	2 (7)	16 (10)	17 (6)	10 (9)	6 (32)	0 (6)	0 (0)	0 (0)	0 (6)	86 (67)	67 (85)	7 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
March	44 (75)	54 (153)	25 (67)	4 (4)	23 (9)	22 (4)	33 (24)	56 (45)	25 (6)	0 (0)	0 (0)	0 (4)	0 (4)	17 (16)	5 (1)	0 (0)	0 (18)	0 (3)	0 (0)	0 (0)	0 (0)
April	8 (50)	21 (43)	28 (4)	20 (25)	108 (26)	4 (2)	22 (33)	23 (26)	2 (8)	0 (0)	0 (0)	0 (0)	0 (0)	22 (13)	0 (0)	0 (0)	0 (17)	0 (20)	0 (0)	0 (0)	0 (0)
May	1 (4)	9 (40)	21 (13)	27 (7)	156 (2)	25 (2)	3 (4)	10 (8)	8 (4)	0 (0)	0 (0)	0 (0)	0 (12)	27 (16)	0 (3)	0 (29)	0 (25)	3 (0)	0 (0)	0 (0)	0 (0)

those of *M. dobsoni*, *M. monoceros* and *P. merguensis* in the Zuari estuary. The postlarvae of *P. stylifera* were absent in samples from both the estuaries (Tables 2&3). The juvenile of this species were recently recorded from the Mandovi and Zuari estuaries (NIO, 1993), probably because the postlarvae attained a larger size quickly and settled down to the bottom as juveniles.

Monthly distribution and abundance of the larval stages in the lower, middle and upper reaches of the estuaries have been tabulated (Tables 4 to 6). The late postmonsoon and premonsoon months were the period of abundance of early larval stages in the estuaries. The peak recruitment of postlarvae was during the monsoon season. The maximum numbers (3303/100 m³) of larvae occurred in the lower reaches of the estuaries in January and September. The maximum ingress of protozoa (1064/100m³) was in December. The protozoa and mysis stages of *M. affinis*, *M. monoceros*, *P. merguensis* and *P. stylifera* were poorly represented in the zooplankton in the lower reaches during July to September (Table 4). In the middle reaches, the larval stages evinced poor distribution between June to October. The highest total number of larvae (1027/100m³) was obtained in December. The maximum abundance of mysis stages (540/100m³) and postlarvae (155/100m³) was recorded in December and March respectively. The larval distribution was scanty in the upper reaches and no larval stage was obtained there during July to August. The maximum number of mysis (117/100m³) occurred in December. The recruitment periods of protozoa and postlarvae showed minor differences among the months. It may be due to species specific variations in spawning.

M. dobsoni appeared to be a continuous breeder as the protozoa and mysis stages were invariably present throughout the year in both the estuaries. The active breeding was during November to January. *M. affinis* and *M. monoceros* had the same spawning period but the maximum larval abundance in case of *M. affinis* (1200/100m³) and *M. monoceros* (1227/

10m³) was in December and January respectively. *P. merguensis* and *P. stylifera* showed a discontinuous breeding pattern with maximum larval density during the premonsoon months of February and May (Tables 4&6). The breeding season of *M. affinis* was reported to be from October to March with a peak in November and December in the Cochin backwaters. The peak spawning in *P. merguensis* during February was reported from the coastal waters of Goa (George and Goswami, 1977). *P. stylifera* was described to breed year round in the Mangalore coastal region (Ramanurthy, 1980) but only during the premonsoon season in the coastal waters of Goa (Achuthankutty and Parulekar, 1986).

The present study has indicated that irrespective of the breeding pattern of the penaeid prawns, their larval ingress was maximum in the lower reaches of the Mandovi and Zuari estuaries. The currents at the mouth of these estuaries were reported to be weaker than at the middle and upstream areas (Cheriyian *et al.*, 1975 and Varma, *et al.* 1975). The larval stages could be collected in sufficient quantities by operating different types of nets for stocking in ponds for prawn culture.

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REFERENCES

- Achuthankutty, C.T., George, M.J. and Goswami, S.C. 1977. Larval ingress of penaeid prawns in the estuaries of Goa. *Proc. Symp. Warmwater. Zoopl., Spl. Publ. UNESCO/NIO* : 412-424.
- Achuthankutty, C.T. and Parulekar, A.H. 1986. Distribution of penaeid prawn larvae in the coastal waters of Goa. *Indian J. Mar. Sci.*, 15 : 45-47.

- Bose, V.C. and Venkatesan, V.** 1982. Prawn and fish seed resources of Marakanam estuary. *Proc. Symp. Coastal Aquaculture*, 1 : 196-201.
- Cheriyian, T., Rao, L.V.G. and Varma, K.K.** 1975. Variations in physical characteristics of the waters of Zuari estuary. *Indian J. Mar. Sci.*, 4 : 5-10.
- George, M.J. and Goswami, S.C.** 1977. Observations on the larvae of penaeid prawns of commercial importance in the coastal waters of Goa. *Proc. Symp. Warmwater Zoopl., Spl. Publ. UNESCO/NIO* : 146-154.
- George, M.J. and Suseelan, C.** 1982. Distribution of species of prawns in the backwaters and estuaries of India with reference to coastal aquaculture. *Proc. Symp. Coastal Aquaculture*, 1 : 273-384.
- Gopalakrishnan, V. and Rao, R.M.** 1968. Observations on the distribution of juveniles of brackishwater prawns in the Hooghly-Matlah estuarine system. *Proc. Sem. Prod. Quality Seed Fish Culture, Barrackpore* : 240-261.
- Goswami, S.C. and Goswami, Usha.** 1992. Lunar, diel and tidal variability in penaeid prawn larval abundance in the Mandovi estuary, Goa. *Indian J. Mar. Sci.*, 21 : 21-25.
- Kuttyamma, V.J.** 1975. Studies on the relative abundance and seasonal variations in the occurrence of postlarvae of three species of penaeid prawns in the Cochin backwaters. *Bull. Dept. Mar. Sci., Univ. Cochin*, 7 : 213-219.
- Menon, M.K.** 1953. Notes on the bionomics and fishery of the prawn *Parapenaeopsis stylifera* (M.Edw.) on the Malabar Coast. *J. Zool. Soc. India*, 5 : 153-162.
- Mohamed, K.H., Rao, P.V. and George, M.J.** 1968. Postlarvae of penaeid prawns of southwest coast of India with a key to their identification. *FAO Fish Rep.*, (57) 2 : 487-503.
- National Institute of Oceanography (NIO)** 1993. Resource potential of juvenile marine prawns in the estuaries of Goa. *Tech. Report - NIO/SP-2.93* : 40pp.
- Raje, P.C. and Ranade, M.R.** 1972 a. Larval development of Indian penaeid shrimps-I. *Penaeus merguensis* de Man. *J. Indian Fish. Ass.*, 2 : 1-16.
- Raje, P.C. and Ranade, M.R.** 1972 b. Larval development of Indian penaeid shrimps-II. *Metapenaeus monoceros* (Fabricius). *J. Indian Fish. Ass.*, 2 : 30-46.
- Ramamurthy, S.** 1980. Resource characteristics of the penaeid prawn *Parapenaeopsis stylifera* in Mangalore area. *Indian J. Fish.*, 27 : 161-171.
- Ramamurthy, S.** 1982. Prawn seed resource of the estuaries in the Mangalore area. *Proc. Symp. Coastal Aquaculture*, 1 : 160-172.
- Rao, P.V.** 1970. Synopsis of biological data on the penaeid prawn *Parapenaeopsis stylifera* (M.Edw.) *FAO Fish. Rep.* (57) 4 : 1575-1605.
- Sambandam, K.P., Lawrence, R. and Noble, J.** 1982. Some observations on penaeid prawn seed resources in the Vellar estuarine system (Porto Novo). *Proc. Symp. Coastal Aquaculture*, 1 : 308-313.
- Strickland, J.D.H. and Parsons, T.R.** 1968. A Practical Handbook of Seawater Analysis. *Bull. Fish Res. Board Can.*, 167 : 311pp.
- Subramanyam, M. and Ganpati, P.N.** 1971. Observations on Postlarval prawns from Godavari estuarine system with a note on their role on capture and culture fisheries. *J. mar. biol. Ass. India*, 13 : 195-202.
- Varma, K.K., Rao, L.V.G. and Cheriyian, T.** 1975. Temporal and spatial variations in hydrographical conditions of Mandovi estuary. *Indian J. Mar. Sci.*, 4 : 11-17.