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## STUDIES ON THE ECOLOGY AND FAUNA OF THE RUSHIKULYA ESTUARY, (GANJAM), ORISSA.

KAZA V RAMA RAO, C. A. NAGESWARA RAO,  
S. C. NAHAR, D. V. RAO & A. MOHAPATRA

*Estuarine Biological Station, Zoological Survey of India,  
Berhampur, (Orissa)*

### INTRODUCTION

Estuaries have long been important to mankind both for reasons of navigation and providing locations on their banks for towns and cities. These are under constant pressure as repositories for the effluents of industrial and domestic waste. The estuaries are also interesting biologically as well due to their periodical changing environment with an admixture of marine and fresh water fauna. Estuaries are typical in having mudflats formed by fine sedimentary material carried from the rivers. These mudflats provide an excellent habitat for a variety of animals.

Several major and minor rivers passing through the state of Orissa and joining the Bay of Bengal thus forming many estuaries along the coast. Of these the major are Mahanadi estuarine complex, Brahmani and Bitarani estuary etc. Further many smaller estuaries are also present among which Rushikulya estuary is situated in the southern part of Orissa. This estuary being nearer to the Estuarine Biological Station, Zoological Survey of India, Berhampur, regular investigations were carried out for understanding its bioecology.

Fauna of the Chilka lagoon by Annandale & Kemp (1915) is the first information on ecology and fauna from estuarine and brackish areas of Orissa. The available literature on estuaries of Orissa and its fauna mainly deals with fish & Fisheries, (Shetty et al. 1965, 1967, 1969; Rao N.G.C. 1964, 1967 and Mohapatra, 1966); wood boring mollusca of Mahanadi estuary were reported by Subba Rao, (1968); Polychaetes of the Mahanadi and Bitarani estuary by Rao and Julka, (1977) and Rao, C.A.N. (1981), studies on the milk fish larvae and phytoplankton of the Rushikulya estuary by Patnaik, (1984) and Rajshree Gouda & Panigrahi, (1989) respectively. However, no detailed studies on the estuaries of Orissa and its fauna are available.

With a view to have more information on Indian estuaries in general and Orissa in particular, studies on Rushikulya estuary were conducted during 1985-86 by collecting fauna and its ecological parameters at regular intervals.

### GENERAL FEATURES OF THE ESTUARY

River Rushikulya originates from the Rushimala mountains of eastern ghats and flows through the Ganjam District and meets the Bay of Bengal at Ganjam thus forming an estuary. This is a minor river with less water flow during most part of the year except monsoon period. Most of the water of this river is being utilised for agriculture and other domestic purposes thus further reducing the flow

of water into the sea. The tidal effect in the river extends for about 4 to 5 Kms upstream forming a small estuarine complex. This estuarine part of the river is less than one Km in width and very shallow, with depth of less than one metre at the upper reaches and gradually the depth increases towards lower reaches. Before joining the sea the river divides into three branches thus exposing the land masses in between the river branches and meets again to open into the sea. A narrow canal (Palur or Chilka canal) was dug out west of the mouth of the estuary parallel to the coast line connected to the southern part of the Chilka lake to facilitate incursion of sea water during high tides into the lake for enriching the fishery resources. The fresh water inflow through this channel to the estuary is very negligible except during monsoon. The slopes of the river banks are very less as the river reaches towards the mouth, and there are no bunds on either side, thereby causing submersion of vast areas of land during the monsoon.

The tidal range varies from 0.5 to 1.0 mt. in height, however the water spreads during high tide to about 20 to 25 mts. On either side of the river, as the slopes of the banks are very less. The water spread during high tides is profound in the middle areas and near the mouth of the estuary. The inter-tidal area near the mouth is sandy while adjacent coastline towards the river course for about 2 Kms. is muddy with less sand composition.

#### MATERIALS AND METHODS

Sampling and data collections were made at three stations during 1985-1986, fixed along the estuary starting from its mouth on one side (Sta. I) and a point about 4 Kms. upstream of river (Sta. III) and in between these two stations a middle station (Sta. II) was also selected (Fig. 1). The 1st station was near the river mouth which is subjected to regular tidal effect and at this point the Palur (Chilka) canal is opening into the river. The 2nd station is about 2 Kms. from the first station where also the tidal influence is noticed and vast areas submerged during high tide. The 3rd station was fixed near the bridge area, which is about 1.5 Kms. from the 2nd station, where the tidal influence is negligible.

Fortnightly samplings were made at all the three stations both at high and low tides during the period 1985-86. Physico-chemical parameters like temperature, pH, depth, transparency, etc. were collected in the field by using instruments while salinity, dissolved oxygen, total solids were analysed in the laboratory following standard methods. Plankton sampling was made at three stations through plankton net for quantitative and qualitative studies. The other groups of animals were collected by hand picking, sieving the sediment collected from inter-tidal areas and through grab sampling. Fish larvae were collected at mouth region by operating standard Midnapore shooting net during high tides and through hand net at other stations. The adult fishes were collected from fish landing centres and from fishermen while they were fishing in the estuary.

#### HYDROGRAPHIC FEATURES

*Depth* : The depth near the mouth of the river was between 0.5 to 3.5 mts. and increase in its depth was noticed during monsoon period. At the middle of the estuary (Station II) the depth pattern is similar to that of the mouth area, and a marginal increase in depth was noticed here also during monsoon. In the upper reaches of the estuary (Station III) the depth is very less, not even

exceeding one metre during most part of the year, and appreciable increase in depth was noticed at this region also during monsoon

*Temperature* : The atmospheric temperature was between 24.5 to 35°C the three stations during the different months of the year. The lowest temperature noticed December and highest during September. Differences between air and water temperature were found to be less at the mouth. While higher water temperature was noticed than the air temperature at the middle and upper reaches of the estuary (IInd & IIIrd stations) during February, March, April, July, August and September (fig 2)

*pH* : At the mouth of the river the pH values varied from 9.05 to 7.6 and the maximum during November and minimum in July. At the middle area (Station-II) maximum was about 8.9 in November and 7.5 during January. While in the upper reaches maximum 9.5 in the month of November and minimum of 7.5 in July recorded (Fig. 3)

*Salinity* : At the mouth of the river the salinity ranging from 35.37 to 33.71 ppt. during the March to August, and during September complete fresh water conditions with salinity of 0.07 ppt. and during October-March salinity ranging between 19.63 to 25 ppt. were noticed. The mixing of freshwater with sea water is very high at middle area of the estuary, thus varying the salinity between 25.21 to 5.77 ppt. during most part of the year except a high salinity of 35.05 during May and very low salinity (1.5 to 0.07 ppt.) during September-October were found. At the upper reaches of the estuary salinities ranging between 23.17 to 14.75 ppt. during March to June and in the remaining months ranging between 5.05 to 0.14 ppt. and during July and September fresh water conditions were noticed (Fig 5).

*Dissolved Oxygen* : The Dissolved Oxygen quantity ranging from 21.0 to 5.8 mg /lt were noticed at the three stations during the period of study. At the middle and upper reaches of the estuary more Dissolved Oxygen quantities were noticed than at the mouth area. At all the three stations maximum Dissolved Oxygen quantities were noticed during May-October and minimum during November-April (Fig. 6)

## ZOOPLANKTON

Though the Zooplankton was found consisting several groups of organisms, fish eggs and larvae, copepoda, cladocerans and chaetognaths are found to be dominant groups. However, larval invertebrates were seen in most of the samples also.

i) *Fish eggs and larvae* : Fish eggs and larvae were found in almost all the zooplankton samples collected from the mouth and middle areas of the estuary but their number and frequency of occurrence is very less in the upper reaches (Station III). During the monsoon months of July and August fish eggs and larvae were not found in any of the samples.

ii) *Copepods* : Copepods were found to be the major component of the Zooplankton. Abundance of copepods throughout the estuary is noticed during March-May and Sept.-Oct., while very less number were seen during June, Nov.-Jan. Generally at the mouth of the estuary more copepods were seen than at the remaining two stations except during July.

iii) *Chaetognaths* : Chaetognaths were found more in the mouth and middle areas of the estuary

during the period from May to October, but their occurrence is almost nil at the upper reaches. More number of Chaetognaths were found in the mouth area during the month of October.

Table 1 : Physico-Chemical Parameters, Station-I (Mouth of the River) During 1985-86.

Month	Temperature°C		pH	Salinity (ppt.)	D.O. (mg./Lt.)
	Air	Water (Subsurface)			
Jul.	29.0	28.2	7.6	33.64	16.5
Aug.	27.8	28.5	7.9	33.71	13.0
Sep.	31.2	31.7	7.7	0.07	13.8
Oct.	29.1	29.1	8.52	19.63	17.1
Nov.	27.0	27.2	9.05	25.0	5.8
Dec.	24.5	24.0	7.83	23.46	9.9
Jan.	27.0	26.9	7.76	18.59	8.4
Feb.	28.7	27.9	8.3	21.51	7.3
Mar.	29.9	29.1	8.0	35.37	13.9
Apr.	30.5	30.8	7.91	31.72	8.8
May	30.5	29.75	8.09	35.05	18.0
Jun.	28.5	29.5	8.0	31.6	11.3

Table 2 : Physico-Chemical Parameters, Station-II (Middle of the River) During 1985-86.

Month	Temperature°C		pH	Salinity (ppt.)	D.O. (mg./Lt.)
	Air	Water (Subsurface)			
Jul.	28.2	28.4	7.9	10.46	15.3
Aug.	26.7	28.4	8.2	20.21	16.0
Sep.	35.0	35.0	8.57	0.07	13.6
Oct.	31.3	28.0	8.88	1.5	20.4
Nov.	28.7	25.2	8.9	8.5	7.8
Dec.	26.0	24.5	8.45	23.10	11.4
Jan.	28.4	25.9	7.52	5.77	8.8
Feb.	29.0	30.0	8.10	10.46	8.1
Mar.	28.1	29.9	8.3	25.21	12.4
Apr.	29.3	30.4	7.83	19.24	6.2
May	30.5	29.0	8.2	35.05	15.0
Jun.	31.0	29.25	8.0	18.03	16.6

iv) *Cladocera* : Cladocerans are seen during all the months except in the month of December in the estuarine waters. However they were more in the samples collected from middle and upper reaches of the estuary. These were also present in the samples collected from mouth area during the months of January to April, and surprisingly their number is very high during March-April. The minimum number of cladocerans were seen in the months of May, August and October.

v) *Meroplankters* : The meroplankters viz. crustacea, ploychcata and mollusca larvae were seen in all the samples throughout the year. However these are seen in more numbers during March, April, May and September.

Table 3 : Physico-Chemical Parameters, Station-III, (Bridge Area) During 1985-86

Month	Temperature °C		pH	Salinity (ppt.)	D.O. (mg/Lt)
	Air	Water (Subsurface)			
Jul	28.0	27.0	2.51	0.0	16.0
Aug	26.5	28.2	8.4	5.05	16.0
Sep	34.7	35.2	8.82	0.0	13.0
Oct	32.6	28.7	8.93	0.33	21.0
Nov	26.0	25.8	9.5	0.14	8.8
Dec	26.0	25.5	8.46	2.31	4.6
Jan	28.0	26.7	7.8	2.59	9.4
Feb	28.9	30.7	7.9	2.16	9.4
Mar	28.7	30.5	8.0	14.75	13.00
Apr	31.5	32.5	7.96	23.17	7.3
May	31.0	29.5	8.15	22.7	10.0
Jun	29.5	28.5	8.5	19.13	16.5

Table 4 : Zooplankton Quantity ml/200 lt.

Month	Station-I (Mouth area)	Station-II (Middle area)	Station-III (Bridge area)
Jul	0.1	0.2	0.3
Aug	0.1	0.1	0.1
Sep	0.2	0.5	0.5
Oct	1.9	0.1	1.05
Nov	0.1	0.2	0.2
Dec	0.3	-	0.2
Jan	0.1	0.1	0.1
Feb	0.15	0.1	0.3
Mar	1.5	0.9	0.1
Apr	1.3	0.5	0.5
May	0.8	0.2	0.5
Jun	0.3	0.1	0.1

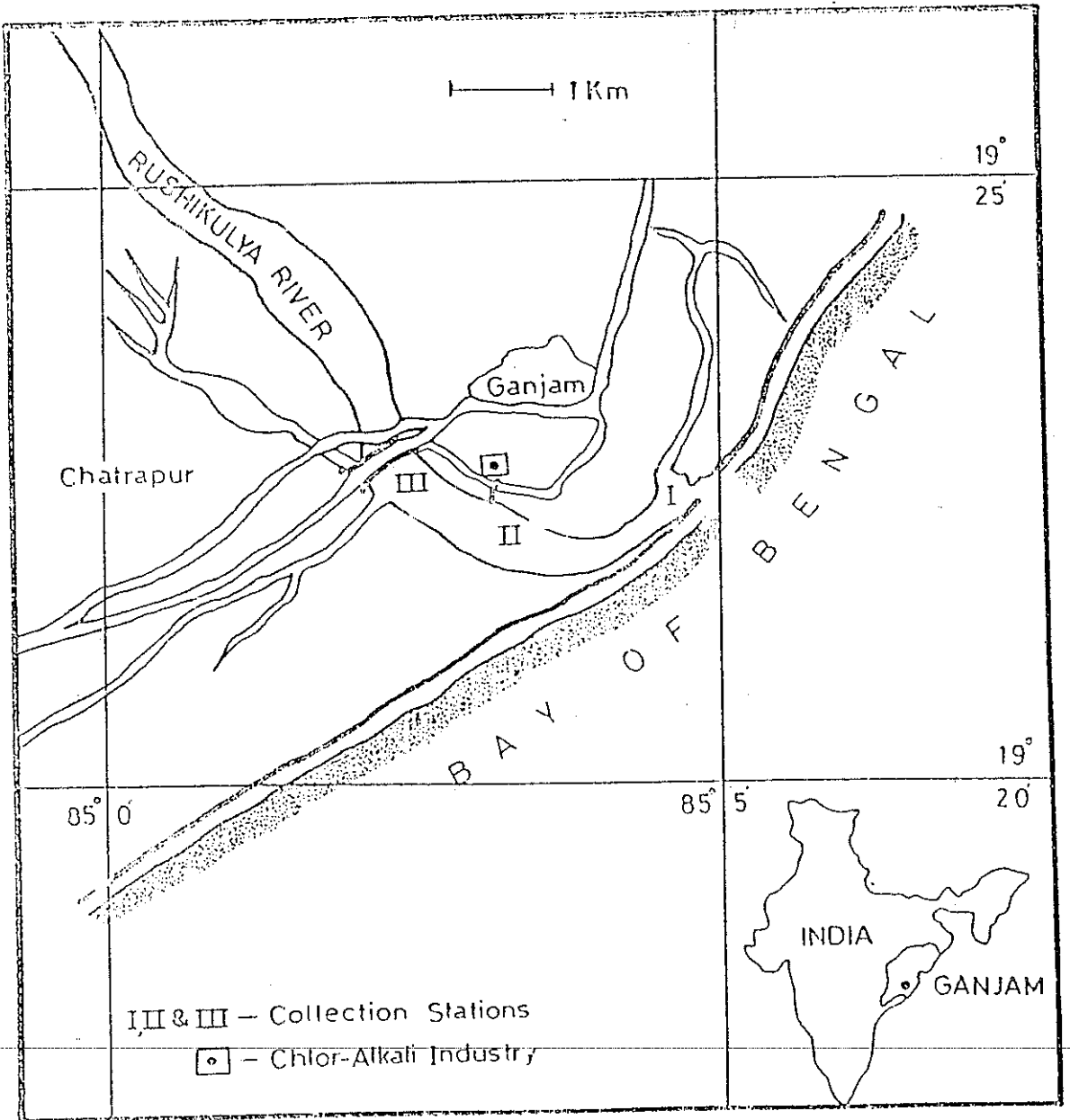


Fig. 1 Map of Rushikulya estuary showing collection stations

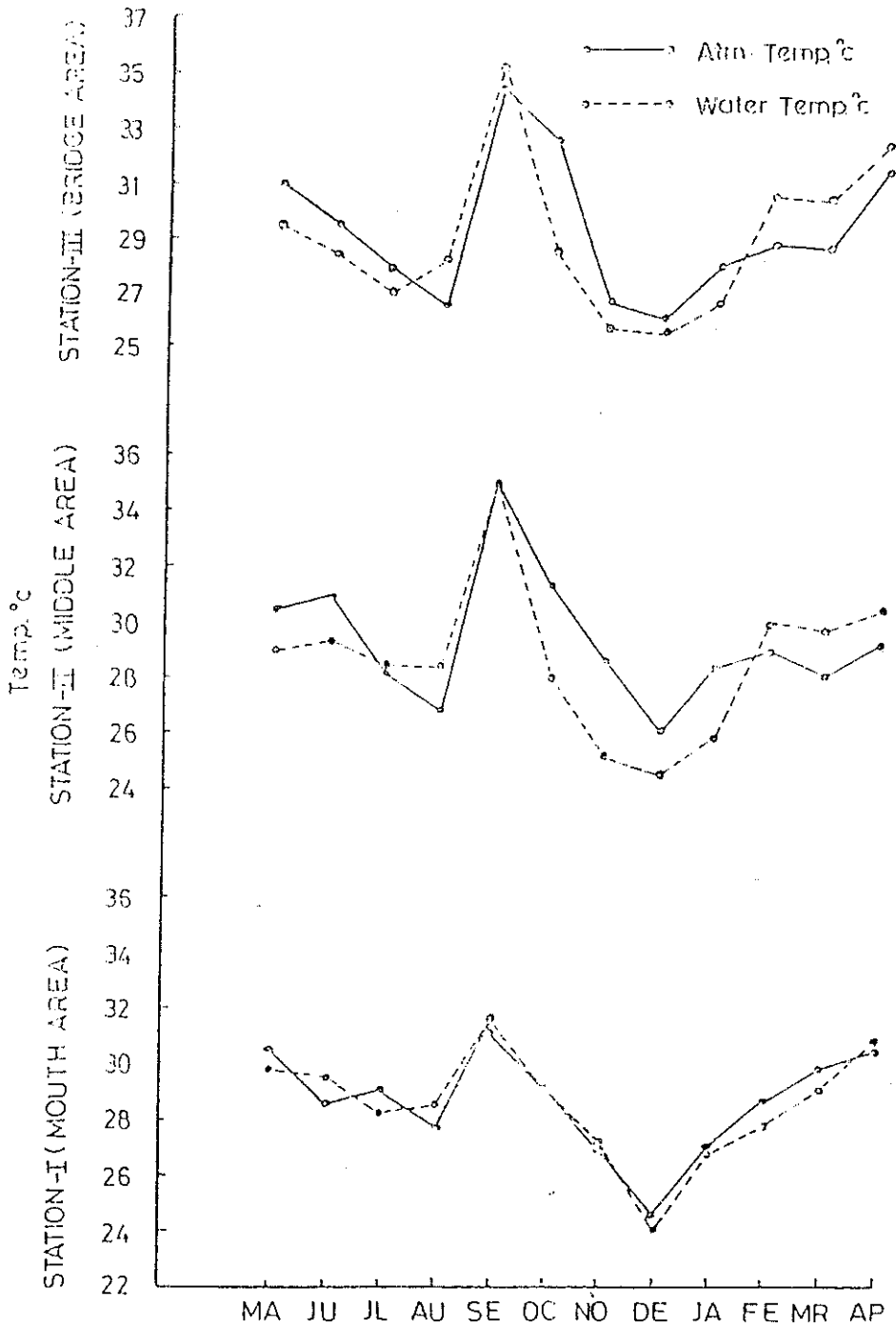


Fig 2 Air and water temperature at stations I, II & III during 1985-86

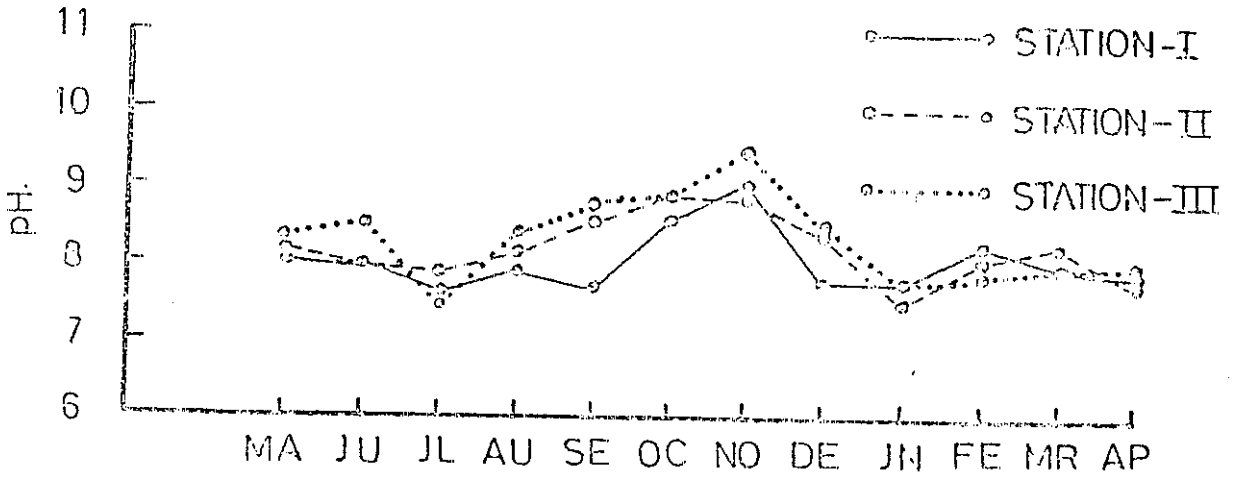


Fig 3 pH of water at stations I, II & III during 1985-86

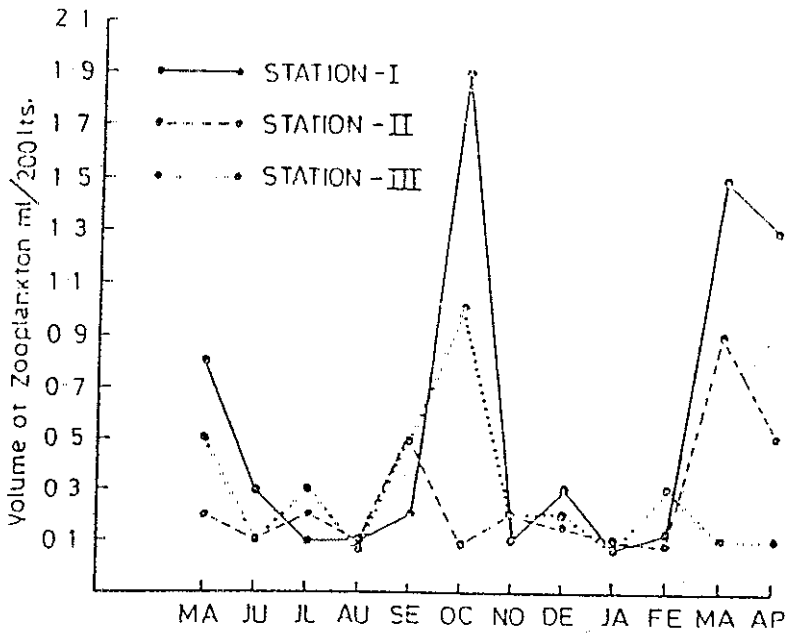


Fig. 4 Volume of Zooplankton at stations I, II & III



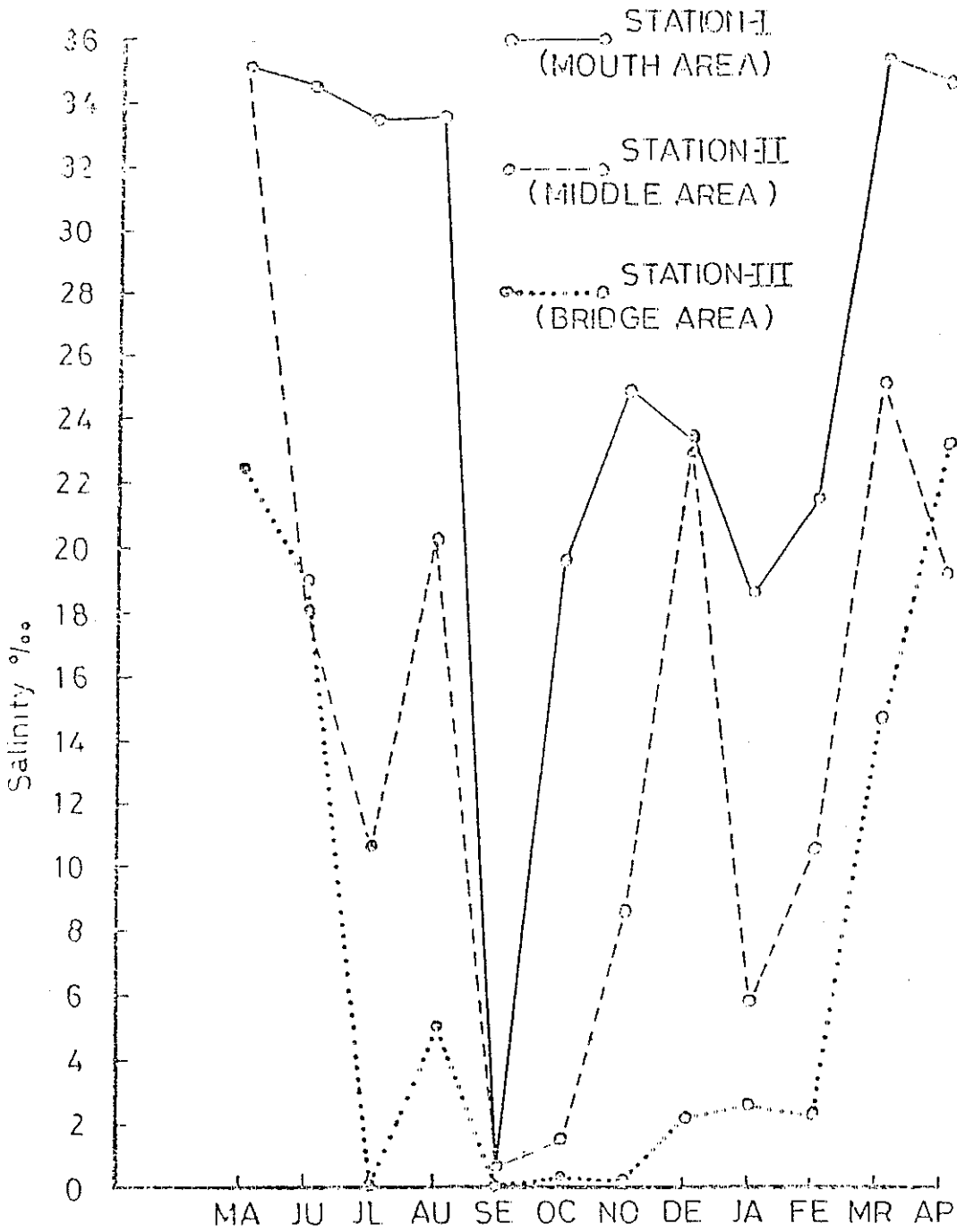


Fig. 5 Salinity at stations, I, II & III during 1985-86

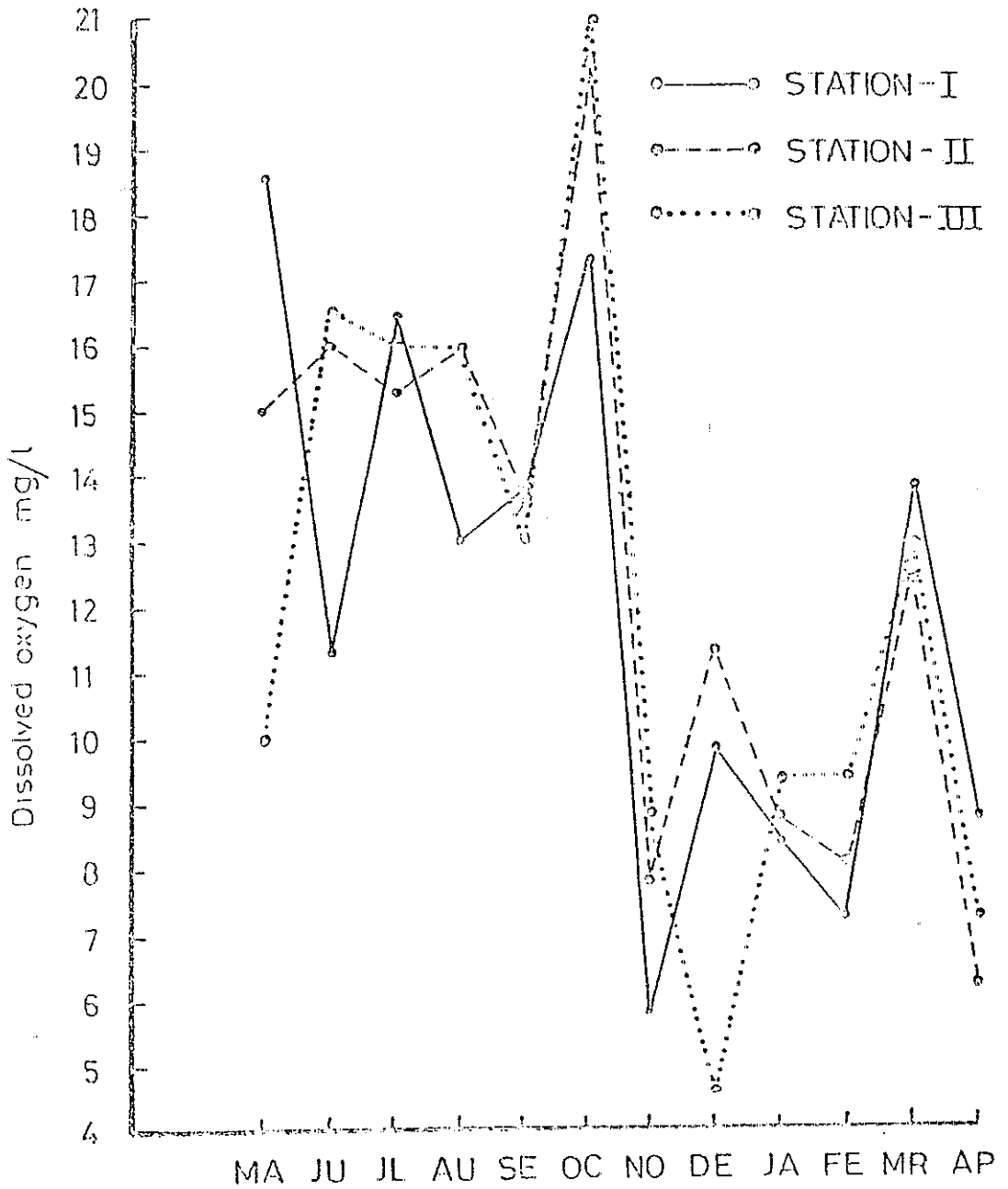


Fig 6 Dissolved Oxygen at stations I, II & III during 1985-86

*Quantitative studies* : The volume of Zooplankton shows seasonal fluctuations with two peaks in a year (fig. 4). The first peak is in the month of March and the other in the month of October i.e. premonsoon and post monsoon. During the monsoon period low quantities of Zooplankton were noticed. The above situation occurs in all the three stations. However the Zooplankton volumes at the middle and upper regions were lower than in the mouth area. In the middle area the post monsoon increase was very less in comparison to the mouth area. In the upper reaches of the estuary the increase in Zooplankton quantity during premonsoon period is very less compared to the lower reaches of the estuary (Fig. 4).

#### MACROFAUNA

The important constituents of the estuarine macrofauna comprises polychaetes, crustaceans, molluscs and fishes. However other groups such as coelenterates, sipunculids, echinoderms etc. also occur in less numbers. As the major groups, viz. polychaetes, crustaceans, molluscs and fishes, are abundant and commercially important, regular collections of these were made from different localities of the estuary and studied in detail.

*Polychaetes* : Polychaetes are one of the important constituents of the benthic fauna of the estuary as these are the most abundant of all the invertebrates. Although polychaetes were seen all along the estuary their presence is very less at the upper reaches of the estuary where freshwater conditions are seen during most part of the year except few months. In the middle region, the vasty exposed intertidal mud flats were found inhabited by large populations of polychaetes of different families. At the mouth are also, sediments of the intertidal region mixed with sand and mud harboured good number of polychaetes.

About 18 species belonging to 11 families of polychaetes were collected, of which majority of them belong to the Families, Nereididae, Eunicidae, Spionidae, Capitellidae and Sabellidae. At the upper reaches of the estuary except few Spionids, no other polychaetes were seen. The following is the list of the polychaete fauna of the Rushikulya estuary.

1. Family : Pilargiidae
  1. *Ancistrosyllis constricta* Southern
2. Family : Phyllodoceidae
  2. *Eudalia viridis* (Muller)
3. Family : Pisionidae
  3. *Pisionidius indica* (Niyar and Alikunhi)
4. Family : Nereididae
  4. *Nereis (C. caioneris) burmensis* Munro
  5. *Nereis (Neanthes) reducta* Southern
5. Family : Glyceridae
  6. *Glycera alba* Rathke.
  7. *Glycera lunca-divae* Schmarda
6. Family : Eunicidae

8. *Lumbrineria notocirrata* Fauvel
9. *Diopatra neapolitana* Delle Chiaje
7. Family : Trochochaetidae
  10. *Poecilochaetus serpens* Allen
8. Family : Spionidae
  11. *Malacoceros indicus* (Fauvel)
  12. *Prionospio cirrifer* Würen
  13. *Scolelepis squamata* (Müller)
9. Family : Sebellidae
  14. *Laonome indica* Southern
10. Family : Capitellidae
  15. *Heteromastus similis* Southern
  16. *Paraheteromastus tenuis* (Munro)
  17. *Bianchiocaputella singularis* Fauvel
11. Family : Terebellidae
  18. *Loimia medusa* (Savigny)

Of the above *Glycera*, *Pisionidens*, *Eulalia*, and *Poecilochaetus* occur in few numbers and the remaining are abundant during most part of the year except in August and September.

**Crustacea** : Though this group comprises prawns, crabs, hermit crabs, amphipods and Isopods etc., only the commercially important crabs and prawns were collected and studied. The taxonomic list of the crabs and prawns is given below:

1. Family : Penaeidae
  1. *Penaeus monodon* (Fabricius)
  2. *Penaeus semisulcatus* (De Hann)
  3. *Parapenaeus rectacuta* Bata
  4. *Matipenaeus* sp.
2. Family : Oxypodidae
  5. *Macrophthalmus depressus* Rupell
  6. *Oxyпода macrocera* M. Edwards
  7. *Oxyпода* sp.
  8. *Uca annulipes* Latr.
  9. *Uca triangularis* M. Edwards
  10. *Dotilla brevitarsis* De Hann
3. Family : Grapsidae
  11. *Varuna littorea* (Fabricius)
4. Family : Portunidae

12. *Scylla serrata* (Forsk.)
13. *Theclamita crenata* (Later)
14. *Charybdis affinis* Dana

Among the crabs, oecypoda crabs were seen abundant in the intertidal areas at the middle and mouth areas of the estuary. The intertidal mud flats at the middle region of the estuary is dotted with thick populations of *Uca* sp while at the mouth and middle areas the mud crab *Scylla serrata* were found caught in large numbers by fishermen. Though large number of prawn larvae and juveniles were observed in the estuary, only few species of prawns were encountered. However, good catches of prawn were also noticed during the fishing activities in the estuary.

*Mollusca* : Molluscan shells both living and dead ones were found abundant at the mouth and middle areas of the estuary but very less in numbers at the upper reaches. In the intertidal mud flats at the middle region, many bivalves viz *Solen*, *Crassostrea*, *Macra*, *Corbicula* were found buried along with other benthic fauna. At the mouth region dead shells were seen washed ashore of which many are probably of marine origin. However all the shells found in the estuary upto the mouth region were collected and the list of the molluscan fauna given below.

Class : GASTROPODA

Order : MESOGASTROPODA

1. Family : Turritellidae
  1. *Turritella columanaris* Kiener
2. Family : Thiariidae
  2. *Thiara (Tarebia) lineata* (Gray)
  3. *Thiara (Tarebia) granifera* (Lamarck)
  4. *Thiara (Stenomelania) torulosa* (Bruguiere)
3. Family : Architectonicidae
  5. *Architectonica laevigata* (Lamarck)
4. Family : Potamididae
  6. *Telescopium (Telescopium) telescopium* (Linnaeus)
  7. *Cerithidea (Cerithidopsis) cingulata* (Gmelin)
5. Family : Cypraeidae
  8. *Mauritia arabica* (Linnaeus)
  9. *Erosaria ocellata* (Linnaeus)
6. Family : Cymatiidae
  10. *Cymatium tripus* (Lamarck)
  11. *Distorsio reticulata* Rooding
7. Family : Viviparidae
  12. *Bellamyia bengalensis* f. *typica* (Lamarck)
  13. *Bellamyia dissimilis* (Mueller)

8 Family : Pilidae

14. *Pila globosa* (Swainson)

9. Family : Naticidae

15. *Natica gualteriana* Recluz

Order : NEOGASTROPODA

10 Family : Muricidae

16. *Murex tribulus* Linnaeus

11 Family : Olividae

17. *Oliva oliva* (Linnaeus)

12. Family : Turridae

18. *Lophiotoma (Lophioturris) indica* (Roeding)

13. Family : Buccinidae

19. *Babylonia spinata* (Linnaeus)

Order : Basommatophora

14. Family : Planorbidae

20. *Indoplanorbis exustus* (Deshayes)

Class : BIVALVIA

Order : ARCOIDA

15. Family : Arcidae

21. *Anadara* sp.

22. *Anadara (Anadara) granosa* (Linnaeus)

23. *Anadara (Tegillarca) rhombata* (Born)

24. *Scapharca deyrollei* Jousseaume

16. Family : Glycymerididae

25. *Glycymeris tenuicostata* (Reeve)

Order : Veneroida

17. Family : Carditidae

26. *Cardites antiquata* (Linnaeus)

18. Family : Cardiidae

27. *Cardium* sp.

28. *Acanthocardia coronata* (Schroeter)

29. *Acanthocardia lata* (Born)

19. Family : Mactridae

30. *Mactra luzonica* Deshayes

31. *Mactra mera* Deshayes

32. *Mactra cuneata* (Gmelin)

20. Family : Donacidae  
33. *Donax scortum* Linnaeus
21. Family : Corbiculidae  
34. *Corbicula striatella* Deshayes
22. Family : Veneridae  
35. *Marcia pinguis* (Schroeter)  
36. *Meretrix meretrix* (Linnaeus)  
37. *Meretrix casta* (Gmelin)  
38. *Timoclea imbricata* (Sov erby)  
39. *Sunetta effosa* (Hanley)  
40. *Sunetta donacina* (Gmelin)  
41. *Sunetta* sp.  
42. *Sunetta scripta* (Linnaeus)  
43. *Sunetta meroe* (Linnaeus)
23. Family : Solenidae  
44. *Solen truncatus* Wood  
Order : PTERIOIDA
24. Family : Anomiidae  
45. *Anomia achaeus* Gray
25. Family : Ostreidae  
46. *Crassostrea cuttackensis* (Smith and Newton)  
Order : Unionoida
26. Family : Amblemidae  
47. *Parreysia (Parreysia) corrugata* (Mueller)  
Order : MYTILOIDA
27. Family : Mytilidae  
48. *Perna viridis* (Linnaeus)

*Fish and fish larvae* : Fishing operations in the estuary were seen during most part of the year. The fish fauna of the estuary is very rich both quantitatively and qualitatively. Different types of gear were found operated in the estuary and near the mouth area by the fishermen. The adult fish fauna of the estuary will not give the total fish potential of the estuary as the estuaries are considered to be the nurseries and breeding grounds for a variety of fishes. Hence the abundance and taxonomy of the fish larvae and juveniles were also studied. The fish larvae and juveniles were collected during high and low tides by using Midnapore shooting net and were identified up to generic level. The fish samples were collected from fish landing centres and from the fishermen while fishing in the estuary. The details of the fish fauna is given below.

*Fish fauna of the estuary :*

1. Family : Ophichthidae
  1. *Callechelys longipinnis* (Knar and Steidachner)
2. Family : Clupeidae
  2. *Hilsa ilisha* Hamilton
  3. *Sardinella fimbriata* Valenciennes
3. Family : Engraulidae
  4. *Stolephorus indicus* (Van Hasselt)
  5. *Stolephorus commersonii* Lacepede
4. Family : Bagridae
  6. *Mystus gulio* (Hamilton-Buchanan)
5. Family : Ariidae
  7. *Arius arius* (Hamilton-Buchanan)
  8. *Arius caelatus* Valenciennes
6. Family : Syngnathidae
  9. *Microphis brachyurus* Bleeker
7. Family : Platycephalidae
  10. *Platycephalus indicus* (Linnaeus)
8. Family : Ambassisidae
  11. *Ambassis wotaenia* Bleeker
9. Family : Theraponidae
  12. *Therapon jarbua* Forskal
10. Family : Sillaginidae
  13. *Sillago sihama* (Forskal)
11. Family : Carangidae
  14. *Caranx carangus* (Bloch)
12. Family : Lutjanidae
  15. *Lutjanus jhonii* (Bloch)
13. Family : Gerriidae
  16. *Gerres filamentosus* Cuvier
14. Family : Mullidae
  17. *Upeneus tragula* Richardson
15. Family : Scatophagidae
  18. *Scatophagus argus* (Linnaeus)
16. Family : Mugilidae



19. *Mugil cephalus* Linnaeus
20. *Liza parsia* (Hamilton-Buchanan)
21. *Valmugil seheli* (Forsk.)
22. *Valmugil speidleri* (Bleeker)
17. Family : Callionymidae
  23. *Callionymus sagitta* Pallas
18. Family : Gobiidae
  24. *Glossogobius giuris* (Hamilton)
  25. *Glossogobius biocellatus* (Valenciennes)
  26. *Oxyurichthys microlepis* (Bleeker)
19. Family : Siganidae
  27. *Siganusomaliculatus* (Park)
20. Family : Cynoglossidae
  28. *Cynoglossus semifaciatius* Day
21. Family : Tetraodontidae
  29. *Chelodon patoca* (Hamilton-Buchanan)

*Fish larvae* : The fish larvae were collected by using standard Midnapore shooting net at mouth area during high and low tides for a period of 12 months to know the composition of the fish larvae as the fishery of the estuary is dependent on successful recruitment of larvae and juveniles from the sea. Nearly 60% to 70% of the fishery is constituted by these recruits which migrate to the upper reaches of the estuary and grow to larger sizes. This estuary is ideal for collection of seeds of culturable species of brackish water fishes viz. *Chanos*, *Mugil*, *Elops*, *Megalops*, etc.

In all, 38 species belonging to 19 families were encountered in the present collections of which 8 families of fish are commercially important viz. Mugilidae, Chanidae, Leiognathidae, Cynoglossidae, Engraulidae, Theraponidae, Elopidae and Megalopidae.

The occurrence and abundance of these larvae varies during different periods of the year. In the month of March, June and December the larval representation is almost nil and during August and October very few fish larvae were seen represented by only Gobiidae and Elopidae larvae. But in the remaining months (January, February, April, May, July, September and November) fish larvae and juveniles belonging to many families were encountered. Along with the fish larvae many species of post larvae and juveniles of Prawns and Crabs were also encountered round the year in the Midnapore net collections. The following are the various groups of fish larvae of the Rushikulya estuary.

1. *Elopids* : The transparent leptocephalus like post larvae of *Elops saurus* Linn. Measuring 26 to 36 mm occur in the months of January, February, April and May in lesser numbers and occur in large numbers during July-August.

2. *Megalopids* : Transparent leptocephalus like post larvae of *Megalops cyprinoides* (Brouss) ranging 22 to 28 mm in length occur in stray numbers and found only in the month of May. No single specimen was found during the remaining period.

3 *Eel leptocephali* : Four species of transparent ribbon-like leptocephalus larvae of eels belonging to the families Muraenidae and Ophichthidae were found in large numbers in the month of January, May and July. Usually these eel larvae are seen entering the estuaries during high tides only.

4 *Engraulids* : Large number of larvae and post larvae of two species of engraulids viz. *Stolephorus* and *Thryssa* sp. measuring 8 to 25 mm. in length occur in the collections made in the month of January, February, July and November.

5 *Milk fish* : Large number of post larvae and juveniles of *Chanos chanos* in the size range of 11.5 to 15 mm. were found during high tides before the on-set of monsoon i.e. in May. The larvae and juveniles of *Chanos chanos* usually found along with the larvae of *Elops*, *Megalops* and *Mugils*.

6 *Mulletts* : Two species of mullet larvae and juveniles of the *Liza* ranging 11 to 17.5 mm. in length were seen in large numbers during the month of May and in very less numbers during October - November, i.e. post monsoon period.

7 *Cyprinids* : Few species of cyprinid fish larvae were collected during October - November. A single juvenile specimen of *Esomus danricus* (Ham.) and larvae of different species of *Puntius* measuring 15 to 20 mm. were found.

8 *Leiognathids* : Large number of post larvae and juvenile leiognathids belonging to *Leiognathus leniolatus* (Cuv. & Val.) and other species of *Leiognathus* ranging from 7.5 to 18 mm. in length were found during the month of January, February, July and September.

9 *Theraponids* : Post larvae and juveniles of *Therapon juluha* (Forsk.) ranging 10 to 15 mm. in length occurred in the month of April, May, June and July i.e. during premonsoon and monsoon periods. During remaining months no specimen was encountered.

10 *Gobiids* : Large number of juveniles of Gobiid fishes were collected during premonsoon and post monsoon (i.e. in January, February, April, September, October and November) of which nine larvae belong to *Gobius* sp., two *Gobioides* sp. and one species of *Boleophthalmus* were identified.

11 *Cynoglossids* : Metamorphosed larvae of two species of *Cynoglossus* sp. measuring 4.6 to 7.8 in length were found in small numbers during only January and May.

12 *Ambassis* : Post larvae and juveniles of *Ambassis* sp. measuring 7.5 to 23 mm. in length were recorded in large numbers during post monsoon period of September, October and November months.

13 *Tetraodontids* : Post larvae and juveniles of *Chelonodon Patoca* (Ham. & Buch.) ranging 9 to 17 mm. were found in stray number during the months of January, February and July.

In addition, larvae and juveniles of some fishes of other families in smaller numbers were seen of which post larvae and juveniles of *Scatophagus argus* (Linn.), *Vespicula* sp., *Platycephalus* sp. and *Macrogathus aculeatus* are noteworthy.

## DISCUSSION

Estuaries provide a dynamic ecosystem with constantly changing physico-chemical conditions and its fauna during different periods of the year and different regions within the estuary due to floods, monsoon, tides, etc. At the Station-I and II increase in depth was noticed due to tidal

influence. However appreciable increase in depth is noticed at all the stations during monsoon periods. Marked difference in the air and water temperature was not noticed in the estuary except at Station-III where the depth is very less. Due to tidal influence, at Station-I and II, less differences in the air and subsurface water temperature was noticed. Nearly sea water conditions are seen at the I<sup>st</sup> Station during the most part of the year except during September-October. Very high volume of sea water enters the estuary during high tide, and the river water flow is very less compared to the sea water inflow. This observation was also made by Murthy *et al.* (1988). However real estuarine conditions exists at Station-II as mixing of fresh water with sea water takes place. At the III<sup>rd</sup> Station very less salinities are noticed throughout the year except summer months of March - June and during this period negligible amount of fresh water flow is seen in the river and thereby maximum sea water inflow to this station. Marked seasonal difference in the dissolved oxygen values are seen. The dissolved oxygen content in the estuarine waters is more during summer and monsoon months in comparison to post monsoon period at all the stations. Generally more dissolved oxygen quantities are seen at Station-III, probably due to the running water conditions at this place. The dissolved oxygen values observed in this estuary were found to be higher in comparison to Ennore estuary (Raghunathan and Srinivasan, 1983) where in 1.5-7.5 mg./lt. dissolved oxygen values are reported. The high values of dissolved oxygen seen in Rushikulya estuarine water might be due to less depth.

pH values did not show any marked seasonal fluctuations except at Station-I where nearly neutral values are seen during monsoon months. pH ranging between 7.5 to 9.5 was recorded in the estuary during the study; slightly more alkaline conditions are noticed at Station-III, in comparison to the other two stations. Similar observations are noticed in the estuaries of Ramaniathpuram (Banganal, 1975) and Ennore (Raghunathan and Srinivasan, 1983). Generally two peaks in Zooplankton quantities are found one in summer and the other during post monsoon period. Zooplankton at Station-I is found to be rich both quantitatively and qualitatively as higher salinities influence in Zooplankton production. Peaks in Zooplankton in general, and copepoda in particular after phytoplankton blooms are reported by Ramamurthy (1953) and Krishnaswamy (1950). Raghunathan (1980) also reported the relationship between the abundance of Diatoms and Copepods in Ennore estuary. Quantitative studies on Phytoplankton of the Rushikulya estuary enables us to understand the Zooplankton distribution pattern.

The occurrence of rich macrofauna viz. polychaetes, crustaceans, mollusca along with high Zooplankton quantities at Station-I in general shows the important role of salinity in the abundance of fauna and its variety.

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