

# PLANKTON STUDIES IN THE ESTUARINE SYSTEM OF GOA

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Distribution of zooplankton with special reference to copepods at two stations in the Mandovi and Zuari estuaries of Goa was studied over a period of one year. The annual fluctuations in temperature at Old Goa (Stn. 1, Mandovi) and at St. Jacinto Island (Stn. 2, Zuari) were within the range of 6°C. However, the salinity varied from 0.21 to 33.6‰ in Mandovi and 1.96 to 36.61‰ in Zuari. Mean biomass (wet weight) was higher at Stn. 2 (175g 1000 m<sup>3</sup>) than at Stn. 1 (81g 1000 m<sup>3</sup>).

Ctenophora, polychaete larvae, decapod larvae, Sergestidae, Copepoda, Chaetognatha, veligers, fish eggs and larvae were the major constituents of zooplankton population but no single group dominated the community throughout the year. The faunistic composition was more diverse at Stn. 2. Quantitative and qualitative variations in copepod species were well pronounced at these two stations. 43 species of planktonic copepods belonging to 20 genera and 16 families were recorded at Stn. 2, whereas at Stn. 1, there were only 33 species under 16 genera and 12 families.

Correlation between salinity and copepod species found at both the stations are discussed. Members of six copepod families showed varying degrees of coexistence at both the stations.

## INTRODUCTION

Earlier work on the distribution of zooplankton including copepods in the estuaries along the west coast of India is confined to Cochin backwaters (George, 1958; Tranter and Abraham, 1971; Menon *et al.*, 1971; Nair and Tranter, 1971; Pillai, 1971; Pillai *et al.*, 1973 and Madhupratap and Haridas, 1975). Goswami and Singbal (1974) described the zooplankton community in relation to hydrography of the Mandovi-Zuari estuarine complex of Goa during monsoon months. No published account is available on the seasonal distribution of zooplankton from this important estuarine system. The topographical features of this area have been described by Dehadrai (1970) and Parulekar and Dwivedi (1973).

## MATERIAL AND METHODS

Zooplankton samples were collected fortnightly near Old Goa (Mandovi estuary), stn. 1 and St. Jacinto Island (Zuari estuary), stn. 2, from June 1971 to May 1972. The stations are located at a distance of 15 km and 10 km from the respective river mouths (Fig. 1). Stn. 1 showed more or less estuarine conditions but stn. 2 was marine. Horizontal samples were taken using a modified HT net of 0.3 mm mesh size. The net had a mouth area of 0.25 m<sup>2</sup>. The amount of water filtered was determined by a calibrated 'TSK' flowmeter. The duration of the tow varied from 2 to 5 minutes and the samples were fixed in 5% formaldehyde prepared in seawater buffered with 1% hexamine. In the laboratory, aliquot samples were taken for the determination of total biomass, faunistic

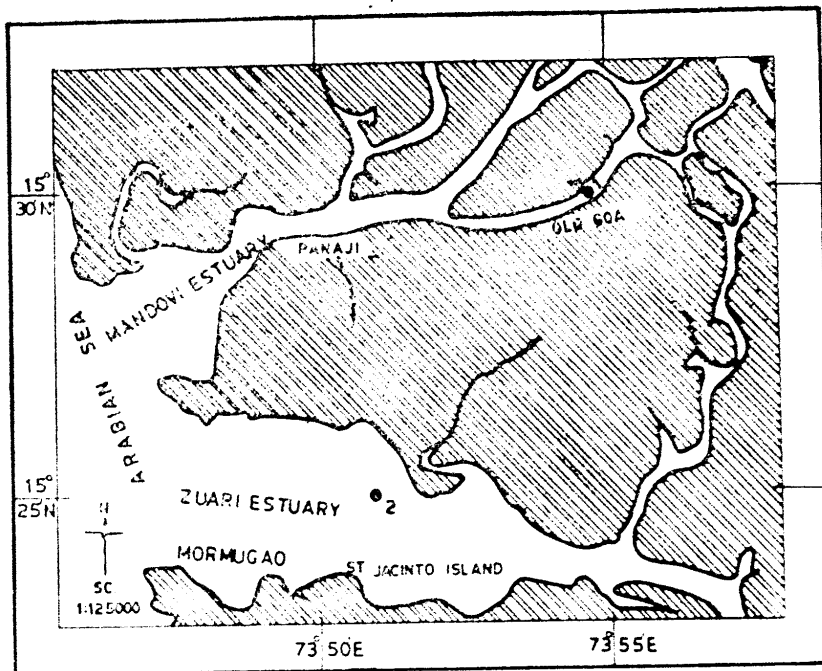


Fig. 1. Location of stations

composition and distribution of dominant species. For the count of various taxa and their species, one of the aliquots was made up to 150 ml of which 10 ml was examined under stereoscopic microscope. The number of organisms was calculated for the whole sample and estimated per  $m^3$ . The salinity was estimated following the method of Mohr as described in Strickland and Parsons (1968). The species diversity of copepods was calculated following Shannon and Weaver (1963).

## RESULTS

Seasonal changes in temperature, salinity, zooplankton biomass and the numerical abundance of various plankton groups and their species at both the stations seem to be influenced by the monsoon cycle. The salinity values were quite high during postmonsoon (October to January) and premonsoon months (February to May) but during the monsoon period (June to September) sudden decrease could be seen in surface salinity in the Mandovi estuary. There was a correlation between salinity and zooplankton biomass (Fig. 2). The highest mean biomass value (wet weight) of 150g  $1000 m^3$  was recorded at stn. 1 during premonsoon season when the salinity and temperature were quite high but at stn. 2, the highest mean value of 220g  $1000 m^3$  was obtained during monsoon months. This may be due to the fact that the Zuari estuary is more saline even during the rainy season since influx of freshwater is less.

## FAUNISTIC COMPOSITION

The predominant groups in this estuarine system were Copepoda, Sergestidae, decapod larvae, veligers, Chaetognatha, Ctenophora, fish eggs and larvae.

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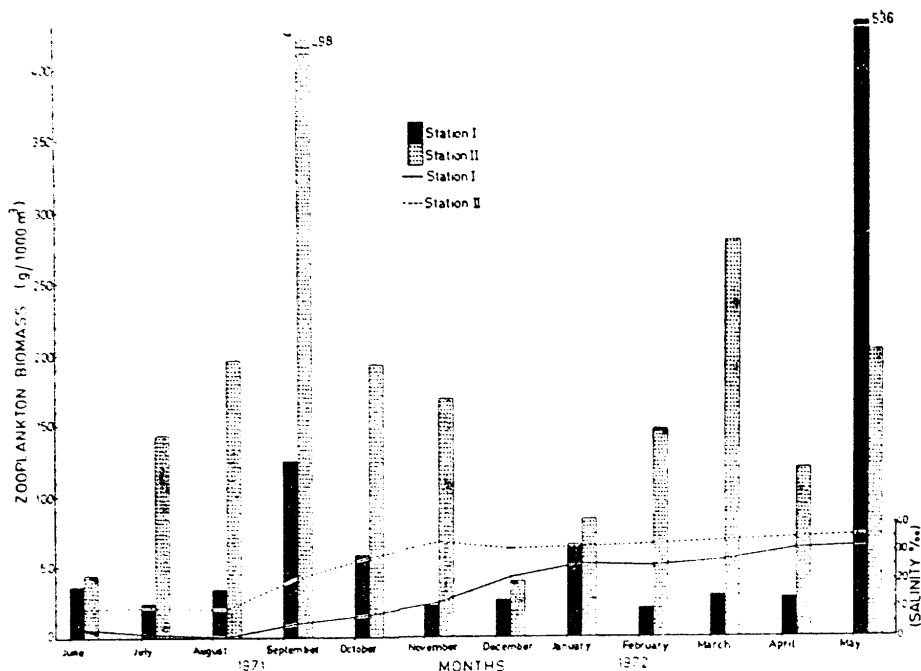


Fig. 2. Correlation between zooplankton biomass and salinity at the two stations

The faunistic composition was different at both stations. Ctenophores, polychaete larvae and veligers were more abundant in the samples from stn. 1 while hydro-medusae, sergestids, cladocerans, copepods, chaetognaths, fish eggs and larvae were dominant at stn. 2. Amphipoda and cirriped larvae were recorded only at stn. 1 and appendicularians and pteropods from stn. 2. The distribution of the dominant groups and their species at both the stations was as follows:

*Copepoda*: This group was the most important constituent of the zooplankton community throughout the year except during the period of cladoceran and ctenophore abundance. The copepods showed a bimodal type of distribution (Fig. 3). At stn. 1, the major peak was during October November, the highest percentage of 94.61% occurring in early November. The secondary copepod peak was during March April. Similarly at stn. 2, the major peak (90.2%) was during November and the secondary peak during February.

A total of 49 copepod species was observed in the surface collections from the two stations, of which 46 were identified. Qualitative and quantitative variations in copepod species were discernible at these two stations. At stn. 1, 33 species belonging to 16 genera and 12 families were collected whereas, at stn. 2, there were 43 species belonging to 20 genera and 16 families (Table 1). The percentage occurrence of some of the common species at both the stations has been shown in Fig. 4.

The distribution patterns of various copepod species along with the range of salinity are given in Fig. 5 and 6. The figures show that the majority of the species occurred during the period of high salinity. *Acartia southwelli*, *Acartiella southwelli*, *Heliodyptomus cinctus*, *Diaptomus* sp. and *Cyclops* sp. were observed in low salinity and few others showed varying degrees of salinity preference.

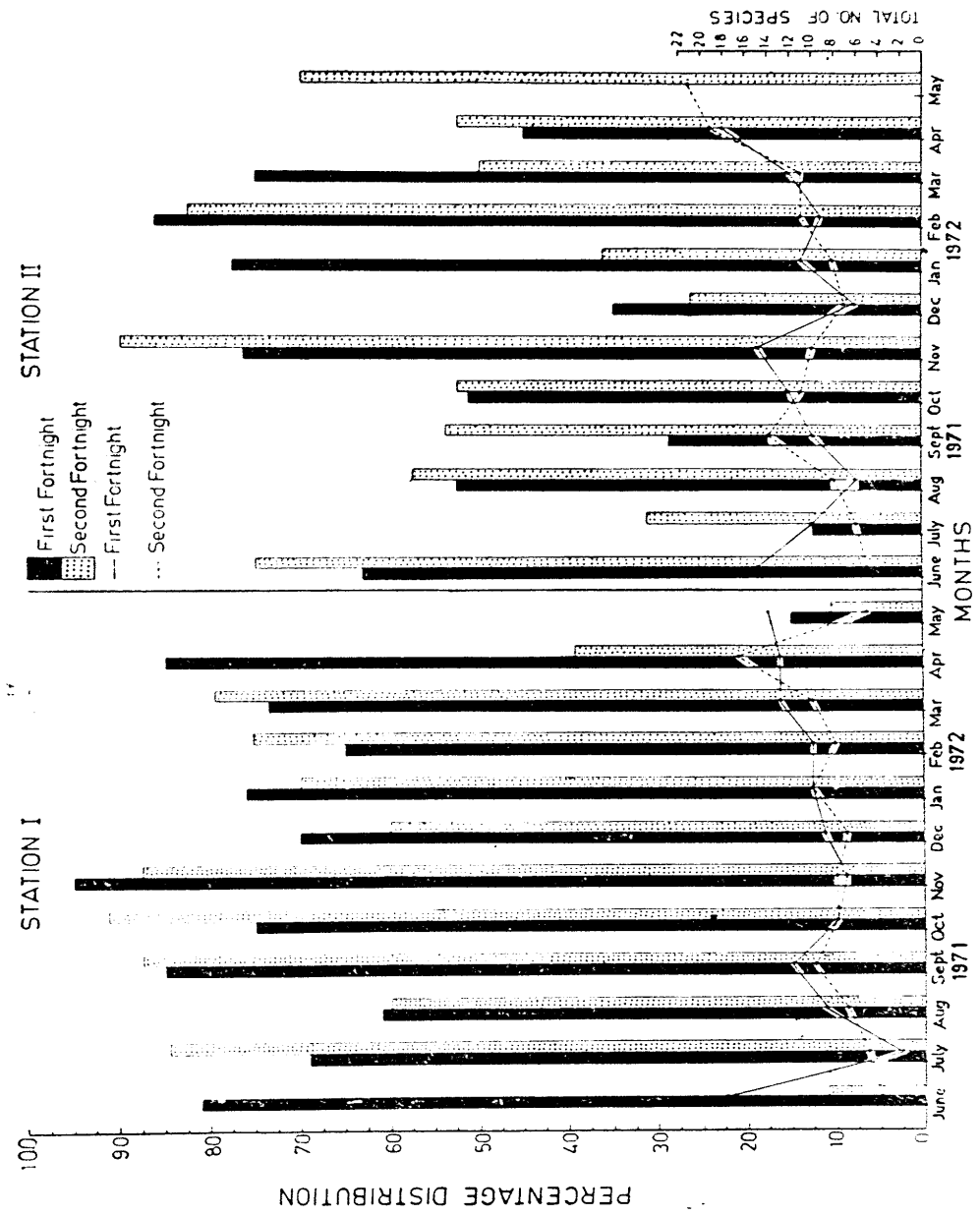


Fig. 3. Percentage distribution and total number of copepod species at the two stations

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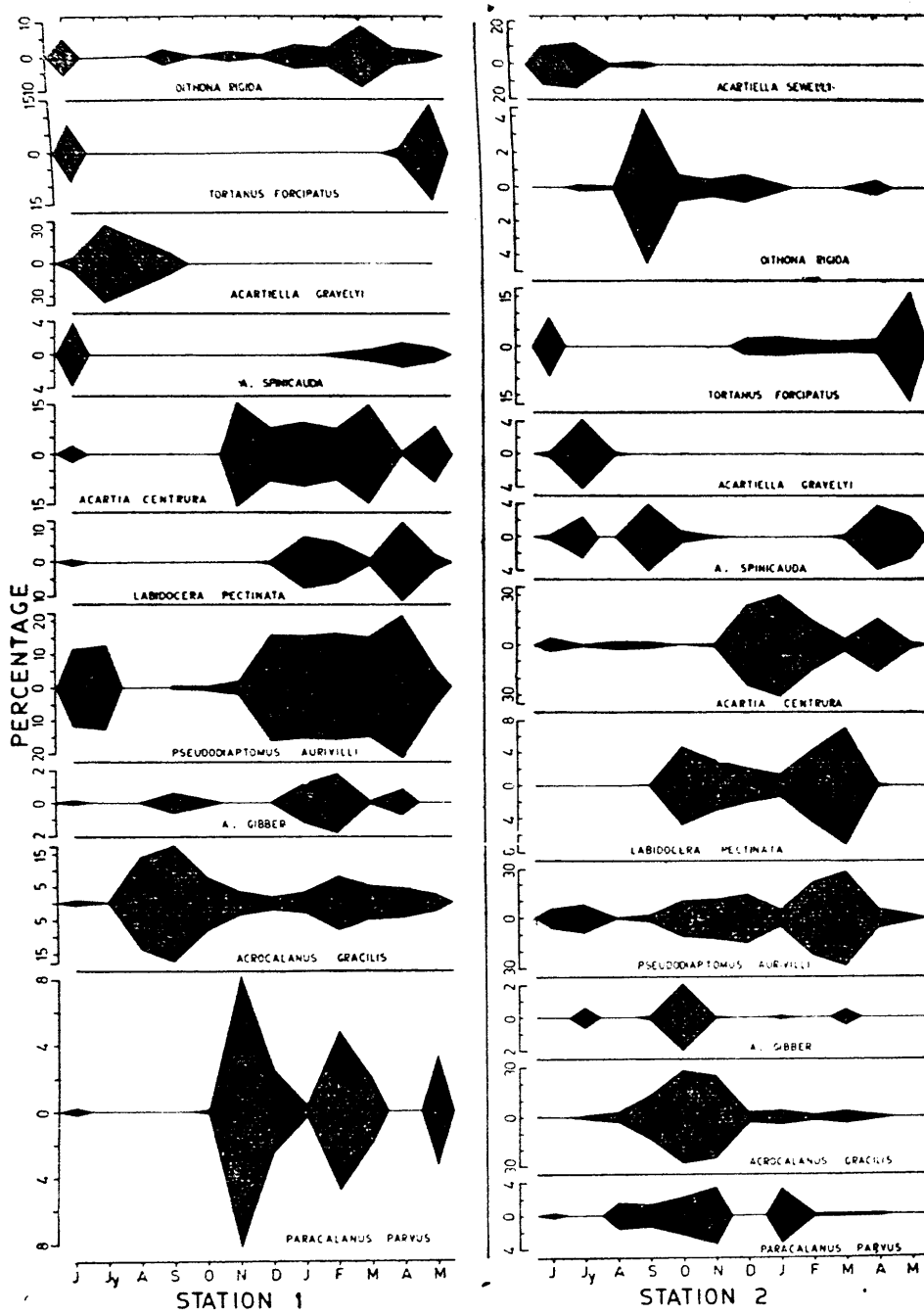


Fig. 4. Percentage occurrence of dominant copepod species at both the stations

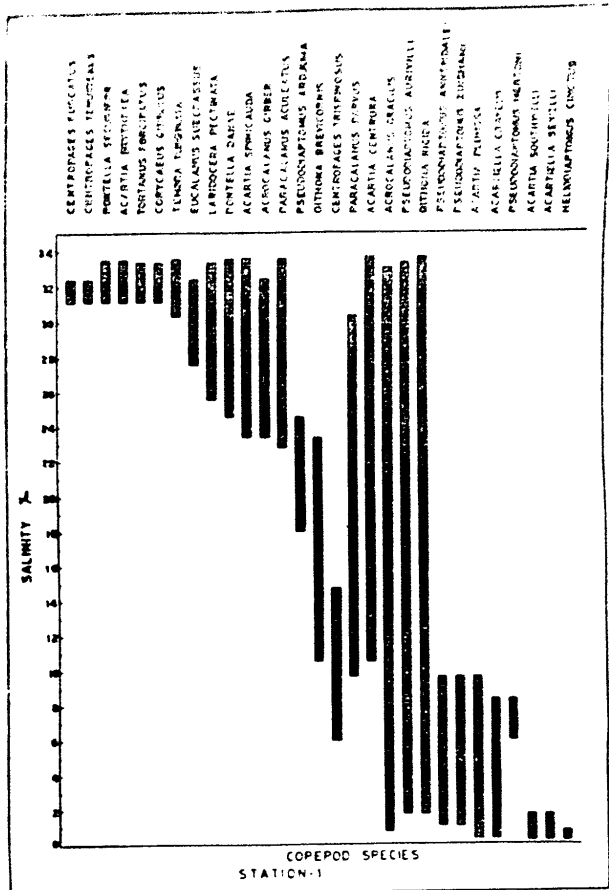


Fig. 5. Salinity range of copepod species at Station 1

The copepod species identified in the present investigation have been classified into five different groups depending upon the salinity gradation from marine to freshwater environments. Of the 49 species found at both the stations, 19 belonged to Orthostenohaline group, 8 to Orthosteno-euryhaline, 11 to the euryhaline, 8 to the eury-oligostenohaline and 3 to the Oligostenohaline group (Table 2). Nineteen species of the first category were recorded mostly from stn. 2, where marine conditions prevailed almost throughout the year. They migrate into the estuaries during high saline conditions. The Oligostenohaline species were observed only at stn. 1, where freshwater conditions ( $S‰ = 0.21$ ) were observed during the second fortnight of July. Most of the euryhaline forms appear to be endemic. Significant correlation coefficient ( $r$ ) values have been obtained between some common copepod species and salinity (Table 3). *Paracalanus aculeatus*, *Acrocalanus gracilis*, *Centropages furcatus*, *Temora turbinata*, *Pontella securifer*, *P. danae*, *Acartia erythraea*, *A. plumosa*, *Tortanus forcipatus* and *Corycaeus danae* exhibited positive correlation either at 1% or at 5% level. *Acartiella graveleyi* showed negative correlation at both the stations indicating preference for low saline conditions. *A. sewelli* also showed negative correlation at stn. 2 and occurs there in large numbers (44.12%) during low salinity regime.

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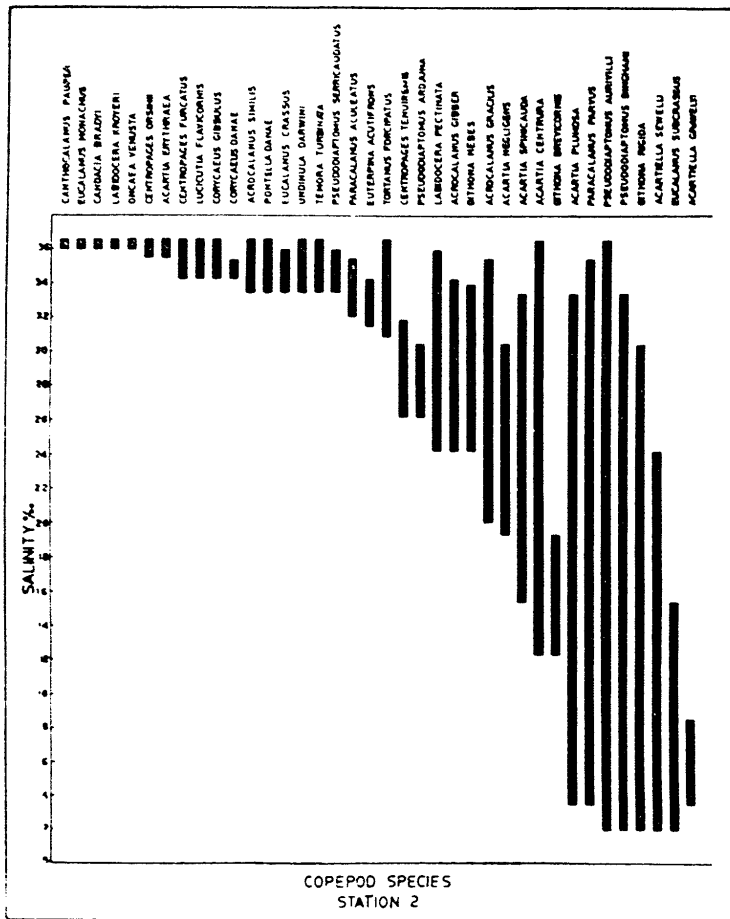


Fig. 6. Salinity range of copepod species at station 2

Species diversity ('D') values varied from 0.99 to 3.34 at stn. 1 and from 0.36 to 4.72 at stn. 2. At both the stations, higher and lower values were obtained during higher and lower salinity conditions respectively. Many neritic species migrate into this estuarine system when both temperature and salinity are high. The maximum of 17 and 21 copepod species were observed at stns. 1 and 2 respectively during premonsoon months and the minimum of 2 and 5 species in the surface collections during monsoon. Coexistence between members of six copepod families viz. Paracalanidae, Centropagidae, Pseudodiaptomidae, Pontellidae, Acartiidae and Oithonidae was observed at both the stations (Tables 4, 5). The species of the family Acartiidae were found to be dominant with the highest mean number 40152/100 m<sup>3</sup> at stn. 1 and 30666/100 m<sup>3</sup> at stn. 2.

Species of genus *Eirene* were the common representatives of hydromedusae in this estuarine system. *Pleurobrachia globosa* was the only ctenophore recorded in the samples, their highest percentage (90.4%) was obtained at stn. 1 during the first fortnight of May. The polychaete larvae recorded mostly at stn. 1 were

TABLE 1. DISTRIBUTION OF COPEPOD SPECIES AT STATION 1 AND 2

Species	Stn. 1	Stn. 2
<b>CALANIDAE</b>		
<i>Canthocalanus pauper</i> (Giesbrecht)	—	+
<i>Undinula darwini</i> (Lubbock) var. <i>typica</i> Sewell	—	+
<b>EUCALANIDAE</b>		
<i>Eucalanus subcrassus</i> Giesbrecht	+	+
<i>E. crassus</i> Giesbrecht	—	+
<i>E. monachus</i> Giesbrecht	—	+
<b>PARACALANIDAE</b>		
<i>Paracalanus parvus</i> (Claus)	+	+
<i>P. aculeatus</i> Giesbrecht	+	+
<i>Acrocalanus gracilis</i> Giesbrecht	+	+
<i>A. gibber</i> Giesbrecht	+	+
<i>A. similis</i> Sewell	—	+
<b>CENTROPAGIDAE</b>		
<i>Centropages furcatus</i> (Dana)	+	+
<i>C. tenuiremis</i> Thompson & Scott	—	—
<i>C. trispinosus</i> Sewell	+	—
<i>C. orsinii</i> Giesbrecht	—	+
<b>PSEUDOLIPTOMIDAE</b>		
<i>Pseudodiaptomus aurivilli</i> Cleve	+	—
<i>P. serricaudatus</i> (T. Scott)	—	—
<i>P. annandalei</i> Sewell	—	—
<i>P. mertoni</i> Früchtl	—	—
<i>P. ardjuna</i> Brehm	+	—
<i>P. binghami</i> var. <i>malayalus</i> Wellershaus	+	—
<b>DIAPTOMIDAE</b>		
<i>Heliodytaptomus cinctus</i> (Gurney)	—	—
<i>Diaptomus</i> sp.	+	—
<b>TEMORIDAE</b>		
<i>Temora turbinata</i> (Dana)	+	—
<b>LUCICUTHIDAE</b>		
<i>Lucicutia flavicornis</i> (Claus)	—	+
<b>CANDACIIDAE</b>		
<i>Candacia bradyi</i> A. Scott	—	+



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Species	Stn. 1	Stn. 2
<b>PONTELLIDAE</b>		
<i>Pontella danae</i> Giesbrecht, var. <i>ceylonica</i> Thompson & Scott	+	+
<i>P. securifer</i> Brady	+	+
<i>P. spinipes</i> Giesbrecht	—	+
<i>Labidocera pectinata</i> Thompson & Scott	+	+
<i>L. kroyeri</i> (Brady)	—	+
<b>ACARTIIDAE</b>		
<i>Acartia</i> (Odontocartia) <i>centrura</i> Giesbrecht	+	+
<i>A. (O) spinicauda</i> Giesbrecht	+	+
<i>A. (O) erythraea</i> Giesbrecht	+	+
<i>A. (Acanthacartia) plumosa</i> T. Scott	+	+
<i>A southwelli</i> Sewell	+	—
<i>A. negligens</i> Dana	—	+
<i>A. sp.</i>	+	+
<i>Acartiella sewelli</i> Steuer	+	+
<i>A. graveleyi</i> Sewell	+	+
<b>TORTANIDAE</b>		
<i>Tortanus forcipatus</i> Giesbrecht	+	+
<b>TACHIDIIDAE</b>		
<i>Euterpina acutifrons</i> (Dana)	—	+
<b>OITHONIDAE</b>		
<i>Oithona rigida</i> Giesbrecht	+	+
<i>O. brevicornis</i> Giesbrecht	+	+
<i>O. hebes</i> Giesbrecht	—	+
<b>ONCAEIDAE</b>		
<i>Oncaea venusta</i> Philippi	—	+
<b>CORYCAEIDAE</b>		
<i>Corycaeus danae</i> Giesbrecht (= <i>C. crassiusculus</i> Dana).	+	+
<i>C. gibbulus</i> Giesbrecht	+	+
<b>SAPPHIRINIDAE</b>		
<i>Sapphirina ovatolanceolata</i> Dana	—	+
<b>CYCLOPOIDAE</b>		
<i>Cyclops</i> sp.	+	—

+ = Present

— = Absent

TABLE 2. GROUPING OF COPEPOD SPECIES AT THE TWO STATIONS UNDER DIFFERENT SALINITY GRADIENTS

Marine Orthostenohaline	Marine-brackish (Orthosteno-euryhaline)	Brackish (Euryhaline)	Brackish-freshwater (Eury-Oligostenohaline)	Freshwater (Oligostenohaline)
<i>Canthocamptus pauper</i>	<i>Paracalanus aculeatus</i>	<i>Eucalanus suberassus</i>	<i>Centropages trispinosus</i>	<i>Heliodiaptomus cinctus</i>
<i>Undinula darwini</i>	<i>Acrocalanus gibber</i>	<i>Paracalanus parvus</i>	<i>Pseudodiaptomus annandalei</i>	<i>Diaptomus</i> sp.
<i>Eucalanus crassus</i>	<i>Centropages tenuirenis</i>	<i>Acrocalanus gracilis</i>	<i>P. mertoni</i>	<i>Cyclops</i> sp.
<i>E. monachus</i>	<i>Pseudodiaptomus ardjuna</i>	<i>Pseudodiaptomus aurivilli</i>	<i>P. binghami</i>	
<i>Acrocalanus similis</i>	<i>Labidocera pectinata</i>	<i>Acartia centrura</i>	<i>Acartia southwelli</i>	
<i>Centropages furcatus</i>	<i>Pontella danae</i>	<i>A. spinicauda</i>	<i>Acartiella senelli</i>	
<i>C. orsinii</i>	<i>P. securifer</i>	<i>A. plumosa</i>	<i>A. graveleyi</i>	
<i>Pseudodiaptomus serricaudatus</i>	<i>Oithona hebes</i>	<i>A. negligens</i>	<i>Oithona brevicornis</i>	
<i>Temora turbinata</i>				
<i>Lucicutia flavicornis</i>		<i>Oithona rigida</i>		
<i>Caulacua bradyi</i>		<i>Corycaeus danae</i>		
<i>Labidocera kroeyeri</i>		<i>Acartia</i> sp.		
<i>Pontella spinipes</i>				
<i>Acartia erythraea</i>				
<i>Tortanus forcipatus</i>				
<i>Euterpina acutifrons</i>				
<i>Oncaea venusta</i>				
<i>Corycaeus gibbulus</i>				
<i>Sapphirina ovalata- nucolata</i>				

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TABLE 3. CORRELATION COEFFICIENT (r) VALUES BETWEEN COPEPOD SPECIES AND SALINITY AT TWO STATIONS

Species	Station 1		Station 2	
<i>Eucalanus subcrassus</i>	0.147	NS	-0.536	NS
<i>Paracalanus parvus</i>	-0.006	NS	0.057	NS
<i>P. aculeatus</i>	0.823	*	0.962	**
<i>Acrocalanus gracilis</i>	0.443	NS	0.235	NS
<i>A. gibber</i>	0.614	**	0.384	NS
<i>Centropages furcatus</i>	0.679	**	0.712	**
<i>Pseudodiaptomus aurivilli</i>	0.267	NS	0.324	NS
<i>Temora turbinata</i>	0.810	**	0.609	*
<i>Labidocera pectinata</i>	0.297	NS	0.139	NS
<i>Pontella danae</i>	0.710	*	0.684	*
<i>P. securifer</i>	0.914	**	0.762	*
<i>Acartia centrura</i>	0.163	NS	0.160	NS
<i>A. spinicauda</i>	0.788	*	0.032	NS
<i>A. erythraea</i>	0.933	**	0.919	**
<i>A. plumosa</i>	0.710	*	0.727	*
<i>Acartiella sewellii</i>	0.987	*	-0.527	NS
<i>A. graveyi</i>	-0.640	NS	-0.602	NS
<i>Tortanus forcipatus</i>	0.716	**	0.742	**
<i>Oithona rigida</i>	0.128	NS	0.035	NS
<i>Corycaeus danae</i>	0.641	**	0.704	**

NS = Not Significant

\* = Significant at 5% level

\*\* = Significant at 1% level

TABLE 4. POOLED MEAN VALUES (NO 100M<sup>2</sup>) OF COPEPOD SPECIES UNDER DIFFERENT FAMILIES AT OLD GOA (Stn. 1) DURING FIRST AND SECOND FORTNIGHT OF 1971-72

Families	M O N T H S												
	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	M
Eucalanidæ	96	---	---	---	---	---	---	263	---	---	51	---	34
Paracalanidæ	62	---	1318	9797	8852	1272	373	391	500	579	314	130	1966
Centropagidæ	13	---	---	---	37	80	31	---	---	---	329	---	41
Pseudodiaptomidæ	328	1	172	913	1315	115	1042	2250	715	3333	2132	61	1036
Diaptomidæ	---	36	143	---	---	---	---	---	---	---	---	---	15
Temoridæ	38	---	---	---	---	---	---	---	---	164	242	244	57
Pontellidæ	127	---	---	---	---	---	42	751	187	162	514	119	158
Acartiidæ	198	274	598	40152	5593	1732	1456	437	240	655	327	129	4316
Tortanidæ	1886	---	---	---	---	---	---	---	---	---	589	385	230
Oithonidæ	22	---	---	1801	557	491	279	416	182	835	464	81	427
Corycaeidæ	48	---	---	---	---	---	---	---	---	---	33	41	10
Cyclopoidæ	---	---	18	---	---	---	---	---	---	---	---	---	1

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TABLE 5. POOLED MEAN VALUES (No 100m<sup>3</sup>) OF COPEPOD SPECIES UNDER DIFFERENT FAMILIES AT ST. JACINTO ISLAND (Stn. 2) DURING FIRST AND SECOND FORNIGHT 1971-72.

	M O N T H S												
	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar.	April	May	M
Calanida	61	.....	.....	.....	.....	23	159	35	43	.....	505	133	56
Eucalanidae	122	9	.....	.....	.....	.....	.....	.....	159	.....	43	17	29
Paracalanidae	43	420	5543	3297	7703	3382	146	1328	577	135	224	51	1887
Centropagidae	.....	.....	.....	.....	58	.....	.....	.....	167	14	29	97	30
Pseudodiaptomidae	278	1603	39	506	1535	2636	275	894	1997	1995	479	213	1031
Temoridae	61	.....	.....	.....	.....	52	.....	.....	.....	93	102	120	35
Lancutellidae	.....	.....	.....	.....	.....	.....	.....	.....	.....	72	112	34	18
Candaciae	52	.....	.....	.....	.....	.....	.....	.....	.....	.....	143	8	17
Pontellidae	24	.....	.....	2	682	376	227	451	480	320	172	39	231
Acartiidae	2893	3604	30666	3901	225	371	1520	3709	1556	518	1507	922	4321
Tortanidae	2017	.....	.....	.....	.....	.....	138	443	501	814	1419	5251	882
Tachidiidae	.....	.....	.....	.....	.....	46	.....	.....	.....	279	11	.....	28
Oithonidae	.....	21	132	1091	556	217	133	71	.....	8	79	.....	192
Oncaelidae	112	.....	.....	.....	.....	.....	.....	.....	.....	.....	27	85	18
Corycaeiidae	35	.....	.....	.....	.....	.....	.....	.....	.....	9	4	19	5
Sapphirinidae	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13	.....	1

represented by members of the families Nereidae, Eunicidae and Terebellidae, Brachyuran zoea, naupliar, mysis and postlarval stages of *Metapenaeus dobsoni*, *M. monoceros*, *Penaeus merguensis* etc. were the common decapod larvae at both the stations. *Lucifer hensani* was the only species of sergestids, occurring more at stn. 2 where the highest number of 30775/100 m<sup>3</sup> was recorded during July. Two species viz., *Evadne tergestina* and *Penilia avirostris* formed the cladoceran population. *Evadne* was observed to be a dominant cladoceran species at stn. 1 preferring low salinity (0.21 to 1.67‰). *Penilia* was recorded more at stn. 2 and occurred during high saline conditions (19.31 to 33.95‰). *Sagitta enflata*, *S. bedoti* and *Sagitta* sp. were the common chaetognaths, *S. bedoti* being the most dominant. The chaetognaths were recorded almost throughout the year at stn. 2 but at stn. 1, this group was not observed during monsoon months. Appendicularians (*Oikopleura* sp.) and pteropods (*Cresis acicula*) were recorded only at stn. 2 when marine conditions (34.31 to 36.61‰) prevailed there. The veligers, fish eggs and larvae were recorded almost throughout the year. The highest percentage of fish eggs (4.9%) and fish larvae (5.2%) of family Clupeidae was obtained at stn. 1 during second fortnight of July.

#### DISCUSSION

The Mandovi-Zuari estuarine complex is a highly variable environment due to strong tidal influence. Because of perennial connection with the sea, there is a rhythmic ingress and egress of marine plankton. The annual range in temperature at both the stations was of the order of 6 C but the salinity varied from 0.21 to 33.3‰ at stn. 1 and from 1.96 to 36.61‰ at stn. 2 with an annual mean of 16.23‰ and 26.33‰, respectively. It seems that salinity is an important factor which influences the seasonal distribution of different groups of zooplankton in this area. Dehadrai (1970) reported fresh-water conditions at low tide in the Mandovi estuary during monsoon months stating that the salinity variations play an important role in the ecology of Mandovi and Zuari estuaries. The annual zooplankton biomass was higher at stn. 2 than at stn. 1 with the mean weight of 175 g 1000 m<sup>3</sup> at the former and 81 g 1000 m<sup>3</sup> at the latter.

Eighteen major zooplankton taxa were present in the collections. Hydro-medusae, Ctenophora, Chaetognatha, Pteropoda and Appendicularia occurred more during high saline period (premonsoon) while Amphipoda, Mysidacea, Cladocera and Veligers were predominant during low salinity. Copepods were found to be one of the most dominant groups of zooplankton with bimodal type of distribution at the two stations which agrees with the report of Prasad (1954) from Gulf of Mannar. During the present study, a total of 49 copepod species have been recorded, bulk of which were from stn. 2. Pillai (1971) in his account on the estuarine copepods of India has recorded 41 species from Cochin backwaters, out of which 26 have been observed in the collections from the present two stations.

Significant correlation was found between the number of copepod species and salinity at both the stations indicating presence of several species of marine origin. During premonsoon months when the salinity was high in this estuarine system, neritic species viz. *Canthocalanus pauper*, *Undinula darwini*, *Eucalanus crassus*, *E. monachus*, *Acrocalanus gracilis*, *Centropages furcatus*, *C. orsinii*, *Pseudodiaptomus serricaudatus*, *Temora turbinata*, *Lucicutia flavicornis*, *Candacia bradyi*, *Acartia erythraea*, *Tortanus forcipatus* etc. were recorded. Pillai (1971) also stated that *A. erythraea*, *A. spinicauda*, *P. serricaudatus*, *P. mertonii*, *P. aurivilli*, *P. ardjuna* etc. are marine forms but are present in the backwaters during high salinity. During monsoon months, the hydrographical conditions and

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consequently the copepod species were different at both the stations. *Pseudodiaptomus annandalei*, *Acartiella graveleyi* and *Oithona brevicornis* were recorded at stn. 2 and *Acartia southwelli*, *A. graveleyi*, *Heliodyptomus cinctus*, *Diaptomus* sp. and *Cyclops* sp. at stn. 1. Though *A. graveleyi* occurred at both the stations during monsoon, it preferred low saline conditions. Previously Pillai *et al.* (1973) recorded *A. graveleyi*, *A. keralensis* and members of the family Diaptomidae during the period of very low salinity and Kasturirangan (1963) has also reported the occurrence of *A. southwelli* in low saline conditions.

Members of six families of copepods coexisted in the Mandovi-Zuari estuarine complex. Pillai *et al.* (1973) reported the coexistence of six major families *i.e.*, Acartiidae, Centropagidae, Pseudodiaptomidae, Pontellidae, Temoridae and Diaptomidae, out of which the first four families occur commonly in this environment. According to Tranter and Abraham (1971) four factors are important for the coexistence of species of genus *Acartia* in the Cochin Backwater, namely tolerance to salinity, food supply, generation length and flow. They state that the available food present in the estuary may be a limiting factor in the distribution of species of *Acartia*. During the present study, nine species of *Acartia* were recorded at the two stations. Dehadrai and Bhargava (1972) based on their studies from January to August 1970, have given peak primary production (gross) of 360 to 400 mgC m<sup>3</sup> day during low tide and 550 to 580 mgC/m<sup>3</sup>/day during high tide respectively in the Mandovi and Zuari estuaries. The overall production potential of these two estuaries thus appear to be high. Qasim (1970) and Qasim *et al.* (1969) have also reported that the phytoplankton production in an estuarine system far exceeds the rate of consumption by the zooplankters. Thus, the availability of food may not be a limiting factor controlling the distribution of members of Acartiidae in this environment.

The present study has indicated that the seasonal distribution of different zooplanktonic groups and the species composition are dependent upon the prevailing hydrographical conditions. The total biomass and species under various taxa are far more diverse at stn. 2 (Zuari) than at stn. 1 (Mandovi). There exists a significant relationship between different species of copepods and the salinity. It is thus obvious that these two stations represent different ecosystems differing in hydrographical and biological characteristics.

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