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Research Article

INFLUENCE OF SEASONS ON COPEPODS OF AGNIYAR ESTUARY, PALK STRAIT, TAMIL NADU, INDIA

J. Sugumaran*

P.G. and Research Department of Zoology, Khadir Mohideen College, Adirampattinam-614701, Tamilnadu, India

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ABSTRACT

Seasonal variations of copepod diversity, density and physicochemical properties of Agniyar estuary was studied during 2014 and 2015. Physicochemical characteristics such as temperature, salinity, calcium and nitrite were high during premonsoon, while dissolved oxygen (DO) and nitrate were high during monsoon season. Copepods showed seasonal variations in diversity and density. Nineteen species of copepods belonging to 3 orders and 15 genera were reported. Density (1868 numbers/m^3) was high during Postmonsoon, low diversity (948 numbers/m^3) was recorded during monsoon. The marine and brackish water forms dominated during dry seasons while, the freshwater forms dominate rainy season. The study may serve as a basic platform for future studies and monitoring programmes of Agniyar estuary.

Keywords: Agniyar Estuary, Zooplankton, Copepods, Seasonal changes.

INTRODUCTION

Estuarine ecosystems may be smaller, in terms of area and volume, but they provide a unique environment to their biota by the mixing action of riverine and seawater (Bienfang and Ziemann, 1992, Carlsson *et al.*, 1995). Estuaries support high zooplankton diversity that often exceeds those found over the adjacent continental shelves. The species that comprise this high biomass vary according to the geographical location of the estuary, temperature, and the salinity regime within each system (Benfield, 2013).

Zooplankton assemblages within estuaries are dominated by copepods, cladocerans and mysids. These small crustaceans have high secondary production and serve as prey for organisms in higher trophic levels such as fish, ctenophores, medusae, chaetognaths, and various decapod crustaceans. Copepods are one of the major components of zooplankton community of both marine and fresh water ecosystems (Schminke 2007; Chang *et al.*, 2010). They occupy an important position in the aquatic food web and transfers energy form producers to secondary consumers. Estuarine copepods are descended from marine counterpart's later they paved way for origin of freshwater species (Huys and Boxshall, 1991).

In spite of a playing a vital role in estuarine food web and productivity, there are relatively few publications on seasonal patterns of estuarine copepods with high taxonomic resolution in relation to hydrographic parameters. Further, the studies on zooplankton of Agniyar estuary are rather scanty except the study of rotifer diversity by Sugumaran and Amsath (2015). Hence the present study was undertaken to know the seasonal distribution and diversity of copepods from Agniyar estuary.

MATERIALS AND METHODS

Sampling station

Agniyar estuary is located in Palk Strait of Bay of Bengal, the estuary is formed by merger Maharajasamudram river and Agniyar river. Before entering the Bay of Bengal the river divides into 3 branches (Figure 1).

Sample collection

Samples for Physicochemical parameters and zooplankton were collected seasonally during Premonsoon (August, 2014), Monsoon (November, 2014) and Postmonsoon (February, 2015) periods at Agniyar estuary in Rajamadam. Water samples were collected simultaneously with zooplankton collections. Sampling was done in the early morning using a hand-held nylon net (0.25m^2 diameter, 65µm mesh size). Quantitative samples were collected by filtering 100 liters of water while, Qualitative sample was taken by towing the plankton net for 25 times in knee depth

*Corresponding author: Assistant Professor, P.G. and Research Department of Zoology, Khadir Mohideen College, Adirampattinam-614701, Tamilnadu, India, Email: jsugumaran@hotmail.com, Mobile: +91 99414 65127.

water. After collection the samples were fixed and preserved in 4% formaldehyde.

Sample analysis

Physicochemical parameters were recorded following the methodology of Janakiraman *et al*., 2013. In the laboratory copepod samples were made up to 100 ml. An aliquot of 1 ml was taken in a Sedgwick-Rafter counting chamber and observed under a binocular dissection microscope. The different groups/species/genera of copepods were identified following the standard taxonomic keys (Altaff, 2004) and their density was expressed as individuals/m^3. The relation between the copepod species was tested by Bray-Curtis cluster analysis using Primer 5. Cluster was performed on double square root transformed data followed by Bray-Curtis similarity (Bray and Curtis, 1967).

RESULTS

Physicochemical parameters

Physicochemical parameters recorded in the present study are given in Table 1. Temperature salinity, calcium and nitrite were high during premonsoon, while dissolved oxygen and nitrate were high during monsoon.

Diversity of copepods

Copepods showed seasonal variations in diversity and density. Nineteen species of copepods belonging to three major groups namely, Cyclopoida, Calanoida and Harpacticoida were recorded (Table 2). Cyclopoids were represented by 7 species (*Mesocyclops* sp., *Thermocyclops decipiens, Apocyclops royi*, *Oithona brevicornis, O. rigida, O. oculata* and *O. simplex).* Calanoids are represented by 8 species (*Diaptomus* sp., *Acartia tonsa*, *Parvocalanus crassirostris*, *Pseudocalanus minutus, Centropages typicus*, *Temora longicornis*, *Paracalanus parvus* and *Paracalanus aculeatus*). While harpacticoids are represented by 4 species namely, *Onychocamptus bengalensis*, *Euterpina acutifrons, Microsetella norvegica* and *Macrosetella* sp.

Seasonally copepod diversity was high during postmonsoon. Diversity was less during monsoon season. Cyclopoid copepod *O. simplex* and harpacticoid copepod *Macrosetella* sp. were present only during postmonsoon season. Cyclopoid *O. brevicornis*, calanoids *Parvocalanus crassirostris*, *Temora longicornis* and *Paracalanus parvus* were absent during monsoon season.

Density of copepods

The copepods density of Agniyar estuary showed fluctuations. High density (1868 numbers/m^3) was recorded during postmonsoon, followed by premonsoon season (1494 numbers/m^3). Density was less (948 numbers/m^3) during monsoon season (Figure 3). Among the cyclopoid copepods *Apocyclops royi* density was high during premonsoon and postmonsoon seasons, while *Mesocyclops* density was high during Monsoon season. Among calanoids *Centropages typicus* density was high during premonsoon and postmonsoon seasons, its density decreased during monsoon period. Among the harpacticoids *Onychocamptus bengalensis* and *Euterpina acutifrons* were dense during premonsoon and postmonsoon periods (Table 2).

Cluster analysis

Cluster analysis of copepod species shows the formation of two clusters the upper cluster consists of species with less density while the lower cluster has high density species such as *Euterpina acutifrons*, *Onychocamptus bengalensis, Centropages typicus, Thermocyclops decipiens*, *Mesocyclops* sp., and *Apocyclops royi* (Figure 3).

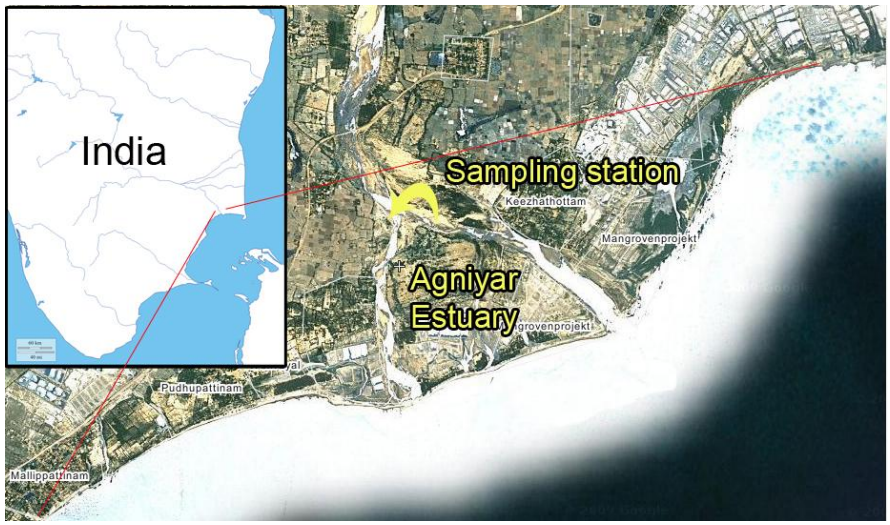

Figure 1. Map of Southern India and Agniyar estuary showing sampling station.

Table 1. Seasonal variations in physicochemical parameters of Agniyar estuary.

Parameters	Premonsoon	Monsoon	Postmonsoon
Temperature (°C)	29.2	27	28.8
Dissolved oxygen (mg/l)	2.57	3.41	2.62
Salinity (‰)	29	18	26
Phosphate (mg/l)	0.11	0.16	0.11
Nitrate (mg/l)	0.09	1.2	0.06
Nitrite (mg/l)	0.11	0.09	0.09

Table 2. Density (individuals/m^3) and species diversity of copepods recorded from Agniyar estuary.

Species	**Premonsoon**	**Monsoon**	**Postmonsoon**
Cyclopoida			
Mesocyclops sp.	112	424	147
Thermocyclops decipiens	124	68	154
Apocyclops royi	441	121	541
Oithona brevicornis	95	0	39
O. rigida	56	23	65
O. oculata	12	2	27
O. simplex	0	0	21
Calanoida			
Diaptomus sp.	18	147	29
Acartia tonsa	24	0	36
Parvocalanus crassirostris	14	0	26
Pseudocalanus minutus	28	12	14
Centropages typicus	124	45	147
Temora longicornis	14	0	25
Paracalanus parvus.	21	0	28
Paracalanus aculeatus	41	8	29
Harpacticoida			
Onychocamptus bengalensis	142	54	248
Euterpina acutifrons	214	38	247
Microsetella norvegica	14	6	28
Macrosetella sp.	0	0	17

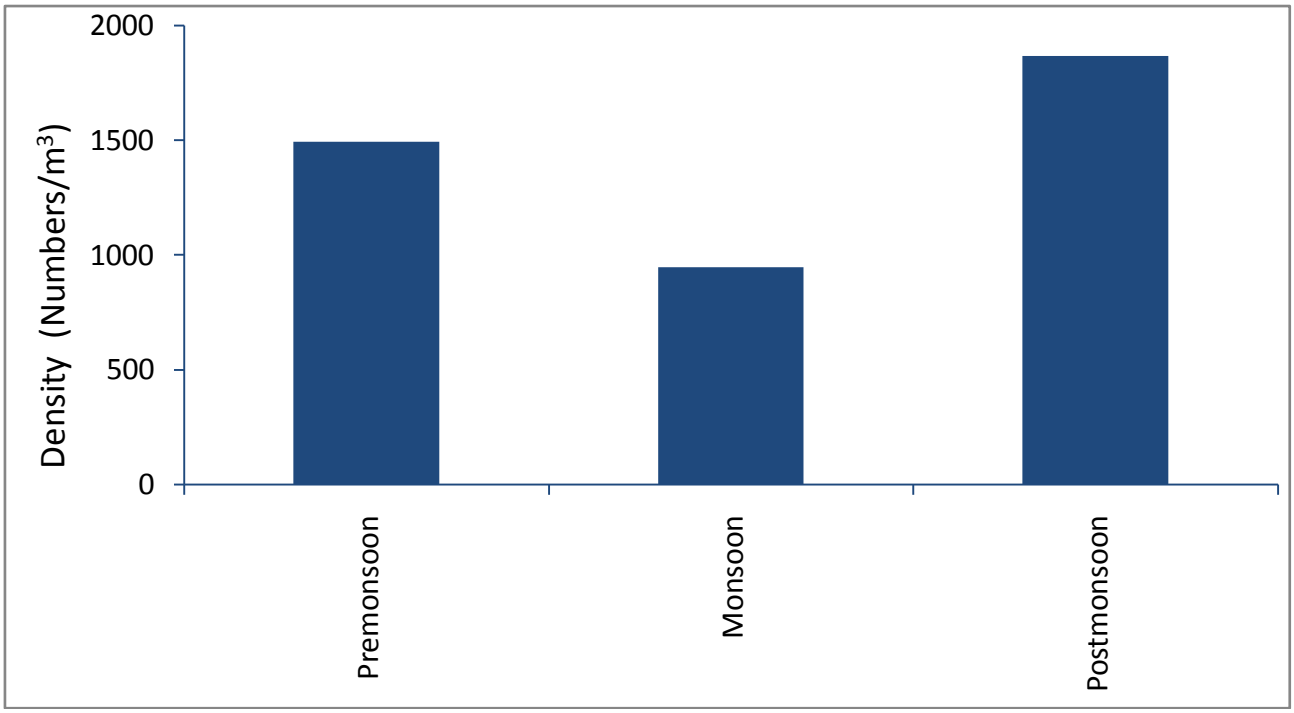

Figure 2. Density (Numbers/m^3) of copepods recorded during different seasons at Agniyar estuary.

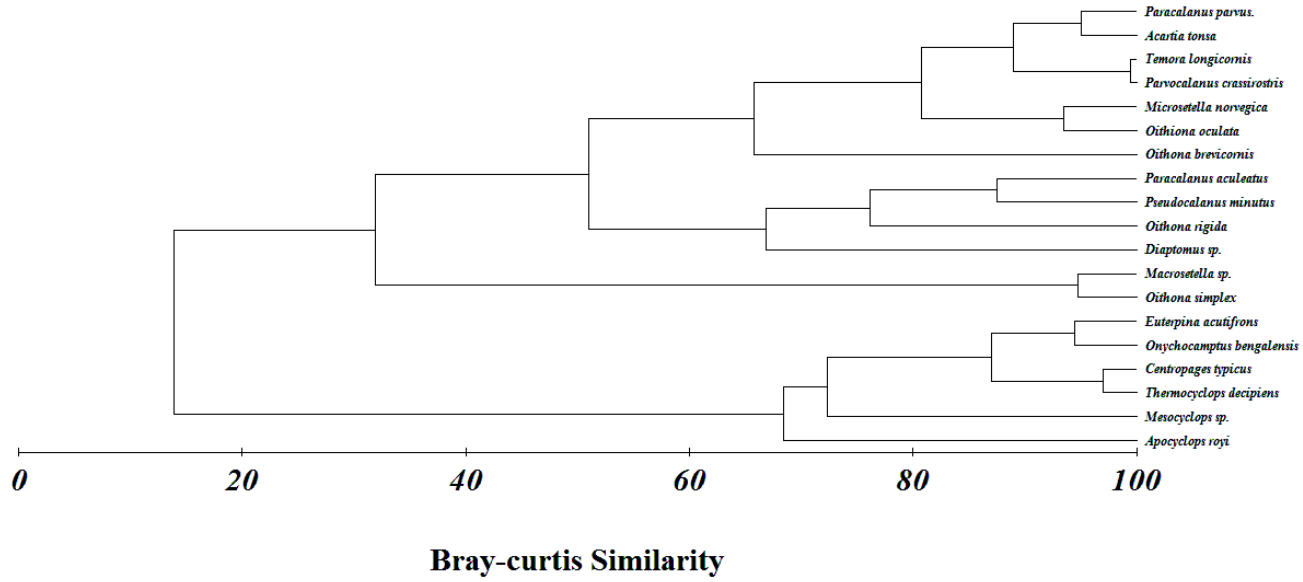

Figure 4. Cluster analysis of copepods of Agniyar estuary.

DISCUSSION

Copepods constituted one of the abundant groups of zooplankton and occurred commonly throughout the year. Studies have identified a vast number of factors responsible for these phenomena. The explanations for these variations depend on prevalent combination of environmental and biological parameters present at each study site. The environmental parameters observed in the present study are comparable with other Indian estuarine environments (Goswami, 1982; Madhu *et al*., 2007; Janakiraman *et al*., 2013). The Monsoon, especially North-East monsoon has a greater influenced in this estuary, which is similar to other estuarine environments of South-East coast of Peninsular India (Perumal *et al*., 2009). Salinity values showed Agniyar estuary is polyhaline in nature. Temperature and salinity had an inverse relation with dissolved oxygen and nitrate. The observed patterns of the environmental parameters mostly agreed with those observed in other

estuaries (Davies and Augustina, 2009; Bacelar-Nicolau *et al*. 2002; Saboor, 2003).

The results of copepod biodiversity indicate that Agniyar estuary is rich in copepod diversity with 19 species while, the composition is not similar to nearby mangrove ecosystems of Adirampattinam (Prabhahar *et al*., 2012). Saboor (2003) also reported similar diversity of copepods from the Adayar estuary. Calanoids are considered to be more sensitive to pollutants their diverse presence in Agniyar estuary indicates that this estuary is still unpolluted/less polluted in nature and the Agniyar river may lack major industries in the nearby areas. Along with marine calanoids the presence of oceanic cyclopoids such as *Oithona brevicornis*, *O. rigida*, *O. oculata* and *O. simplex,* and harpacticoid copepods like *Microsetella norvegica* and *Macrosetella* sp. reveals that tides has more influence than freshwater. In general copepod species richness may be very high in tropical systems, Copepod genera, *Acartia*, *Temora*, *Paracalanus*, *Oithona* are common in estuaries (Benfield, 2013).

Seasonal studies on the diversity of copepods reflect that monsoon favours the existence of freshwater species, which corroborates with the physicochemical conditions of the estuary. The species of genus *Oithona* constituted considerably to the total diversity of cyclopoids. Thompson (1986 and 1991) reported that members of the family Oithonidae are among the most common and abundant zooplankton of Cochin backwaters.

Calanoid and cyclopoid copepods dominate the holoplanktonic zooplankton in certain estuaries. They are important grazers of phytoplankton and microzooplankton and are, inturn, prey for zooplanktivorous fishes and invertebrates (Benfield, 2013). The cluster analysis indicates that the marine, brachishwater and freshwater species dominated the Agniyar estuarine system. The dominant copepods such as *Euterpina acutifrons*, *Onychocamptus bengalensis*, *Centropages typicus, Thermocyclops decipiens*, *Mesocyclops* sp., and *Apocyclops royi* seems to be opportunistic species, they optimally utilized the favourable ecological conditions to increase their density. In a Kenyan estuary Revis (1988) documented 102 copepod species during an 11-month study, although only 12 species were dominant. The less density of copepods during monsoon may be due to low salinity and temperature. However, this affects only the oceanic copepods, while the predominantly freshwater forms occurred in high density in the same period. Similar results are observed by Goswami (1982) in Mandovi-Zuari estuarine systems of Goa.

The density of copepods recorded from the present study is comparative lesser than similar estuarine environments (Saboor, 2003; Janakiraman et al, 2013) and nearby mangrove systems (Prabhakar *et al*, 2012). High density was recorded during postmonsoon (1868 numbers/m^3), followed by premonsoon season, which may be due to the availability of food and favourable ecological conditions such as elevated salinity, temperature and nutrient (nitrate). Fluctuations in the abundances of estuarine zooplankton in general, and copepods in particular, appear to be linked to freshwater discharge. In regions where there is a pronounced wet and dry season, zooplankton may increase in abundance in response to precipitation and runoff (Benfield, 2013). Species level analyses of seasonal variations indicate the dominance of both freshwater and marine copepods in Agniyar estuary. However, the marine forms dominated during dry seasons while the freshwater forms during rainy season.

However, in estuaries, the seasonal patterns of zooplankton abundance and distribution are complex and extremely variable (Gilabert , 2001). This variability results from interactions of various factors. Tidal currents and river flows are also responsible for variability in zooplankton abundances by affecting the period of time that a given zooplanktonic population persists in the estuary (Vieira *et al*. 2003).

CONCLUSION

The present study indicated that the season influenced changes in physicochemical conditions determined density and species composition of copepods of Agniyar estuary. However, a detailed study with regular sampling and inclusion of more physicochemical parameters for study may help to arrive at a concrete conclusion. This study may be used as a baseline data for future studies on of copepod ecology and biodiversity assessment of Agniyar estuary.

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