

Research Article

OBSERVATIONS OF COPEPOD DIVERSITY IN BAY OF BENGAL COAST, DURING THE CRUISE EXPEDITION

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ABSTRACT

Copepod being an important contributor for food chain the observation on diversity and abundance of copepod species determines the ecological condition of an aquatic environment. The study was conducted in the coast of Bay of Bengal from Chennai to Vijayawada during the cruise onboard research vessel ‘Sagar Tara’ in October 2022. The identified copepods were 24 species belonging to 17 families and three orders which is represented in the sequence Calanoida (83.8%), Cyclopoida (13.5%) and Harpacticoida (2.7%). In the present study it is observed that Calanoida dominates the Bay of Bengal region. Many studies have reported that Calanoida are the major group in the marine ecosystem. In the sampling sites maximum abundant species were recorded such as *Acartia fossae*, *Paracalanus indicus*, *Subeucalanus flemingeri* for calanoids, *Corycaeus andrewsi*, *Corycaeus clausi* for cyclopoids, *Euterpina acutifrons*, *Clytemnestra scutellate* for harpacticoids. The correlation matrix between the copepod density and physicochemical parameters results in positive correlation with temperature and negative correlation with salinity, pH and dissolved oxygen. The present study sheds light on the abundance and dominance of one group of copepods occurring in the Bay of Bengal region.

Keywords: Diversity, Copepods, Calanoids, Water temperature, Bay of Bengal.

INTRODUCTION

Marine zooplankton is a largely vast group which contains more than thousand of meroplankton species including protozoans to jellyfish (Leandro *et al.*, 2007). Copepods come under the subphylum crustacea and they are one of the most abundant groups of zooplankton. The holoplanktonic copepods are identified to be one of the largest groups of metazoans on the earth (Schminke, 2007; Chang *et al.*, 2010, Hwang *et al.*, 2004; 2010; Kâ and Hwang, 2011). In most aquatic ecosystem they take part in the mobilization of carbon from producers to higher trophic organisms (Jerling and Wooldridge, 1995). They are one of the immensely important food sources for all the fishes due to their wide distribution of copepods in all kinds of aquatic ecosystem (Wroblewski, 1980). They have been identified as indicator species for monitoring the condition of aquatic environment of all kinds (Bonnet and Frid, 2004; Hwang and Wong, 2005; Thor *et al.*, 2005; Hwang *et al.*, 2006; 2009;2010). The study conducted by Ramaiah and Nair (1997) in the west coast of India showed calanoid was the dominant group. In South east coast of Indian estuarine

waters, Eswari and Ramanibai (2004) observed cyclopoid was the dominant group. Santhanam *et al.*, (2012) identified 85 species of copepods from Vellar estuary. Vineetha *et al.*, (2015) reported that copepod was the dominant group among the zooplankton community in Cochin back waters. Kaviyarasan *et al.*, (2019) observed a total of 27 marine copepods in which calanoid were the most dominant group. Recently, Thangaraj and Vijayanand (2023) recorded 46 species of copepods from Palk Bay coastal waters. Enventhough, there is no reports on Copepod communities along the Chennai Vijayawada coastal area so far. Therefore, the present study was aimed to observe the diversity and abundance of copepods in cruise expedition onboard research vessel ‘Sagar Tara’ Bay of Bengal region, India.

MATERIALS AND METHODS

A total of 18 sampling sites (Figure 1) were selected along the coast of Bay of Bengal from Chennai to Vijayawada

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aboard the research vessel 'Sagar Tara' during the period of October 2022. Water quality parameters such as temperature, salinity, dissolved oxygen and pH were analysed at each sampling sites. The water samples were collected in the sterile containers (500ml) and then were immediately transferred to the on-board laboratory for further analysis. The water temperature and salinity were measured using a digital multi-sensor of $\pm 0.01^{\circ}\text{C}$ accuracy (Merck Millipore-Multi 3420). The dissolved oxygen was analysed using modified Winkler's method (Strickland and Parsons, 1972). The plankton samples were collected by towing of bongo net (76 cm mouth diameter) made up of bolting silk cloth (No 10: mesh size $158\ \mu\text{m}$) horizontally for 30 minutes. The samples were stored in 5% neutralized formalin for further analysis. The qualitative and

quantitative analysis were carried out in the laboratory using stereo microscope and cell counting done with Sedgewick-Rafter counting cell. The identification of copepod species was carried out by standard identification keys (Perumal *et al.*, 1998; FaizaYousif Al-Yamani *et al.*, 2011). Copepod species abundance was symbolized using individual per m^3 of water. Shannon and Weaver (1963) and Pielou (1966) were used to calculate the species diversity indices. The standard formulae used were $H' = -\sum P_i \ln P_i$, $E' = H' / \ln S$, $D' = S - 1 / \ln N$ (Ludwig and Reynolds, 1988). The box plot and correlation matrix between copepod abundance and physico-chemical parameters of water were analysed using Microsoft Excel and PAST Software Version 4.03.

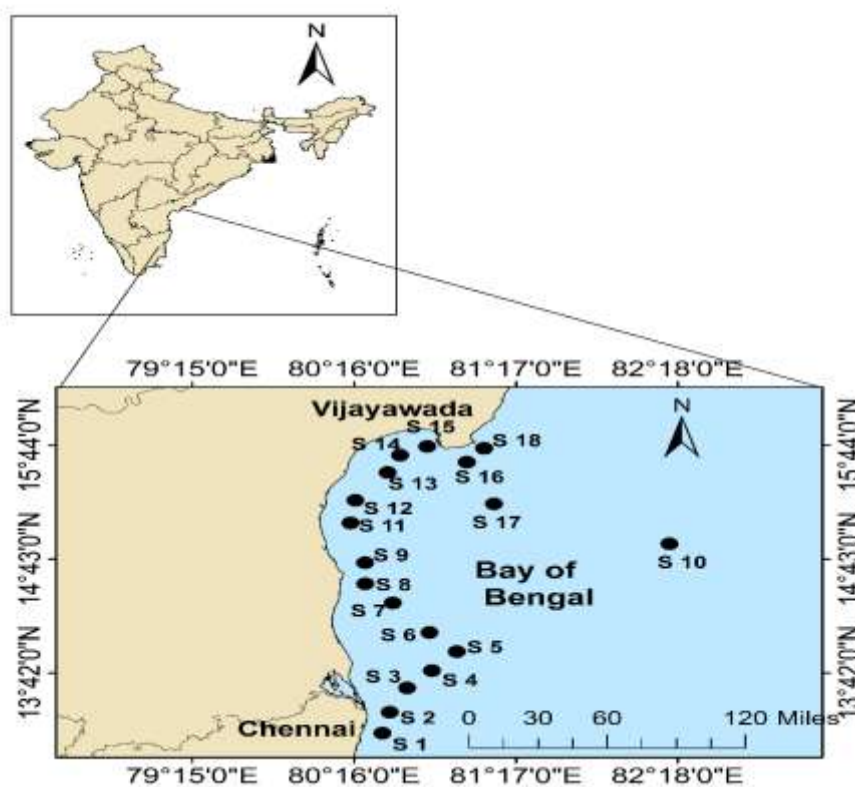


Figure 1. Map showing the sampling sites of Bay of Bengal.

RESULTS AND DISCUSSION

A total of 24 species of copepods belonging to 17 families and three orders (Table 1) (Calanoida- 13 species, Cyclopoida-7 species and Harpacticoida-4 species) were identified (Figure 2). The overall composition of copepod species was recorded in the following orders: Calanoida (83.8%), Cyclopoida (13.5%) and Harpacticoida (2.7%). Copepod species composition by collection sites is presented in Figure 3. Site 2 and 9 had the highest species diversity with 13 species in each site. The order Calanoida was represented by 9 families and 13 species. In Calanoida, *Acartia fossae* was the dominant species. Under the order

Cyclopoida, 4 families and 7 species were recorded in which *Corycaeus dahli* was the dominant species. Under Harpacticoida 4 species were recorded from 4 families in which *Euterpina acutifrons* was the dominant species. Calanoida was observed as the dominant group in all of the sites. The species composition was ranged from 5 to 14 (site 9) (site 15).

The copepod diversity was assessed by direct counting of organism from sample (number per m^3) is presented in Figure 4. The density of copepods was found as higher in Sites 7 ($70849\ \text{no}/\text{m}^3$), 18 ($69764\ \text{no}/\text{m}^3$), 2 ($65381\ \text{no}/\text{m}^3$) and lower at Sites 15 ($10050\ \text{no}/\text{m}^3$), 13 ($10095\ \text{no}/\text{m}^3$), and

16 (15648 no/m³). In the sampling sites maximum abundant species were recorded such as *Acartia fossae* (225703 no/m³), *Paracalanus indicus* (85527 no/m³), *Subeucalanus flemingeri* (63929 no/m³) for calanoids, *Corycaeus andrewsi* (37148 no/m³), *Corycaeus clausi* (20154 no/m³) for cyclopoids, *Euterpina acutifrons* (6866 no/m³), *Clytemnestras cutellate* (4453 no/m³) for harpacticoids. The copepods diversity indices (H' , E' , D') are shown in the Figure 5. The species diversity index (H') ranged from 1.27 to 2.07, the evenness (E') was from 0.51

to 0.88 and the richness (D') was from 0.43 to 1.13. The water temperature ranged around 28.32°C, salinity around 25.49‰, pH is 8.09 and dissolved oxygen (DO) ranged around 4.4 mg/l (Figure 6). The correlation matrix between the copepod density and physicochemical parameters shows a positive correlation with the temperature ($r = 0.0084$) and negative correlation with salinity ($r = -0.041$), pH ($r = -0.23$) and dissolved oxygen ($r = -0.40005$) (Figure 7).

Table 1. Copepod species recorded in the sampling sites of Bay of Bengal.

Order	Family	Genus	Species
Calanoida	Acartiidae	<i>Acartia</i>	<i>Acartia fossae</i>
	Calanidae	<i>Canthocalanus</i>	<i>Canthocalanus pauper</i>
	Centropagidae	<i>Centropages</i>	<i>Centropages furcatus</i>
			<i>Centropages tenuiremis</i>
	Paracalanidae	<i>Paracalanus</i>	<i>Paracalanus indicus</i>
		<i>Acrocalanus</i>	<i>Acrocalanus gibber</i>
		<i>Parvocalanus</i>	<i>Parvocalanus elegans</i>
		<i>Bestiolina</i>	<i>Bestiolina arabica</i>
		<i>Subeucalanus</i>	<i>Subeucalanus flemingeri</i>
	Clausocalanidae	<i>Clausocalanus</i>	<i>Clausocalanus minor</i>
	Tortanidae	<i>Tortanus</i>	<i>Tortanus barbatus</i>
	Euchaetidae	<i>Euchaeta</i>	<i>Euchaeta rimana</i>
	Pontellidae	<i>Calanopia</i>	<i>Calanopia minor</i>
			<i>Corycaeus clausi</i>
	Corycaeidae	<i>Corycaeus</i>	<i>Corycaeus andrewsi</i>
Cyclopoida	Oithonidae	<i>Oithona</i>	<i>Corycaeus dahli</i>
			<i>Oithona attenuata</i>
			<i>Oithona brevicornis</i>
	Oncaeidae	<i>Oncaea</i>	<i>Oncaea clevei</i>
Harpacticoida	Sapphirinidae	<i>Sapphirina</i>	<i>Sapphirina nigromaculata</i>
	Euterpinae	<i>Euterpina</i>	<i>Euterpina acutifrons</i>
	Ectinosomatidae	<i>Microsetella</i>	<i>Microsetella rosea</i>
	Miraciidae	<i>Macrosetella</i>	<i>Macrosetella gracilis</i>
	Clytemnestridae	<i>Clytemnestra</i>	<i>Clytemnestra scutellata</i>

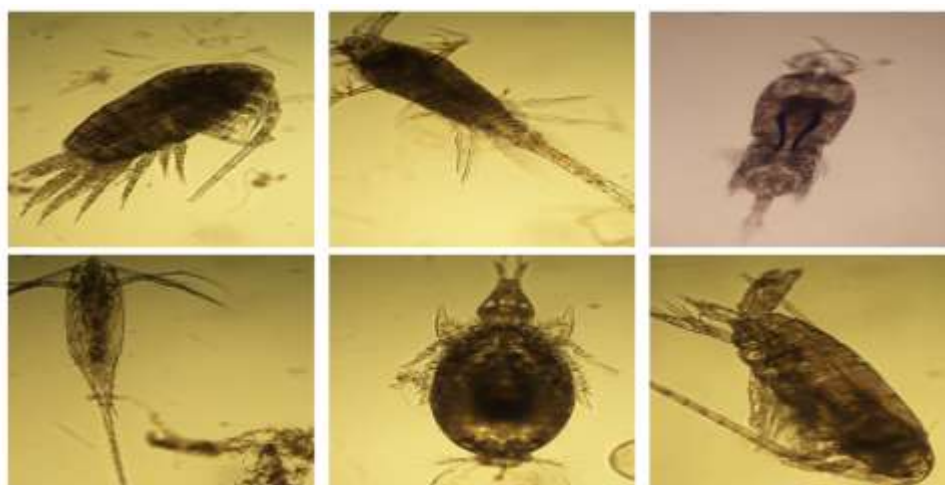


Figure 2. Dominant copepod species recorded in the Bay of Bengal.

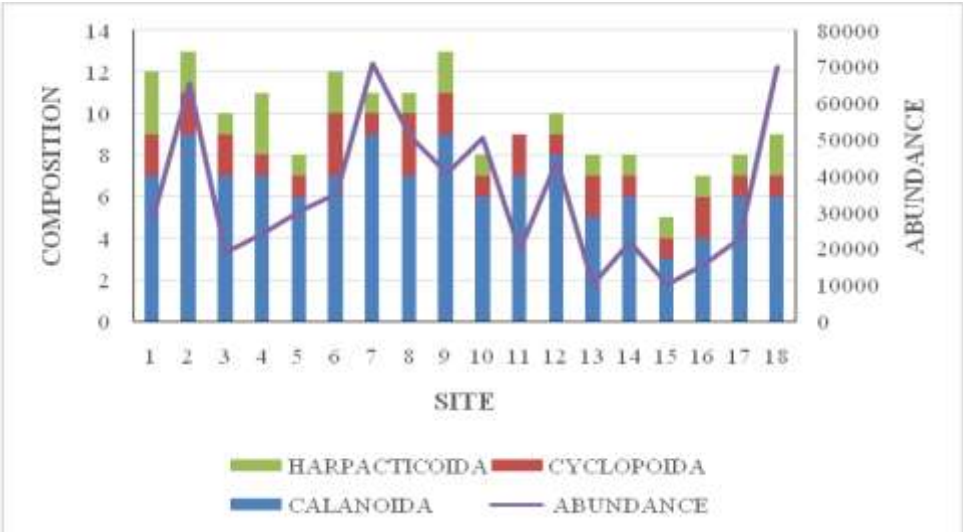


Figure 3. Abundance and composition of copepod group.

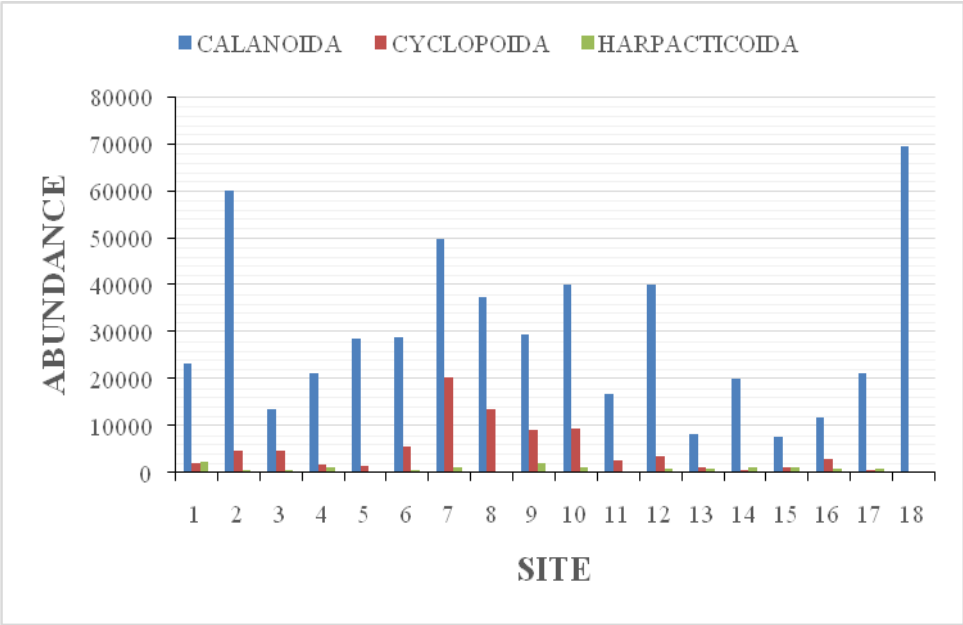


Figure 4. Abundance of Calanoid, Cyclopoid and Harpacticoid groups in the sampling stations.

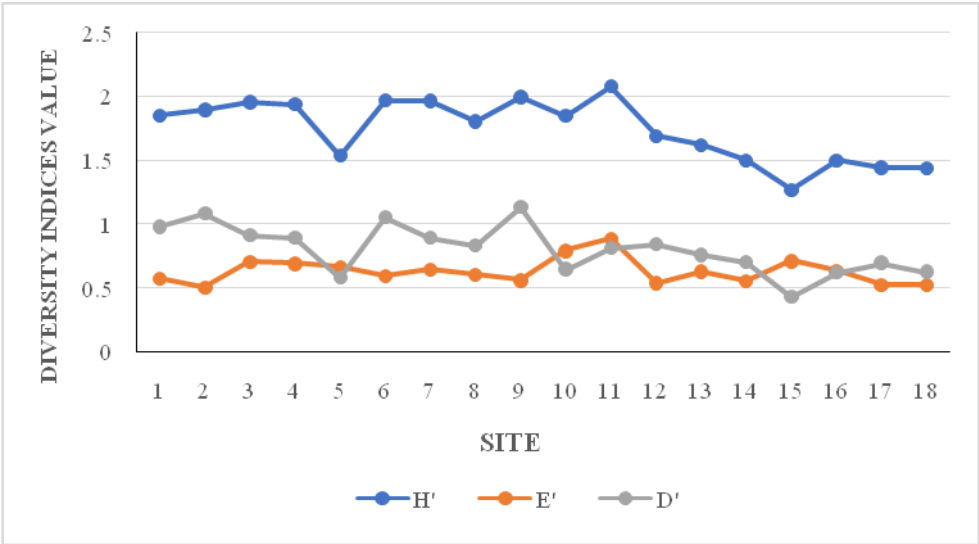


Figure 5.Diversity indices of Copepods species (H', E', D') recorded in the sampling sites.

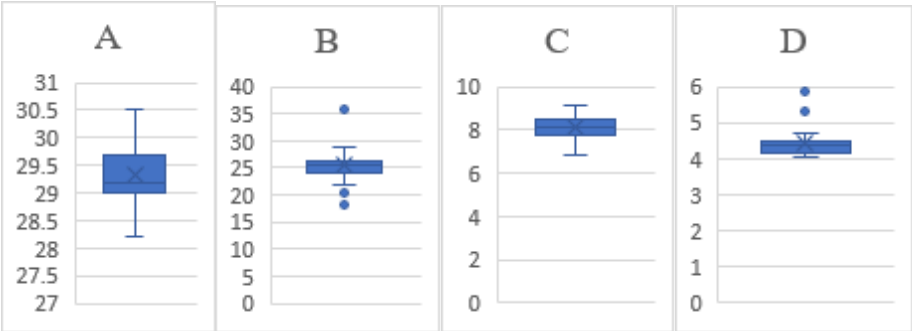


Figure 6.Boxplot showing the variables of A) Temperature (°C); B) Salinity (‰; C) pH and D) Dissolved Oxygen (mg/l).

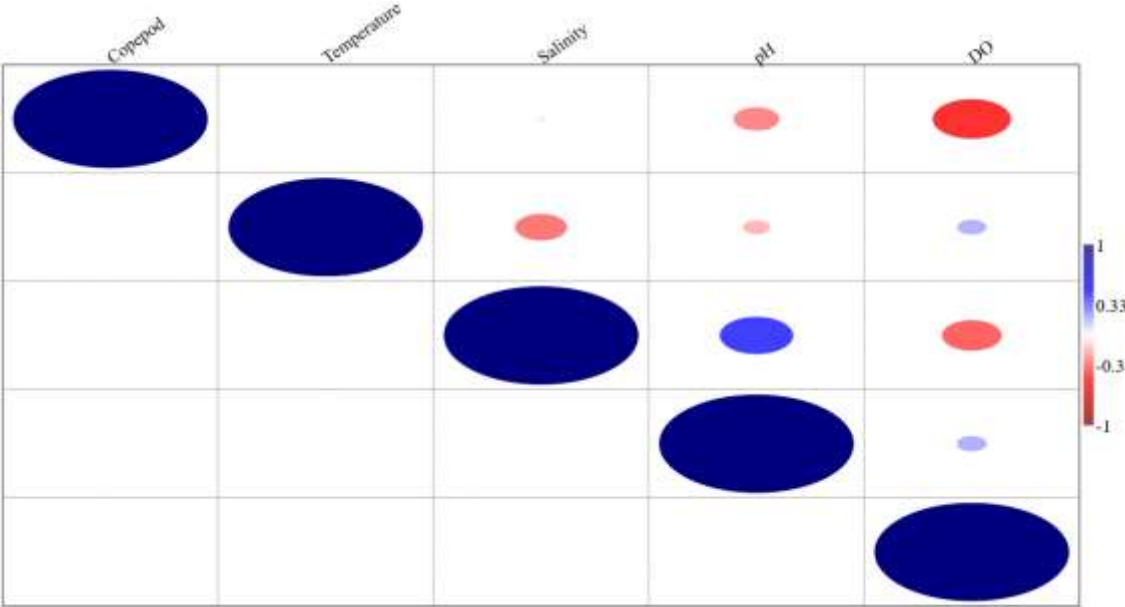


Figure 7. Correlation matrix between the copepods diversity and physico-chemical parameters.

A total of 24 marine copepod species were recorded from the zooplankton sample collected along the Bay of Bengal from Chennai to Vijayawada. The total recorded copepod species during the present study was lower than that of the copepod species recorded by Shanthi and Ramanibai, (2011) from Chennai coast, Bay of Bengal. They have identified 35 copepod species, out of these 31 species belong to Calanoid and four belonged to Cyclopoids. Our present findings also similar resemblance with study of Shanthi and Ramani Bai (2011) from the Chennai coast, Bay of Bengal. According to the observations made from the findings, Calanoida was the dominant group and accounted for 83.8% of all recorded copepods, followed by Cyclopoida (13.5%) and Harpacticoida (2.7%). The dominance of Calanoid copepod may be due to the hard exterior body possessed by this group when compared to the other groups. The low abundance of harpacticoids may be due to their benthic characteristics which hinder the possibility of studying the animals by surface towing in open ocean. Vertical distribution of copepod should also be taken into account while observing copepod diversity. Kavitha *et al.* (2018) reports that, order Calanoida were the most abundant and diverse group represented by 35 species in offshore region of Tuticorin. Similarly, Santhanam *et al.* (2012) recorded that, order Calanoida was the dominant group in the Vellar estuary, Parangipettai coast which represents 54 species out of 84 species. Sreekumaran Nair *et al.*, (1981) found Calanoida as the dominant order in the Bay of Bengal region. Rajkumar *et al.*, (2014) observed Calanoida to be the most dominant group in Coleroon backwaters. Calanoid and Cyclopoid copepods dominate the holoplanktonic zooplankton in certain estuaries. They are important grazers of phytoplankton and microzooplankton and are, in turn, prey for zooplanktivorous fishes and invertebrates (Benfield, 2013). In the present study, Acartiidae and Paracalanidae was the two most dominant group among the collected copepod samples. Similarly, Ramaiah (1996) reports that Acartiidae, Paracalanidae and Pseudodiaptomide were the dominant families in Thana creek, west coast of India. Vineetha *et al.*, (2015) recorded Acartiidae and Paracalanidae were the most dominant families in the southwest coast of India. It is suggested that the species diversity index of plankton community can be used to indicate the overall condition of the ecosystem. An increase in diversity value means the water quality is restored and the decrease in species diversity values indicates the influence of pollution. The species diversity indices obtained in the present study ($H' = 1.27 - 2.07$, $E' = 0.51 - 0.88$ and $D' = 0.43 - 1.13$) indicates lower species diversity of copepod community in the Bay of Bengal region. The correlation matrix between the copepod density and sea water parameters showed positive correlation with the temperature ($r = 0.0084$) and negative correlation with salinity ($r = -0.041$), pH ($r = -0.23$) and dissolved oxygen ($r = -0.40005$). Salinity and pH seem to play a crucial role in determining how copepods thrive in an aquatic ecosystem. Our statistical analysis/ findings are subsequently correlated with study of quantitative composition, distribution and abundance of zooplankton communities in relation to physico-chemical

parameters from in Arabian Sea, southwest coast of India (Sinu and Ajmila, 2023). In Myanmar coastal region, Khin May Chit Maung *et al.*, (2020) also observed positive correlation of copepod abundance with the temperature, chlorophyll a, and fluorescence and negative correlation with the salinity and oxygen.

CONCLUSION

Abundance and diversity of copepods in the coastal waters give a detailed output of the water quality, food availability and the health status of the ecosystem. A total of twenty-one marine copepod species were recorded from the zooplankton sample collected along the Bay of Bengal from Chennai to Vijayawada. This knowledge could shed light on the variety of copepod species present in this area. Calanoid being the large in number can influence the ecosystem. Further long-term intense study is needed for more elaborate information on the diversity and abundance of copepod species and to prove the effect of calanoid dominance in the open ocean ecosystem.

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