**International Journal of Zoology and Applied Biosciences** **ISSN: 2455-9571**
**Volume 9, Issue 2, pp: 5-12, 2024**
**https://doi.org/10.55126/ijzab.2024.v09.i02.002** **http://www.ijzab.com**

**Research Article**

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

**M. Michael Beaven, G. Ananthan and *M. Thangaraj**

Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, -608502.Tamil Nadu, India

**Article History:** Received 25th January 2024; Accepted 23rd February 2024; Published 13th March 2024

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

*Corresponding Author: Dr. M. Thangaraj, Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, -608502.TamilNadu, India. Email: coralholder@yahoo.com.

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 digitalmulti-sensor of ± 0.01$^{o}$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 µm) 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'*=-∑PiIn Pi, *E'*=H'/InS, *D'*=S-1/InN (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.

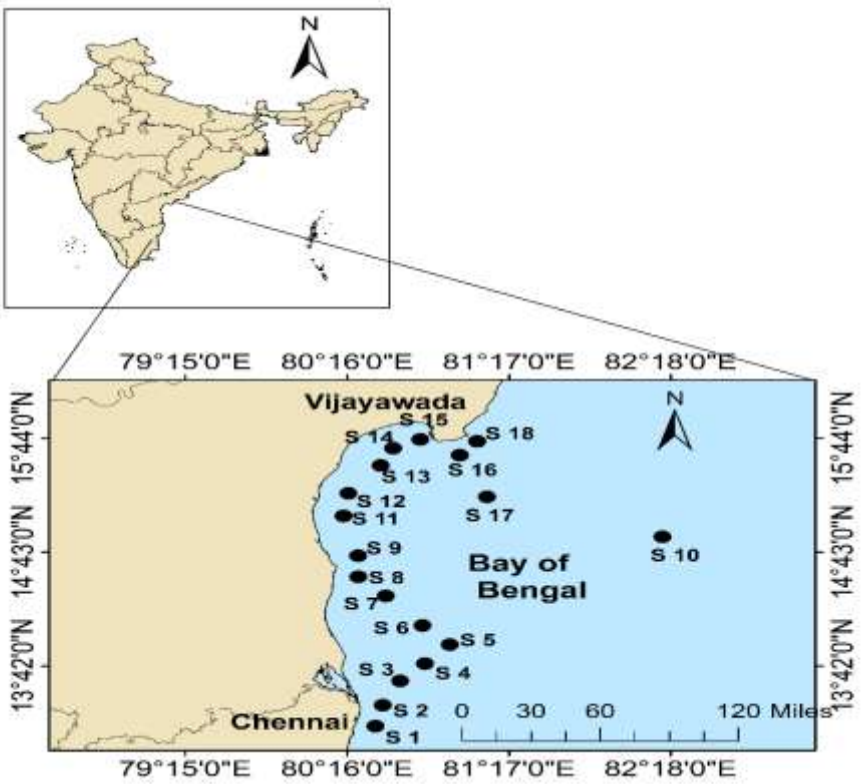


**Figure 1**.Map showing the sampling sites of Bay of Bengal.

## 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 Harpacticoida4 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 to14 (site 9) (site15).

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 no/m$^3$), 18 (69764 no/m$^3$), 2 (65381 no/m$^3$) and lower at Sites15 (10050 no/m$^3$), 13 (10095 no/m$^3$), and

16 (15648 no/$m^3$). In the sampling sites maximum abundant species were recorded such as *Acartia fossae* (225703 no/$m^3$), *Paracalanus indicus* (85527 no/$m^3$), *Subeucalanus flemingeri*(63929 no/$m^3$) for calanoids, *Corycaeus andrewsi* (37148 no/$m^3$), *Corycaeus clausi* (20154 no/$m^3$) for cyclopoids, *Euterpina acutifrons* (6866 no/$m^3$), *Clytemnestras cutellate* (4453 no/$m^3$) for harpacticoids. The copepods diversity indices (*H', E', D'*) are shown in the Figure5. The species diversity index (*H'*) ranged from1.27 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$^o$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 | *Acartia* | *Acartia fossae* |
| | Calanidae | *Canthocalanus* | *Canthocalanus pauper* |
| | Centropagidae | *Centropages* | *Centropagesfurcatus* |
| | | | *Centropagestenuiremis* |
| | Paracalanidae | *Paracalanus* | *Paracalanusindicus* |
| | | *Acrocalanus* | *Acrocalanus gibber* |
| | | *Parvocalanus* | *Parvocalanuselegans* |
| | | *Bestiolina* | *Bestiolinaarabica* |
| | Eucalanidae | *Subeucalanus* | *Subeucalanusflemingeri* |
| | Clausocalanidae | *Clausocalanus* | *Clausocalanus minor* |
| | Tortanidae | *Tortanus* | *Tortanusbarbatus* |
| | Euchaetidae | *Euchaeta* | *Euchaetarimana* |
| | Pontellidae | *Calanopia* | *Calanopia minor* |
| Cyclopoida | Corycaeidae | *Corycaeus* | *Corycaeusclausi* |
| | | | *Corycaeusandrewsi* |
| | | | *Corycaeusdahli* |
| | Oithonidae | *Oithona* | *Oithonaattenuata* |
| | | | *Oithonabrevicornis* |
| | Oncaeidae | *Oncaea* | *Oncaeaclevei* |
| | Sapphirinidae | *Sapphirina* | *Sapphirinanigromaculata* |
| Harpacticoida | Euterpinidae | *Euterpina* | *Euterpinaacutifrons* |
| | Ectinosomatidae | *Microsetella* | *Microsetellarosea* |
| | Miraciidae | *Macrosetella* | *Macrosetellagracilis* |
| | Clytemnestridae | *Clytemnestra* | *Clytemnestra scutellata* |

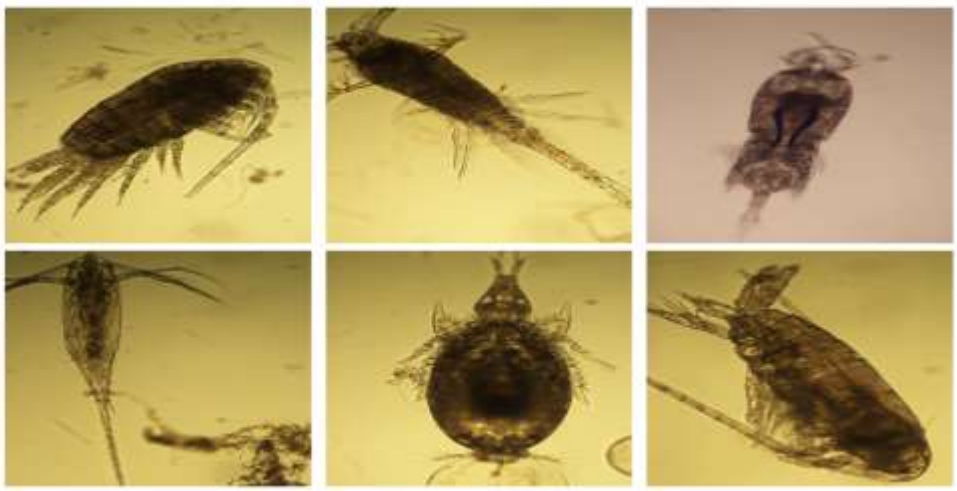

**Figure 2.**Dominant copepod species recorded in the Bay of Bengal.

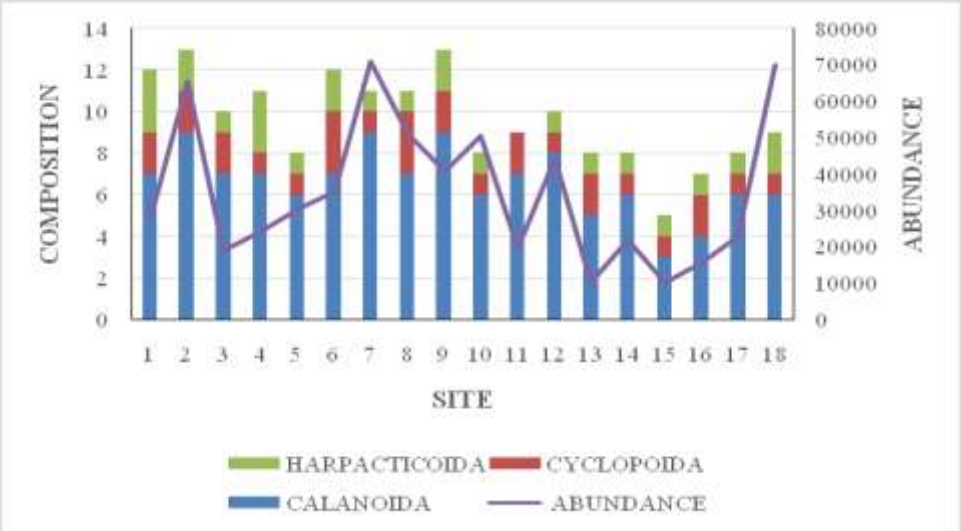


**Figure 3.** Abundance and composition of copepod group.

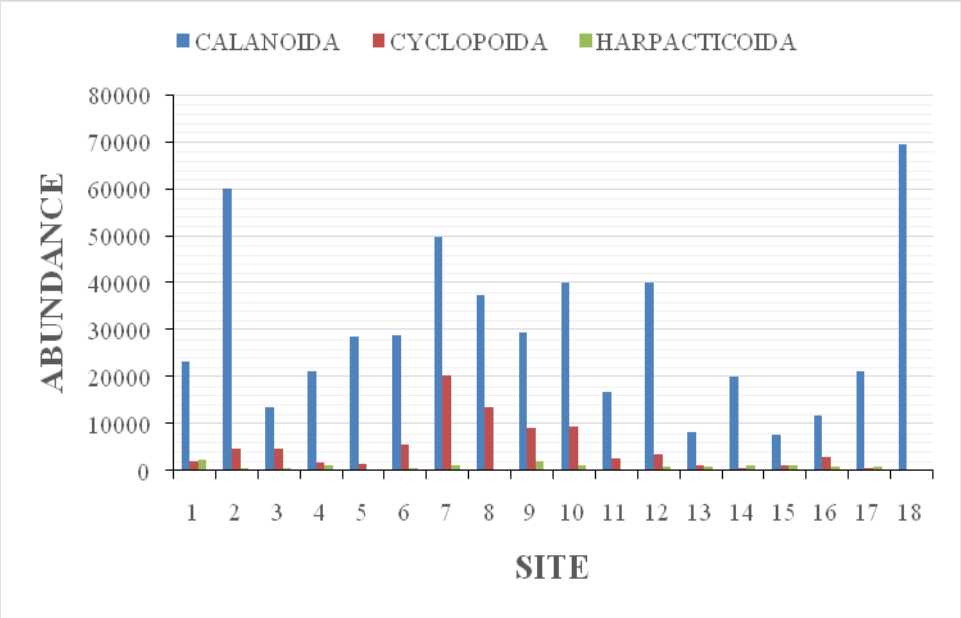


**Figure 4.** Abundance of Calanoid, Cyclopoid and Harpacticoid groups in the sampling stations.

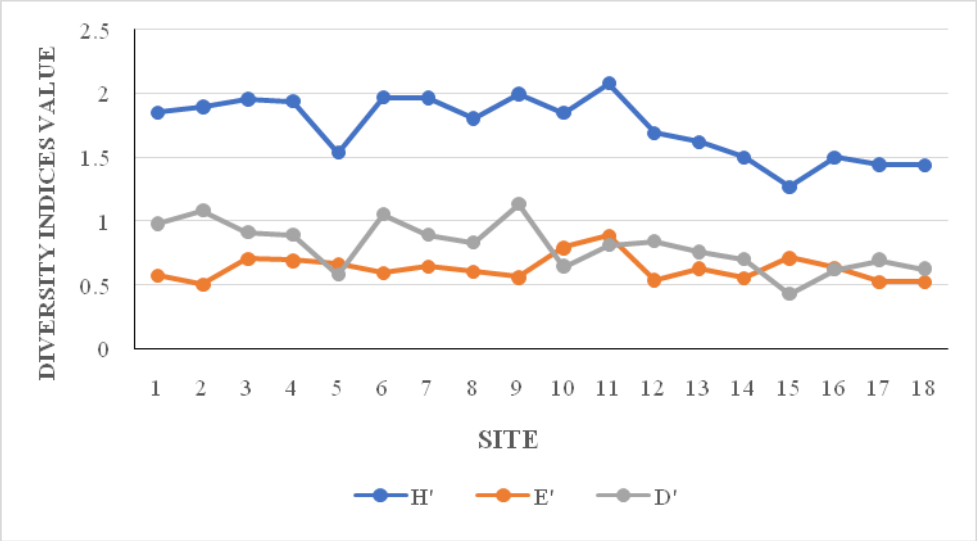


**Figure 5.**Diversity indices of Copepods species (H', E', D') recorded in the sampling sites.

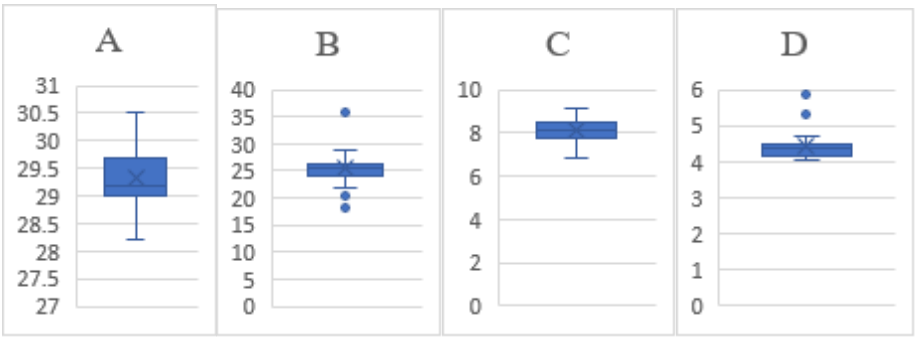


**Figure 6.**Boxplot showing the variables of A) Temperature ($^{o}$C); B) Salinity (‰; C) pH and D) Dissolved Oxygen (mg/l).

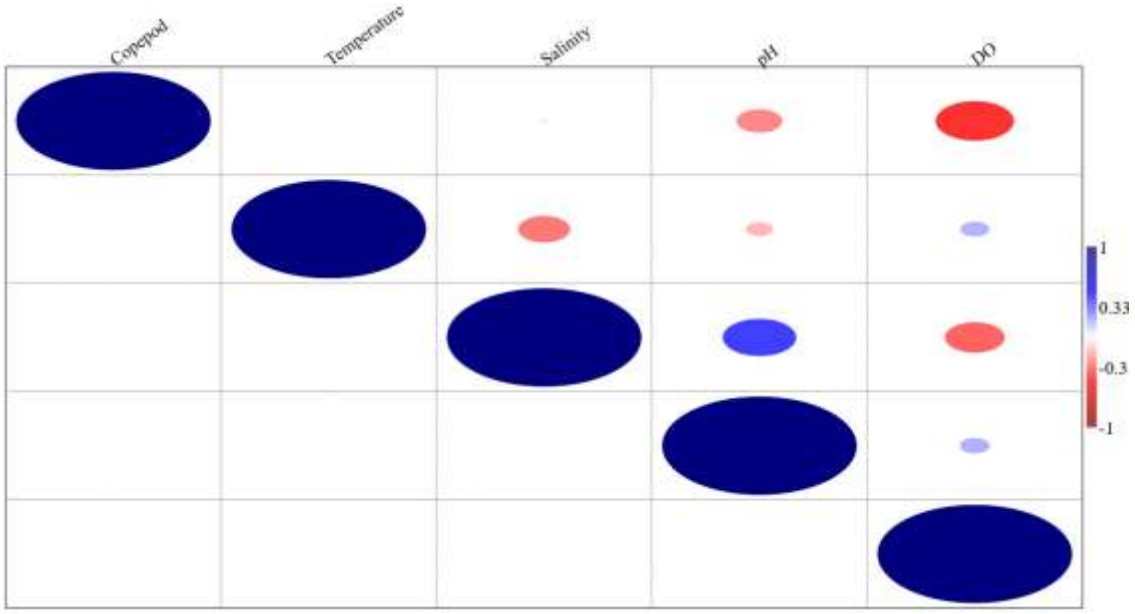


**Figure 7.** Correlation matrix between the copepods diversity and physico-chemical parameters.

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 RamaniBai (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 is 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-termintense 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.

## ACKNOWLEDGMENTS

We thank the authorities of “Sagar Tara”, NIOT vessel management for the sample collection facility and Annamalai University for encouragement and lab facility. We also thank RUSA for providing fellowship in the form of research project (DRD/RUSA 2.0/R&I/Project Proposal/Filed 5/8/2021).

## REFERENCES

Al-Yamani, F. Y., Skryabin, V., Gubanova, A., Khvorov, S., &Prusova, I. (2011).Marine zooplankton practical guide. *Kuwait Institute for Scientific Research, Kuwait*, 399.

Benfield MC. (2013). Estuarine zooplankton. In: Day JW, Crump BC, KempWM, Yanez-Arancibia A (eds.). Estuarine Ecology.2nd ed. Wiley-Blackwell, New York.

Bonnet, D., &Frid, C. (2004). Seven copepod species considered as indicators of water-mass influence and changes: results from a Northumberland coastal station. *ICES Journal of Marine Science*, 61(4), 485-491.

Chang, W. B., Dahms, H. U., & Tseng, L. C. (2010).Copepods assemblages in an embayment of Taiwan during monsoonal transitions. *Zoological Studies*, 49(6), 735-748.

Eswari, Y. N. K., & Ramanibai, R. (2004).Estuarine copepod abundance and diversity in relation to environmental variables, southeast coast of India. *Journal of the Marine Biological Association of India*, 46(1), 10-20.

Hwang, D. S., Lee, K. W., Han, J., Park, H. G., Lee, J., Lee, Y. M., & Lee, J. S. (2010). Molecular

characterization and expression of vitellogenin (Vg) genes from the cyclopoid copepod, *Paracyclopina nana* exposed to heavy metals. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 151(3), 360-368.

Hwang, J. S., & Wong, C. K. (2005). The China Coastal Current as a driving force for transporting *Calanus sinicus* (Copepoda: Calanoida) from its population centres to waters off Taiwan and Hong Kong during the winter northeast monsoon period. *Journal of Plankton Research*, 27(2), 205-210.

Hwang, J. S., Souissi, S., Dahms, H. U., Tseng, L. C., Schmitt, F. G., & Chen, Q. C. (2009). Rank-abundance allocations as a tool to analyze planktonic copepod assemblages off the Danshuei river estuary (Northern Taiwan). *Zoological Studies*, 48(1), 49-62.

Hwang, J. S., Souissi, S., Tseng, L. C., Seuront, L., Schmitt, F. G., Fang, L. S., Peng, S. H., Wu, C.H., Hsiao, S.H., Twan, W.H., Wei, T.P., Kumar, R., Fang, T.H., Chen, Q.C.,& Wong, C,K. (2006). A 5-year study of the influence of the northeast and southwest monsoons on copepod assemblages in the boundary coastal waters between the East China Sea and the Taiwan Strait. *Journal of Plankton Research*, 28(10), 943-958.

Hwang, J. S., Tu, Y. Y., Tseng, L. C., Fang, L. S., Souissi, S., Fang, T. H., Lo, W.T., Twan, W. H., Hsiao, S. H., Wu, C. H., Peng, S. H., Wei, T. P.,& Chen, Q. C. (2004). Taxonomic composition and seasonal distribution of copepod assemblages from waters adjacent to nuclear power plant I and II in northern Taiwan. *Journal of Marine Science and Technology*, 12(5), 4.

Sinu, J. V., &Ajimila, B. (2023).Quantitative composition, distribution and abundance of zooplankton communities in relation to physico-chemical parameters from selected beaches of Alappuzha in Arabian Sea, Southwest Coast of India. *Total Environment Research Themes*, 100054.

Jerling, H. L., & Wooldridge, T. H. (1995).Plankton distribution and abundance in the Sundays River estuary, South Africa, with comments on potential feeding interactions. *South African Journal of Marine Science*, 15(1), 169-184.

Ka, S., & Hwang, J. S. (2011). Mesozooplankton distribution and composition on the north-eastern coast of Taiwan during autumn: effects of the Kuroshio Current and hydrothermal vents. *Zoological Studies*, 50(2), 155-163.

Kavitha, M., Padmavathy, P., Srinivasan, A., Jawahar, P., Ranjith, L., &Linga Prabu, D. (2018).Copepod abundance and Diversity from offshore region of Tuticorin, south east coast of India. *International Journal of Current Microbiology and Applied Sciences*, 7(4), 2767-2792.

Kaviyarasan, M., Santhanam, P., Balakrishnan, S., Kumar, S. D., Ananth, S., &Kandan, S. (2019). Seasonal variations in copepods diversity along the Vettar coastal waters, South Eastern India. *Environment and Ecology*, 37(2), 471-480.

Leandro, S. M., Morgado, F., Pereira, F., &Queiroga, H. (2007). Temporal changes of abundance, biomass and production of copepod community in a shallow temperate estuary (Ria de Aveiro, Portugal). Estuarine, *Coastal and Shelf Science*, 74(1-2), 215-222.

Ludwig, J. A., & Reynolds, J. F. (1988). Statistical ecology: a primer in methods and computing (Vol. 1). John Wiley & Sons.

Maung, K. M. C., Htut, T., Phyu, E. T., Hein, Z. M., &Tun, N. N. (2020).Diversity and abundance of copepods in Taninthayi Coastal Waters, Myanmar. *Journal of Marine Science*, 2(3).

Nair, S. S., Nair, V. R., Achuthan kutty, C. T., & Madhupratap, M. (1981).Zooplankton composition and diversity in western Bay of Bengal. *Journal of Plankton Research*, 3(4), 493-508.

Perumal, P., Sampathkumar, P., &Santhanam, P. (1998).Zooplankton of Parangipettai coastal waters. *Monograph Series*, 1, 31.

Rajkumar, M., Sun, J., Jenkinson, I. R., & Rahman, M. M. (2014).Seasonal variations in the structure of copepod assemblages in tropical marine and estuarine waters, Coleroon, South-east India. *Journal of the Marine Biological Association of the United Kingdom*, 94(3), 521-535.

Ramaiah, N., & Nair, V.R. (1997).Distribution and abundance of copepods in the pollution gradient zones of Bombay Harbour-Thana Creek-Bassein Creek, west coast of India. *Indian Journal of Marine Sciences*, 26, 20-25.

Ramaiah, N., Chatterji, A., & Madhupratap, M. (1996).A studies on the zooplankton of the Burhabalanga Estuary, Orissa Coast. Proceedings of National Academy of Science India, Section B, 62(1), 1-4.

Santhanam, P., Perumal, P., Ananth, S., & Devi, A. S. (2012).Copepod population in Vellar estuary, Parangipettai coast in relation to environmental conditions.Journal of Environmental Biology, 33(6), 1003.

Schminke, H. K. (2007). Entomology for the copepodologist. *Journal of Plankton Research*, 29(suppl_1), i149-i162.

Shanthi, M., &Ramanibai, R. (2011). Studies on copepods from Chennai coast (Cooum and Adyar), Bay of Bengal-during the Cruise. *Current Research Journal of Biological Sciences*, 3(1), 132-136.

Shein, H. (1975). A study on some marine planktonic copepod of Burma waters.Unpublished M. Sc. Thesis.

Department of Marine Biology, Art and Science University, Rangoon, Myanmar.

Strickland, J. D. H., & Parsons, T. R.(1972). A practical handbook of seawater analyses, *Fisheries Research Board of Canada*, Ottawa, https://doi.org/10.1002/iroh.19700550118.

Thangaraj, M., &Vijayanand, P., (2023). Diversity and distribution pattern of copepods in Palk Bay coastal waters of India. *Magna Scientia Advanced Research and Reviews*, 07(01), 042-048.

Thor, P., Nielsen, T. G., Tiselius, P., Juul-Pedersen, T., Michel, C., Møller, E. F., & Gooding, S. (2005). Post-spring bloom community structure of pelagic copepods in the Disko Bay, Western Greenland. *Journal of Plankton Research*, 27(4), 341-356.

Vineetha, G., Madhu, N. V., Kusum, K. K., & Sooria, P. M.(2015).Seasonal dynamics of the copepod community in a tropical monsoonal estuary and the role of sex ratio in their abundance pattern. *Zoological Studies*, 54, 1-19.

Wroblewski, J.S, (1980). A simulation of the distribution of *Acartiaclausi* during the Oregon upwelling, August 1973. *Journal of Plankton Research*, 2, 43- 68.