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Diversity and distribution pattern of copepods in Palk Bay coastal waters of India

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Abstract

The aim of this study was to find the species abundance and composition of copepod zooplankton in four selected sites such as Karangadur, Thevipattinam, Athangarai and Mandapam in Palk Bay region during February 2022 to January 2023. There is no significant difference ($P < 0.05$) in water temperature, salinity, DO and pH values between the sites during this study period. In this study, we have observed 46 species of copepods belongs to 30 genus, 20 families and four orders. The overall percentage of copepod species composition in the four collection sites was: Calanoida (58.7%), Poecilostomatoida (17.4%), Harpacticoida (15.2%) and Cyclopoida (8.7%). In Athangarai site, a maximum of 40 copepod species were recorded. In Karangadu site, 34 species, in Devipattinam site, 28 species and in Mandapam site only 25 species were observed. In calanoid copepods, *Acartia*, *Calanopia* and *Temora* was the dominant genus which representing three species. In Poecilostomatoida order, four families, seven genus and eight species were observed. Out of the seven genus, *Corycaeus* was the dominant genus which comprises two species such as *Corycaeus crassiusculus* and *C. speciosus*. In Harpacticoida order, six families, six genus and seven species were recorded. Among the six genus, *Longipedia* represents two species (*Longipedia coronata* and *L. weberi*). The order Cyclopoida, has only one family, two genus and four species. Among the genus, *Oithona* was the dominant genus which contains three species. Among the 20 families, Pontellidae was the dominant one includes six species.

Keywords: Zooplankton; Copepod; Diversity; Distribution; Palk Bay

1. Introduction

Zooplankton acting a vital role in the aquatic realm due to the direct influence on phytoplankton and play in higher trophic levels also [1]. Fishery productivity can be indirectly influenced by zooplankton in marine sector [2]. Marine zooplankton comprises of a broad range of different organisms with about ten thousand species of meroplankton which includes small flagellates to large jellyfish. Copepods are the major group of zooplankton in terms of biomass, abundance and species number in marine pelagic ecosystems [3]. They are the most important secondary producers in coastal and marine ecosystems which holds link with phytoplankton and higher tropic level animals [2]. They are extensively distributed throughout the world and represents about 80% of the total zooplankton biomass in marine environment [4]. In India, copepods are the dominant taxa both in east and west coast [5,6]. Palk Bay is one of the productive ecosystems in India. This region inhabitate of about 302 algae species, 580 fish species, five marine turtle species, 11 seagrass species and several mangrove species. Copepods are one of the most broadly studied marine zooplankton groups especially on the species composition, temporal distribution in the Indian coastal waters [6,7,8,9,10,11]. There are about 210 described families, 2,280 genera and more than 14,000 species of copepods were recorded throughout the world [2]. As per the earlier reports, about 540 copepod species were documented in Indian waters [13]. Few studies have been described on copepod community in Gulf of Mannar and Palk Bay region [14,15]. Since, there is no recent study on copepod diversity in Palk Bay region, this work was initiated to give a detailed report on the abundance, diversity and distribution pattern in four selected regions of Palk Bay coast.

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2. Material and methods

During the study period, the zooplankton samples were collected in four stations of selected fishing grounds of Palk Bay from February 2022 to January 2023. Locations of sampling sites were Karangadu (9°64' N - 9° 69'N lat. and 78°98'E – 79°00'E lon.), Devipattinam (9°46'N - 9°49'N lat. and 78°90' E – 78°94'E lon.), Athangarai (9°34' N - 9°38'N lat. and 79°01' E – 79°05'E lon.) and Mandapam (9°30' N - 9°33'N lat. and 79°12' E – 79°16'E lon.).

The copepod samples were collected from the four stations at a monthly interval from the surface waters by horizontal towing of a zooplankton net with 45 cm diameter wide mouth made up of blotting silk (No. 10, mesh size 158 µm). The collected zooplankton samples were preserved in 5% buffered formalin. The copepod species were identified by identification key materials reported by Sewell [16], Kasturirangan [17] and Santhanam and Srinivasan [18]. The copepods were identified to genus and species level using a phase contrast microscope (Olympus). One way ANOVA analysis was performed using SPSS (version 10) to find out the significance variation of water temperature, salinity, DO and pH among different sites.

3. Results

3.1. Surface water temperature

During the study period, the surface water temperature was ranged between 24.0 – 30.1 °C. In all the stations the lowest temperature was recorded between October and December and highest in the month of April, May and June. The similar type of water temperature ranges was reported in earlier observations [2, 19, 20] in Gulf of Mannar and Palk Bay region.

3.2. Salinity

During the present investigation, the salinity values were recorded in the range of 31.5 to 37.5 ‰. The high salinity observed during April and May and low was during September and October. The salinity values recorded in the present study was similar to the studies conducted by Asha and Diwakar [19] who registered the salinity in the range of (31.2 to 37.6 ‰) in Gulf of Mannar coastal water. The low salinity was during the northeast monsoon (September-November) may be due to the influence of monsoon. The high salinity was observed during summer (April-June) might be due to low rainfall and high degree of evaporation of surface water. Similar observations were recorded in the earlier report [2, 20].

3.3. Dissolved oxygen

In this study, the dissolved oxygen (DO) value was ranged between 3.1 and 6.3 mL/ L. The higher value of DO was observed during September and October which might be due to the synchronic effect of heavy rainfall and high wind velocity. Dissolved oxygen showed an indirect correlation against temperature and salinity. The same kind of value was reported by previous studies [2, 21, 22].

3.4. pH

As per the present investigation, the pH value was ranged between 7.6 and 8.4. The maximum pH was observed in April and minimum in November. This pH range was similar to the study of Gopinath and Rodrigo [23] and Kavith *et al.* [2] who observed the value of 7.8 - 8.3 in Gulf of Mannar and Palk Bay coastal waters. The high pH values might be due to the influence of sea water penetration and high biological activity [24] and due to the presence of high photosynthetic activity [25, 26]. There is no significant difference ($P>0.05$) in water temperature, salinity, DO and pH values between the stations during this study period.

3.5. Copepod species diversity

During the study period, 46 species of copepod belongs to 30 genus, 20 families and four orders were recorded (Table 1). The overall percentage of copepod species composition in the four collection sites were: Calanoida (27 Spp; 58.7%), Poecilostomatoida (8 Spp; 17.4%), Harpacticoida (7 Spp; 15.2%) and Cyclopoida (4 Spp; 8.7%) (Fig.1). In Athangarai site a maximum of 40 copepod species were recorded. In Karangadu site, 34 species, in Devipattinam site, 28 species and in Mandapam site only 25 species were recorded (Fig.2).

Table 1 Copepod species recorded in Palk Bay region

Order	Family	Genus	Species
Calanoida	Acartiidae	<i>Acartia</i>	<i>Acartia centrura</i> <i>Acartia spinicauda</i> <i>Acartia southwelli</i>
	Paracalanidae	<i>Acrocalanus</i>	<i>Acrocalanus gibber</i> <i>Acrocalanus gracilis</i>
		<i>Paracalanus</i>	<i>Paracalanus parvus</i>
	Pontellidae	<i>Calanopia</i>	<i>Calanopia aurivilli</i> <i>Calanopia elliptica</i> <i>Calanopia minor</i>
		<i>Labidocera</i>	<i>Labidocera acuta</i> <i>Labidocera pectinata</i>
		<i>Pontella</i>	<i>Pontella danae</i>
	Calanidae	<i>Canthocalanus</i>	<i>Canthocalanus pauper</i> <i>Canthocalanus sp</i>
		<i>Nannocalanus</i>	<i>Nannocalanus minor</i>
		<i>Undinula</i>	<i>Undinula vulgaris</i>
	Centropagidae	<i>Centropages</i>	<i>Centropages furcatus</i> <i>Centropages tenuiremis</i>
	Eucalanidae	<i>Subeucalanus</i>	<i>Subeucalanus crassus</i> <i>Subeucalanus monachus</i>
		<i>Eucalanus</i>	<i>Eucalanus elongatus</i>
	Pseudodiaptomidae	<i>Pseudodiaptomus</i>	<i>Pseudodiaptomus aurivilli</i> <i>Pseudodiaptomus spinipes</i>
	Temoridae	<i>Temora</i>	<i>Temora discaudata</i> <i>Temora stylifera</i> <i>Temora turbinata</i>
Tortanidae	<i>Tortanus</i>	<i>Tortanus gracilis</i>	
Poecilostomatoida	Bomolochidae	<i>Bomolochus</i>	<i>Bomolochus sp.</i>
	Sapphirinidae	<i>Copilia</i>	<i>Copilia mirabilis</i>
		<i>Sapphirina</i>	<i>Sapphirina nigromaculata</i>
	Corycaeidae	<i>Onchocorycaeus</i>	<i>Onchocorycaeus catus</i>
		<i>Corycaeus</i>	<i>Corycaeus crassiusculus</i> <i>Corycaeus speciosus</i>
		<i>Farranula</i>	<i>Farranula gibbula</i>
Oncaeiidae	<i>Oncaea</i>	<i>Oncaea venusta</i>	
	Peltidiidae	<i>Clytemnestra</i>	<i>Clytemnestra scutellata</i>
	Euterpinidae	<i>Euterpina</i>	<i>Euterpina acutifrons</i>
	Longipediidae	<i>Longipedia</i>	<i>Longipedia coronata</i>

Harpacticoida			<i>Longipedia weberi</i>
	Miraciidae	<i>Macrosetella</i>	<i>Macrosetella gracilis</i>
	Metidae	<i>Metis</i>	<i>Metis jousseaumei</i>
	Ectinosomatidae	<i>Microsetella</i>	<i>Microsetella norvegica</i>
Cyclopoida	Oithonidae	<i>Oithona</i>	<i>Oithona brevicornis</i> <i>Oithona linearis</i> <i>Oithona similis</i>
		<i>Dioithona</i>	<i>Dioithona rigida</i>

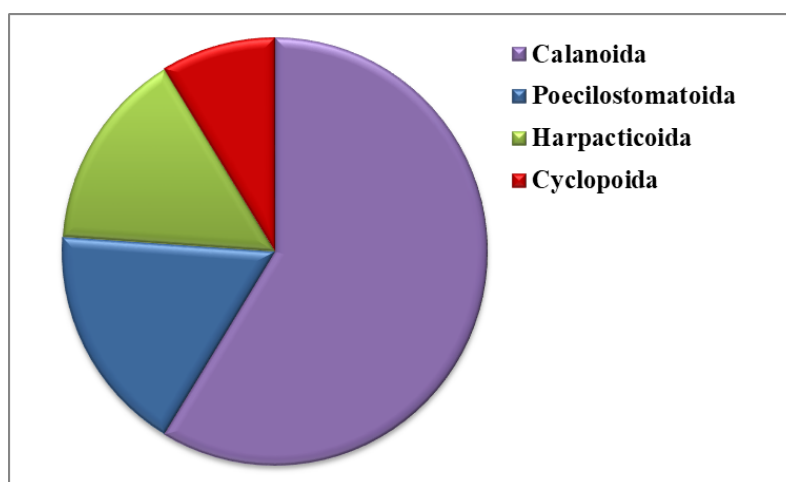


Figure 1 Percentage contribution of four copepod orders in Palk Bay region

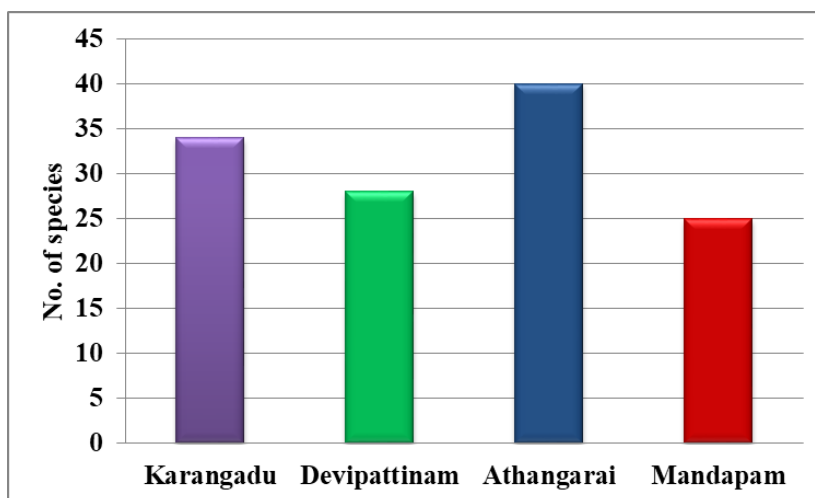


Figure 2 Copepod species diversity in four collection sites in Palk Bay

Under the order calanoida, nine families, in the order Harpacticoida, six families, in the order Poecilostomatoida, four families, and in the order Cyclopoida, only one family was recorded (Fig.3). In calanoid copepods, *Acartia*, *Calanopia* and *Temora* was the dominant genus which representing three species. In Poecilostomatoida order, four families, seven genus and eight species were observed. Out of the seven genus, *Corycaeus* was the dominant genus which comprises two species such as *Corycaeus crassiusculus* and *C. speciosus*. In Harpacticoida order, six families, six genus and seven species were recorded. Among the six genus, *Longipedia* represents two species (*Longipedia coronata* and *L. weberi*).

The order Cyclopoida, has only one family, two genus and four species. Among the genus, *Oithona* was the dominant genus which contains three species. Among the 20 families, Pontellidae was the dominant one includes six species. The details of species composition along the 20 families are represented in Fig.4.

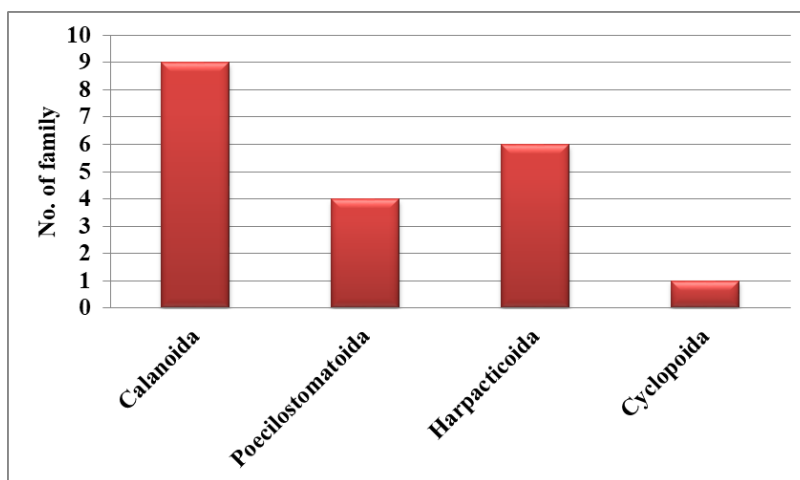


Figure 3 Copepod families contributed by four orders in Palk Bay region

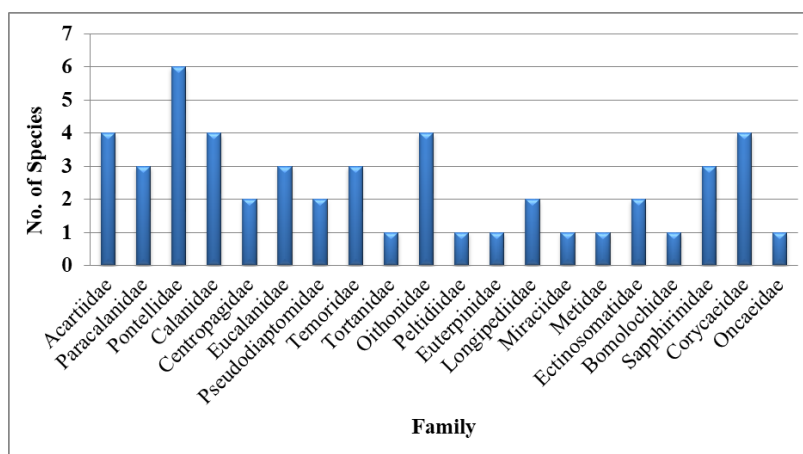


Figure 4 Copepod species contributed by twenty families in Palk Bay region

4. Discussion

The findings of this present study are comparable with other previous reports in various coastal waters of India. Fernandes and Ramaiah [11] recorded that Calanoids were the dominant copepods in the Bay of Bengal coast which represents 132 species. Shanthi and Ramanibai [27] reported that Calanoid copepods were most diverse group which represented about 31 species in Chennai Coast, Bay of Bengal.

The results of this present observations are in corroborate with Pillai *et al.* [28] reported that Paracalanidae was the dominant family in Andaman Islands. Similarly, Paracalanidae and Acartidae were the dominant families throughout the year as recoded by Vineetha *et al.* [29] in Cochin backwaters, Kerala. But, Acartidae was the dominant family in the water of Chennai coast [27]. Kartha [15] reported that, three species such as *Acrocalanus gracilis*, *A. gibber* and *A. monachus* were the dominant species in Gulf of Mannar and Palk Bay region. The present findings are supported by Paffenhofer [30], Gallienne and Robins [31] reports, where they explain that the family Oithonidae is one of the most abundant groups found in the coastal waters in worldwide. Similarly, Rashiba [32] reported that only Oithonidae is represents the sub-order Cyclopoida from Bay of Bengal. Further, Ananthan *et al.* [33] also recorded the dominance of *Oithona* sp in Cuddalore backwaters. According to Vineetha *et al.* [2], *Oithona brevicornis* exhibited in higher abundance

among other Cyclopoids in Cochin back waters. *Oithona* sp. pays a major share of total population in Gulf of Mannar and Palk Bay and exhibits peak density during April [15].

5. Conclusion

In conclusion, the present findings on the abundance and distribution pattern of copepod species and its diversity in selected sites of Palk Bay may give a basic idea for further investigation. This information may provide an insight on the copepod species diversity in this region and future research is needed for species identification using molecular techniques such as DNA barcoding which is generally scarce especially in Palk Bay coast.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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