



Diversity and Taxonomical Identification of Marine Zooplankton from Digha adjacent Coastal Waters

Purbita Bhattacharyya^{1,2}, K. Anbarasu¹ and S. Balakrishnan^{2,*}

¹Department of Marine Biotechnology, Bharathidasan University, Tiruchirappalli – 620 024, Tamil Nadu, India

²Zoological Survey of India, Marine Aquarium and Regional Centre, Digha – 721 428, West Bengal, India
E. mail: marugalbalu82@gmail.com

Abstract

Zooplankton is significant organisms in the food chain as predators of phytoplankton, the photosynthetic oxygen-producing aquatic plants; thus, they protect the ecosystem from eutrophication. Zooplankton are diversified and widely distributed throughout the lotic and lentic water bodies. The marine zooplankton community includes many different species of animals, ranging in size from microscopic protozoans to animals of several meters in dimension with buoyancy capacity. In this article, we describe the distribution, diversity, and taxonomic identification of marine zooplankton as evaluated by collecting species from the Digha adjacent coastal area (21.6222°N; 087.5066°E), West Bengal, India. Generally, almost all zooplankton species have their own specific depth range, but some of those also exhibit nocturnal migration, which helps in conserving energy, as well as beneficial for themselves, by prevent mortality by visual predators. Zooplankton, as the intermediate link between producer (phytoplankton) and consumer (secondary and tertiary) in the trophic chain, plays pivotal roles in the energy and matter transport processes, the cycling of elements, and their vertical flux in marine environments. This community is highly diverse in terms of their size, number, taxonomy, trophic structure, geographical distribution, tolerance to different environmental variables, etc. These are also considered some of the most important bio-indicators and linkages in shaping the extent and pace of climate change. During the survey, a small plankton local net was used to collect zooplankton. Totally, nine genera with ten different species, such as *Euterpina acutifrons*, *Oithona brevicornis brevicornis*, *Paracalanus parvus parvus*, *Paracalanus aculeatus aculeatus*, *Microsetella norvegica*, *Nannocalanus minor*, *Undinula vulgaris*, *Canthocalanus pauper*, *Eucalanus elongatus elongatus* and *Subeucalanus crassus* have been identified and characterized. The survey is a current report of the above species diversity, occurrence, distribution, and characteristics in these coastal areas during this period. We hope it is significant data for further analysis, such as the breeding of fish and crustaceans.

Keywords: Zooplankton, Diversity, Taxonomy, Digha, West Bengal.

Introduction

Zooplankton is a microscopic or macroscopic group of aquatic organisms that float in the water at different zones at the mercy of wind and water flow. Zooplankton are the

predators of phytoplankton, the photosynthetic oxygen-producing aquatic plant, thus they control the ecosystem and bloom of phytoplankton. Zooplankton are diversified and widely distributed throughout riverine, coastal, and marine aquatic bodies (Laakmann *et al.*, 2020). The marine

zooplankton community includes many different species of animals, ranging in size from microscopic protozoans to animals several meters in dimension. In this review of the literature, the distribution, diversity, and taxonomical identification of marine zooplankton are evaluated by collecting species from the Digha-adjacent coastal area, West Bengal. Generally, almost all zooplankton species have their own specific depth range, but some of those also exhibit nocturnal migration and help conserve energy, which is beneficial for them, and prevents mortality by visual predators (Carol *et al.*, 1997). Zooplankton, as the intermediate link between producer (phytoplankton) and consumer (secondary and tertiary) levels in the trophic chain, plays pivotal roles in the energy and matter transport processes, the cycling of elements, and their vertical flux in the marine environment. This community is highly diverse in terms of their size, taxonomy, trophic structure, geographical distribution, tolerance to different environmental variables, etc. These are also considered to be one of the most important linkages in shaping the extent and pace of climate change.

Primary and secondary consumers, the zooplankton community constitutes about one-tenth of the total marine biomass on which the whole class of fishery depends. Owing to its multi-dimensional economic and ecological utility, zooplankton is a core subject of research in all marine biological investigations. Zooplankton studies along the Odisha coast, in general, remained meager and were limited to the Chilika Lake (Devasundaram, 1954; Patnaik, 1973; Naik *et al.*, 2008), Hooghly estuary (Sarkar *et al.*, 1986), Rushikulya estuary (Gouda and Panigrahy, 1995), Bahuda estuary (Mishra and Panigrahy, 1996), Burhabalanga estuary (Ramaiah *et al.*, 1996), Mahanadi estuary (Srichandan *et al.*, 2013), Gopalpur Port (Sahu *et al.*, 2012), Gopalpur Creek (Sahu *et al.*, 2013), Rushikulya estuary (Sahu *et al.*, 2010, Baliarsingh *et al.*, 2013, Srichandan *et al.*, 2015). According to Issarapon zooplankton communities in the Bay of Bengal consisted of 205 species, 119 genera, and 44 taxa (Jitlang *et al.*, 2007). The only study on zooplankton distribution in coastal waters along the Odisha coast was that of Sahu *et al.* (2010) and Srichandan *et al.* (2014). Moharana and Patra (2013) have reported the abundance of 12 species of protozoa, eight species of Rotifera, six species of Cladoceran, and four species of Copepoda, including different genera. A total of twenty different *Tintinnid* species have been recorded by Dash, Behera *et al.* (2017). Horizontal and vertical distribution and abundance of Zooplankton around the Swatch-of-No-Ground of Northern Bay of Bengal, authored by Nurany *et al.* (2021). So far, little attention has been paid to the study of the diversity of plankton. Other sources of

information are also limited to stray records or accounts in expedition reports at the Digha coast.

Materials and Methods

Sampling Study Site

Digha coast is located in the Purba Medinipur district of West Bengal, India. It's stretched from the mouth of the Subarnarekha River to Old Digha, up to Digha Mohana. The total length of the study area is around 9-10 km including Digha Mohana, Old Digha, New Digha, Talsari delta located in Jaleswar district of Odisha State, India (Figure 1).

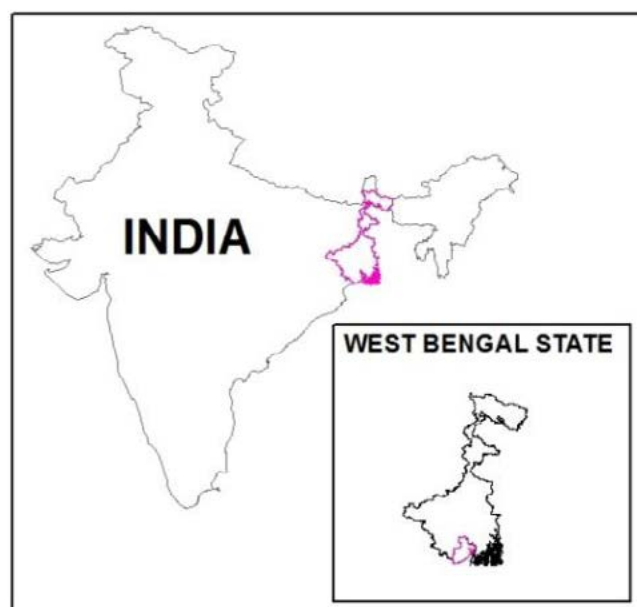


Figure 1. Map showing the study sites Digha along West Bengal.

Water samples analysis

Water samples were collected in sterilized plastic bottles and placed in ice-packed container which later transported to the Laboratory for analysis. Water parameters like temperature (°C), Dissolved Oxygen (DO), Hydrogen-ion concentration (pH) and Salinity (ppt), were determined and recorded right at the sampling stations. All parameters were determined in accordance with the standard methods (AOAC, 2000; APHA, 2005). The seawater temperatures were measured by mercury thermometer with an accuracy of 0.1°C. Salinity of surface seawater was measured by Refractometer Model [HI 98319, Hannah] while the pH was measured using water proof pH meter [HI 98108] and DO was estimated by Winkler's method (Strickland and Parsons, 1972).

Collection, Preservation and Identification

Surveys were conducted in different adjacent coastal areas of Digha, West Bengal. Surface samplings of zooplankton were made at monthly intervals by horizontal small local towing of a plankton net (0.35m diameter) made up of bolting silk (Cloth No. 10; mesh size 158µm) for a number of bucket water filters in the net for several times. The collected samples were preserved in 5% neutralized formalin and used for qualitative analysis. A known quantity of water (1000 lit) was filtered through a bag net of the same mesh size, and the numerical zooplankton analysis was carried out using a binocular microscope. Photographs were taken with the help of a binocular microscope for taxonomic identification. Zooplankton species was measured following standard

by Kasturirangan (1963); Wimpenny (1966); Newell and Newell (1977); Smith (1977); Sarkar *et al.* (1986); Perumal *et al.* (1998); and Conway *et al.* (2003).

Results

Seawater temperatures recorded at two different sites ranged from 30.7 to 31.0°C. The minimum seawater temperature was observed at the hospital beach, and the maximum was registered at Udaipur Beach. The observed salinity values ranged between 31.0 and 31.6 ppt, with the higher salinity (31.6 ppt) at Hospital Beach and the lowest at Udaipur Beach. Hydrogen ion concentration (pH) ranged from 7.92 to 8.3, with the maximum at Udaipur beach and the minimum at Hospital beach, respectively. The dissolved oxygen (DO) concentration varied between 6.1 – 6.4 mg/l registering a maximum at Hospital Beach and minimum values at Udaipur Beach (Figure 2). Totally ten species belonging to nine genera, six families, and three orders were recorded in the present investigation (Table 1). In the present observation, zooplankton distribution can be divided into three distinct categories based on the period of existence at the Digha coast. Zooplankton species such as *Euterpina acutifrons*, *Oithona brevicornis brevicornis*, *Paracalanus parvus parvus*, *Paracalanus aculeatus aculeatus*, *Microsetella norvegica*, *Nannocalanus minor*, *Undinula vulgaris*, *Canthocalanus pauper*, *Eucalanus elongatus elongatus*, *Subeucalanus crassus* and *Oithona brevicornis brevicornis* have been reported (Figure 3).

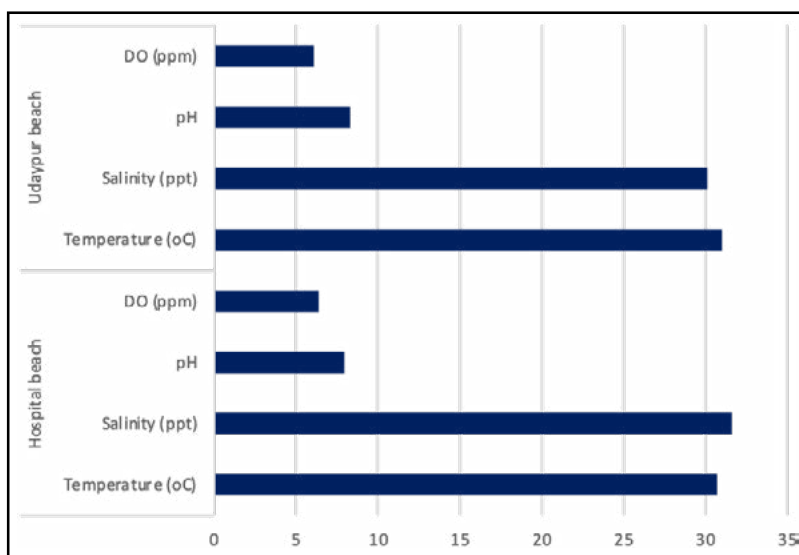


Figure 2. Water quality parameters analysis in Digha adjacent areas.

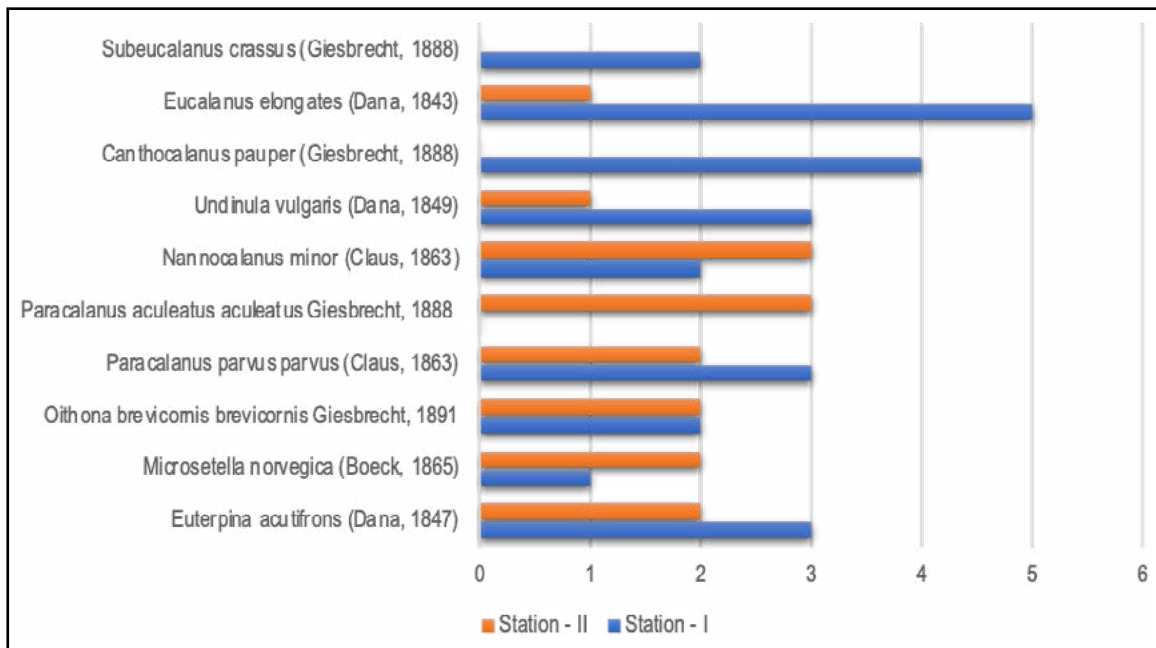


Figure 3. Relative proportion of species wise distribution from two different sites.

Table 1. List of zooplankton species identified from the study.

S. No.	Order	Family	Species	No. of Example	
				S1	S2
01.	Harpacticoida	Paracalanidae	<i>Euterpina acutifrons</i> (Dana, 1847)	03	02
02.	Harpacticoida	Paracalanidae	<i>Microsetella norvegica</i> (Boeck, 1865)	01	02
03.	Cyclopoida	Oithonidae	<i>Oithona brevicornis brevicornis</i> Giesbrecht, 1891	02	02
04.	Calanoida	Calanidae	<i>Paracalanus parvus parvus</i> (Claus, 1863)	03	02
05.	Calanoida	Calanidae	<i>Paracalanus aculeatus aculeatus</i> Giesbrecht, 1888	00	03
06.	Calanoida	Calanidae	<i>Nannocalanus minor</i> (Claus, 1863)	02	03
07.	Calanoida	Calanidae	<i>Undinula vulgaris</i> (Dana, 1849)	03	01
08.	Calanoida	Calanidae	<i>Canthocalanus pauper</i> (Giesbrecht, 1888)	04	00
09.	Calanoida	Eucalanidae	<i>Eucalanus elongates</i> (Dana, 1843)	05	01
10.	Calanoida	Subeucalanidae	<i>Subeucalanus crassus</i> (Giesbrecht, 1888)	02	00
				25	16

Note: S1. Hospital beach; S2. Udaypur beach

The dominant species in the families were Calanidae (5 spp.), Paracalanidae (2 spp.), Eucalanidae, and Subeucalanidae (1 sp.). The maximum number of species identified belongs to Calanidae (5 spp.) followed by Paracalanidae (2 spp.),

Eucalanidae, and Subeucalanidae (1 sp.) (Figure 4). The dominant species in the order were Calanoida (70%), Harpacticoida (20%) and Cyclopoida (10%) (Figure 5).

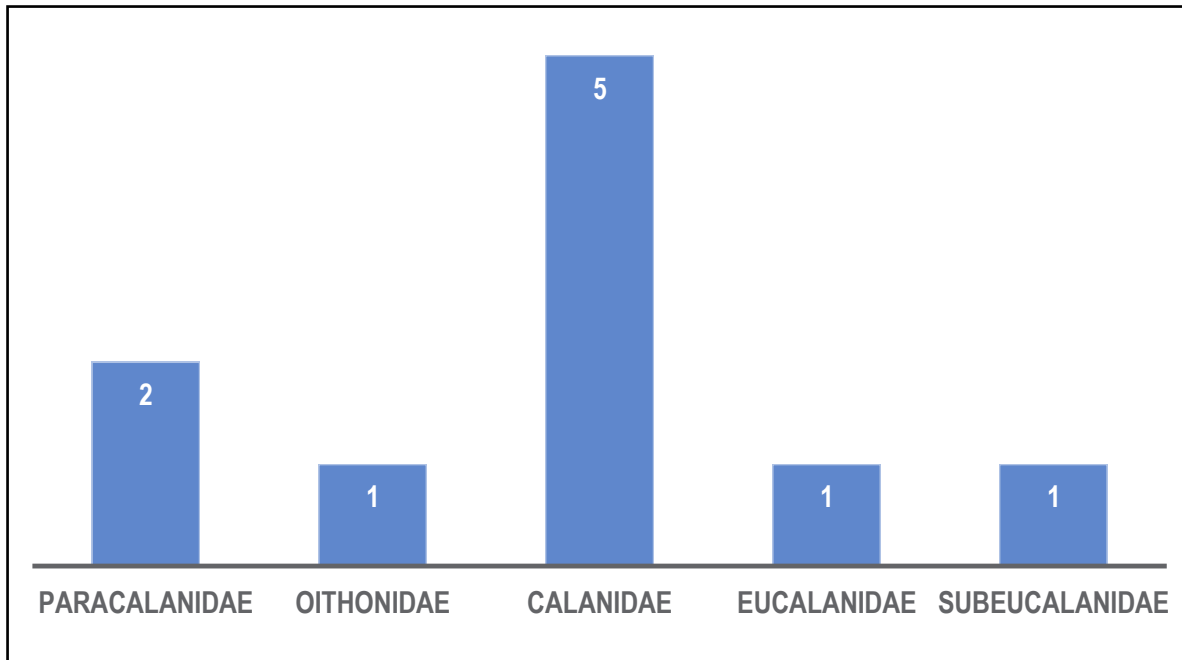


Figure 4. Relative proportion of species composition in the major families of zooplankton.

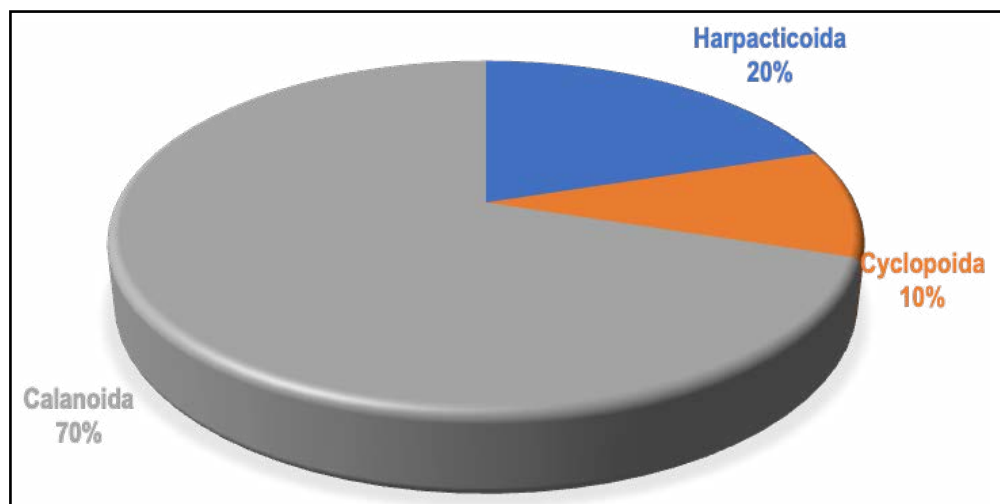


Figure 5. Relative proportion of species composition in the major orders of zooplankton.

Systematic analysis:

***Euterpina acutifrons* (Dana, 1847)**

Phylum : Arthropoda von Siebold, 1848
 Subphylum : Crustacea Brünnich, 1772
 Class : Hexanauplia Oakley, Wolfe, Lindgren & Zaharof, 2013
 Subclass : Copepoda Milne Edwards, 1840
 Infraclass : Neocopepoda Huys & Boxshall, 1991
 Superorder : Podoplea Giesbrecht, 1882
 Order : Harpacticoida Sars G.O., 1903
 Family : Tachidiidae Sars G.O., 1909
 Genus : *Euterpina* Norman, 1903
 Species : *Euterpina acutifrons* (Dana, 1847) (Figure 5).

Characters: Body onion-shaped, length of body greatly abbreviated, 5th legs rudimentary, more or less fused, unlike in the two sexes; length of female 0.35 to 0.5 mm, of male 0.3 to 0.4 m.

Habitat: Marine, tropical, neritic.

Distribution: Indo-west Pacific, West Bengal, Odisha, Kerala coast.

***Microsetella norvegica* (Boeck, 1865)**

Family : Ectinosomatidae Sars G.O., 1903
 Genus : *Microsetella* Brady & Robertson, 1873
 Species : *Microsetella norvegica* (Boeck, 1865) (Figure 5).

Characters: Body slender and laterally compressed. The urosome is as wide as metasome. Caudal rami setae nearly long as body length and divergent.

Habitat: Bathy-pelagic, epipelagic.

Distribution: Found in Hooghly estuary of West Bengal, Odisha, South-east coast of India, Southern Kerala.

***Oithona brevicornis brevicornis* Giesbrecht, 1891**

Order : Cyclopoida Burmeister, 1834
 Suborder : Oithonida Khodami, Mercado-Salas, Tang & Matrinez Arbizu, 2019
 Family : Oithonidae Dana, 1853

Genus : *Oithona* Baird, 1843

Species : *Oithona brevicornis brevicornis* Giesbrecht, 1891 (Figure 5).

Characters: Rostrum is much longer and narrower, comparatively small in size that other cyclopoids. Body has thoracic segments; the forehead is rounded dorsally. The caudal rami have 3x the width. Caudal setae are plumbed and the antennules have segments that differ in male and female.

Habitat: Marine, Subtidal, Intertidal, Euryhaline

Distribution: Indian to Atlantic Ocean, tropical and temperate Pacific Ocean, Hooghly estuary of West Bengal, Odisha.

***Paracalanus parvus parvus* (Claus, 1863)**

Order : Calanoida Sars G.O., 1903
 Family : Paracalanidae Giesbrecht, 1893
 Genus : *Paracalanus* Boeck, 1865
 Species : *Paracalanus parvus parvus* (Claus, 1863) (Figure 5).

Characters: Female *P. parvus parvus* size ranging from 0.6-1.3 mm and the male is between 0.5 and 1.4 mm.

Habitat: Marine, Eastern Mediterranean waters.

Distribution: Indo-Pacific Ocean and northeast Atlantic Ocean, Odisha, Hooghly estuary of West Bengal and Kerala coast.

***Paracalanus aculeatus aculeatus* Giesbrecht, 1888**

Characters: Cephalic region is oval shaped, short and have 4 segments. Thoracic region is uniformly segmented. Antennas are shorter than body length.

Habitat: Marine

Distribution: Indo-Pacific Ocean. Widely distributed in Odisha and North - western coast of Bay of Bengal and West Bengal coast of India.

***Nannocalanus minor* (Claus, 1863) (Figure 5).**

Family : Calanidae Dana, 1849
 Genus : *Nannocalanus* Sars G.O., 1925

Characters: Body is bilaterally symmetrical, length ranging from 1.8-2.45mm.

Habitat: Marine, pelagic.

Distribution: Indo-west Pacific and Atlantic Ocean, also found in West Bengal and Odisha coast of India.

***Undinula vulgaris* (Dana, 1849)**

Genus : *Undinula* Scott A., 1909

Species : *Undinula vulgaris* (Dana, 1849) (Figure 5).

Characters: Short cylindrical body,

Habitat: Marine pelagic.

Distribution: Western Indian Ocean, North-western Bay of Bengal, West Bengal and Odisha coast.

***Canthocalanus pauper* (Giesbrecht, 1888)**

Genus : *Canthocalanus* Scott A., 1909

Species : *Canthocalanus pauper* (Giesbrecht, 1888) (Figure 5).

Characters: Cephalic region segmented into 5 parts, Thoracic region is segmented into 6 parts,

Habitat: Tropical, Marine

Distribution: India, Northern-western coast of Bay of Bengal, West Bengal and Odisha.

***Eucalanus elongatus elongatus* (Dana, 1848) (Figure 5).**

Family : Eucalanidae Giesbrecht, 1893

Genus : *Eucalanus* Dana, 1852-1853

Characters: Elongated slender body, Antenna is longer than body length. Presence of 5 segments in Cephalic region. Thoracic region also segmented in 5 parts.

Habitat: Marine pelagic and Tropical.

Distribution: Widely distributed in the Bay of Bengal coast of West Bengal and Odisha.

***Subeucalanus crassus* (Giesbrecht, 1888) (Figure 5).**

Family : Subeucalanidae Giesbrecht, 1893

Genus : *Subeucalanus* Geletin, 1976

Characters: Cephalic region is sub-elongated and the thoracic part is short (only 3 segments). Antenna are much longer than body length. Have 21-24 segments in the antenna.

Habitat: Marine subtropical and Pelagic

Distribution: Northwest Pacific: China, India, West Bengal, Odisha.

Discussion

Zooplankton shows a higher standing crop on the west coast of India than on the east coast. The International Indian Ocean Expedition Plankton Atlas (Prasad and Singh, 1980) contains maps of the total zooplankton biomass in the Arabian Sea and the total zooplankton biomass in the Indian Ocean (Moharana and Patra, 2013). Total zooplankton biomass and the constituent species under the major taxa in relation to hydrographic conditions in the Hooghly estuarine complex were studied around Sagar Island from March 1979 to February 1981 (Sarkar *et al.*, 1986). The temperature difference is a main factor influencing the abundance of zooplankton in coastal as well as estuarine bodies of water. During the study, the salinity of the study area was found to be moderate to high (30-32ppt), according to Jayalakshmi *et al.* (2017), can be a result of a higher rate of evaporation. In the present study, the dissolved oxygen remained 6-6.4 mg/l which was under the optimum range. Total zooplankton biomass was higher in winter than in summer, and there was no significant relation between tintinnid cell number and total zooplankton biomass. It may mainly be due to the optimum temperature, light, pH, water current etc. This supports the findings of Manna *et al.* (2008) that copepods play the dominant role in total zooplankton biomass in the coastal water of Digha, and therefore, total zooplankton density is not a determinant of tintinnid distribution (Dash *et al.*, 2017). In the present study, the copepods are the most dominant zooplankton groups, which will support the captive larval feeding of marine fishes as reported by Davis, Derbes and Head (2018). Similar kinds of observations about the dominance of copepods in the total density were reported by Perumal *et al.* (2009), Fernandes and Ramaiah (2009), Jagadeesan *et al.* (2013), Jayaraj *et al.* (2014), and Jemi Job and Hatha (2018). The occurrence of higher values of copepods among the other zooplankton on the Odisha coast corroborates many earlier findings (Wellershaus, 1974; Sarkar *et al.*, 1984; Nagarajaiah and Gupta, 1985; Nair *et al.*, 1984; Padmavati and Goswami, 1996; Mishra and Panigrahy, 1999; Karuppasamy and Perumal, 2000; Qasim, 2005; Madhu *et al.*, 2007; Koppelman and Weikert, 2000). In the present study, zooplankton were found to be represented by the families Calanidae (5 spp.), Paracalanidae (2 spp.), Eucalanidae, and Subeucalanidae (1 sp.). The maximum number of species identified belongs to Calanidae (5 spp.) followed by Paracalanidae (2 spp.), Eucalanidae, and Subeucalanidae (1 sp.). The dominant species in the order were Calanoida (70%), Harpacticoida (20%), and Cyclopoida (10%). The findings have generated baseline information regarding zooplankton species diversity and taxonomy in the coastal waters of Digha, West Bengal.



Euterpina acutifrons (Dana, 1847)



Paracalanus parvus parvus (Claus, 1863)



Paracalanus aculeatus aculeatus Giesbrecht, 1888



Oithona brevicornis brevicornis Giesbrecht, 1891



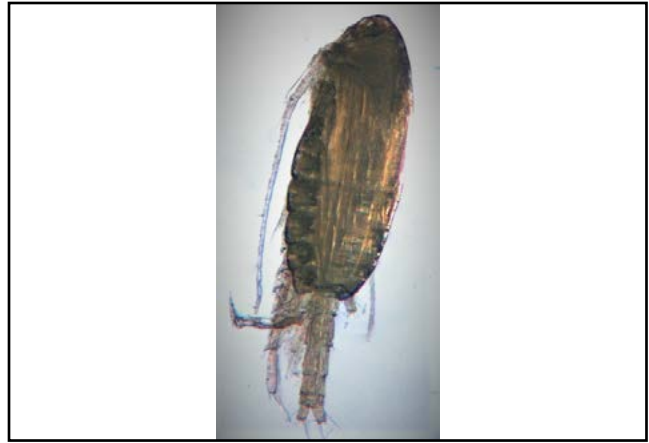
Microsetella norvegica (Boeck, 1865)



Nannocalanus minor (Claus, 1863)



Undinula vulgaris (Dana, 1849)



Canthocalanus pauper (Giesbrecht, 1888)



Subeucalanus crassus (Giesbrecht, 1888)



Eucalanus elongatus elongatus (Dana, 1848)

Figure 5. List of zooplankton species were identified.

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