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Seasonal variations of zooplankton in Shirgaon estuary of Ratnagiri, Maharashtra

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Abstract
The present study was undertaken to study the composition of zoo-plankton in relation to Physico-chemical water parameters of five sampling stations of Shirgaon estuary along the Ratnagiri coast from February 2013 to January 2014. Zooplankton and water quality parameters were investigated to changes of zooplankton community. Variation in atmospheric temperature 17.9-39.7 ^{0}C, water temperature 19.7 - 35.1 ^{0}C, pH varied from 5.3-8.1, light penetration varied from 1-24 cm, salinity varied from 0-28.7 psu, dissolved oxygen varied from 0.4-4.8 mgl^{-1}, alkalinity varied from 3-80 mgl^{-1}, nitrate varied from 0.000323-0.00154 µMl^{-1}, nitrite varied from 0.000052-0.000208 µMl^{-1}, phosphate varied from 0.00253-0.000515 µMl^{-1}, silicate varied from 0.00129-0.000503 µMl^{-1}. A of total of 12 zooplankton species were recorded comprising, 2 spp. of crustaceans, 3 spp. of tintinnids, 2 spp. of cnidarian, 1 sp. of dinoflagellate, 1 sp. of limacinidae, 1 sp. of chaetognatha and species of others i.e fish eggs and polychaete larvae.

Keywords: Zooplankton, estuary, Ratnagiri

Introduction
Estuarine and the coastal areas is complex and dynamic aquatic environment. When river water mixes with sea water, large numbers of physical and chemical process take place which may influence the water quality (Suganthi *et al*., 2018) [13]. Estuaries act as an effective nutrient trap and provide the vital source of living and nonliving resources (Thippeswamy *et al*., 2009) [15]. Estuarine environmental study has accelerated during the past two decades since estuaries support a rich pelagic, benthic communities and serves as excellent nursery and feeding grounds for many commercially important fishes and shrimps (Ganapati, 1975) [6]. They also form the centres for natural seed collection of most of the commercially important fin fishes and shell fishes suitable for aquaculture.
The planktons are two categories, the phytoplankton and zooplankton. Zooplankton are the secondary producers of the ocean (Baliarsingh *et al*., 2014) [4]. Zooplankton forms a major link in the energy transfer in the aquatic biosphere and their ecology is of considerable interest in assessing the production potential of the sea. The fishery exhibits marked fluctuations from season to season and from year to year (Jeyaraj *et al*, 2014) [8]. Zooplankton constitutes the largest ecological group organisms in the sea and play an important role in the marine food chain as intermediate link between phytoplankton and fish. The zooplanktons are more varied as compared to phytoplankton their variability in any aquatic ecosystem is influenced majority by patchiness, diurnal vertical migration and season. The faunal distribution and productivity of estuary depend on various Physico-chemical factors such as temperature, pH, salinity, DO and nutrients such as nitrate, phosphate and silicate. However, the information on zooplankton diversity from the estuarine waters of Shirgaon estuary Ratnagiri is still scanty. Hence the present study was conducted to study the zooplankton in the Shirgaon estuary, Ratnagiri, Maharashtra southwest coast of India.

Materials and Methods
The distributions of zooplankton were investigated in five stations from upper to lower reaches along the Shirgaon estuary (Map.1) at Ratnagiri, south west coast of India. The study was conducted from February 2013 to January 2014. Zooplankton samples were collected at monthly intervals at highest high tide from the surface waters of the study area. In all the five stations, samples were collected by using the 60µ standard plankton net. These samples were preserved in 5% formalin and used for qualitative and quantitative analysis

(Santhanam *et al*, 1987; Newell and Newell, 1963; AOAC, 2006 and APHA, 2005) [12, 2, 3]. The major taxonomic groups of zooplankton were determined under the light microscope with a magnification of 10x10. The species evenness, richness, diversity and index were calculated by using computer statistical software. Physico-chemical parameters such as atmospheric and surface water temperatures, light penetration in the water column, salinity, dissolved oxygen and pH were recorded during the sampling. Nutrients like inorganic phosphate, nitrate, nitrite and silicate were analysed by adopting the standard methods (Strickland and Parsons, 1972) [14].

Map 1: Sampling locations at Shirgaon estuary Ratnagiri

Results and Discussion

Physico-chemical parameters

Atmospheric temperature 17.9 (December)-39.7 ^{0}C (May), water temperature 19.7(December)-35.1 ^{0}C (April), pH 5.3 (November)-8.1(July), light penetration 1(February)-24cm (July), salinity 0 (August)-28.7psu (January), dissolved oxygen 0.4 (July)-4.8 mgl^{-1} (Feb), alkalinity 3 (September)-80 mgl^{-1} (January), Nitrate 0.000323(January)-0.00154µMl^{-1} (August), Nitrite 0.000052 (November)-0.000208µMl^{-1} (July), Inorganic phosphate 0.00253 (March)-.000515 µMl^{-1} (February), silicate. 0.00129(August)-0.000503µMl^{-1} (September).

Qualitative distribution of zooplankton

The zooplankton recorded in the present study consisted of 12 species at five stations during the February 2013 to January 2014. A of total of 12 zooplankton species were recorded comprising, 2 spp. of crustaceans, 3 spp. of tintinnids, 2 spp. of cnidarian, 1 sp. of dinoflagellate, 1 sp. of limacinidae, 1 sp. of chaetognatha and species of others i.e fish eggs and polychaete larvae.

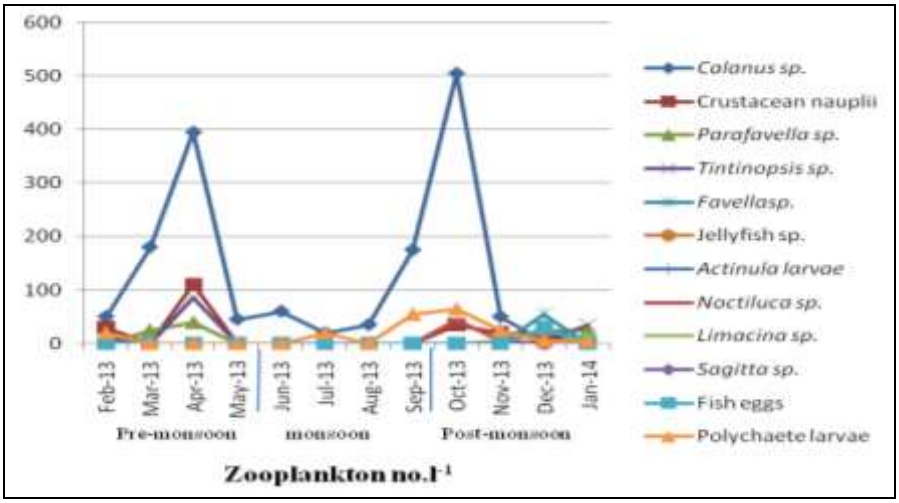
Abundance of various zooplanktons in the estuary fluctuated in accordance with salinity. Copepods which formed the major part of zooplankton were studied in detail while remaining groups were clubbed as other taxonomic group. *Calanus sp.* (Plate 1) of copepod was found abundantly during study period. The minimum population density of zooplankton during the monsoon (July) season might be due to the non-availability of food, low temperature and low salinity while the maximum population density was recorded during post-monsoon (October) season (Perumal *et al*, 2009) [11], along Tamilnadu coast. Copepod formed a major component of the zooplankton in all the samples collected from the estuarine water over the tidal cycle during post-monsoon season. In other seasons also, copepods occurred in large numbers but were not always dominant (Perumal *et al*, 2009) [11] while, crustacean larvae was recorded only once in monsoon period. Crustacean nauplii (Plate 2) was found in two seasons i.e. pre-monsoon and post-monsoon. In the present study, *Tintinopsis sp*., (Plate 5) *Favella sp.* (Plate 4) and *parafavella sp.* (Plate 3) were observed in the pre-monsoon and post-monsoon seasons (Godhantaraman, 2001). Polychaete larvae (Plate 12) was recorded only once in all the three seasons while *Actinula* larvae sp. (Plate 8) was found only once in the pre-monsoon season. *Noctiluca sp.* (Plate 9) was found in post-monsoon season. Among Anthomedusae, jellyfish sp. (Plate 7) was found only once in the post-monsoon season. There was no any specific trend in zooplankton variations (Graph 1). In the present study, chetognath, *Sagitta sp.* (Plate 6) was observed only once in the pre-monsoon in the month of February at lower stretch. (Patil, 1997) [10]. Polychaetes larvae were observed in the monsoon and post-monsoon season (Patil, 1997) [10]. In the present study, *Limacina sp*. (Plate 10) was observed only once in the month of January (post-monsoon) at the lower reach of the estuary (Bhattacharjee *et al* 2006) [5]. In the present study, fish eggs (Plate 11) were observed in the month of October at lower season (Achuthankutty *et al*) (1981) [1] (Table. 1) (Graph 1).

Table 1: Seasonal variations of zooplankton species recorded in Shirgaon estuary during 2013-14

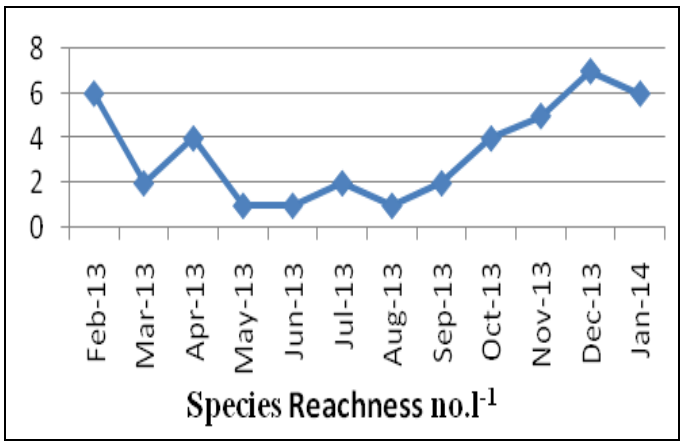
	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14
Calanus sp.	+	+	+	+	+	+	+	+	+	+	+	+
Crustacean nauplii	+	-	+	-	-	-	-	-	+	+	+	-
Parafavella sp.	-	+	+	-	-	-	-	-	-	-	+	+
Favellasp.	-	-	-	-	-	-	-	-	-	-	+	-
Tintinopsis sp.	+	-	+	-	-	-	-	-	-	-	+	+
Jellyfish *sp.*	-	-	-	-	-	-	-	-	-	+	-	-
Actinula larvae	+	-	-	-	-	-	-	-	-	-	-	-
Noctiluca sp.	-	-	-	-	-	-	-	-	+	+	-	+
Limacina sp.	-	-	-	-	-	-	-	-	-	-	-	+
Sagitta sp.	+	-	-	-	-	-	-	-	-	-	-	-
Fish egg	-	-	-	-	-	-	-	-	-	-	+	-
Polychaete larvae	+	-	-	-	-	+	-	+	+	+	+	+

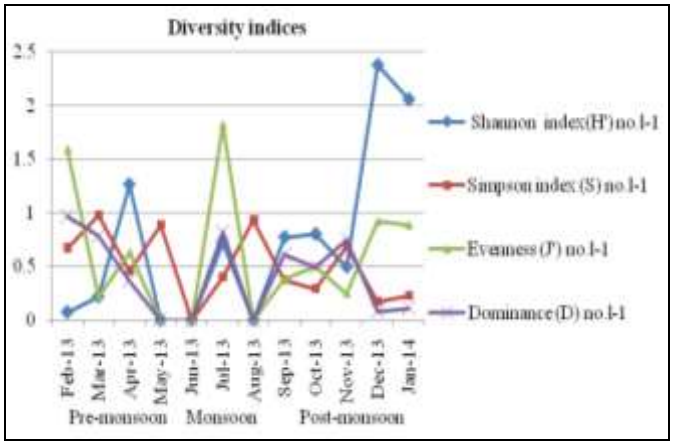
(-) Absent (+) Present

The species richness was maximum in the month of December (7 no.l^{-1}) and minimum in the month of May, June, August (1 no.l^{-1}). Shannon index (*H'*) ranges from 0 (May and August) to 2.3789 no.l^{-1} (December).The Simpson index (*S*) ranges from 0 (June) to 0.9762 no.l^{-1} (March). The Evenness index (*J'*) ranges from 0 (May and August) 1.8206 no.l^{-1} (July). The Dominance index (*D*) ranges from 0 (May,June and August) to 0.9686 no.l^{-1} (February) (Graph 2,3).



Graph 1: Seasonal qualitative variations of zooplankton recorded during 2013-14





Graph 2, 3: Seasonal variations of zooplankton richness, species diversity and evenness recorded during 2013-14

Zooplankton
Crustaceans

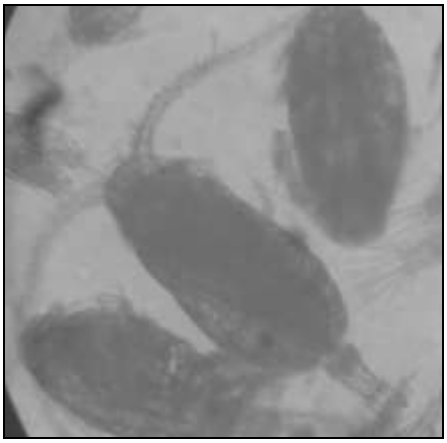


Plate 1: *Calanus sp.* 40X × 10X

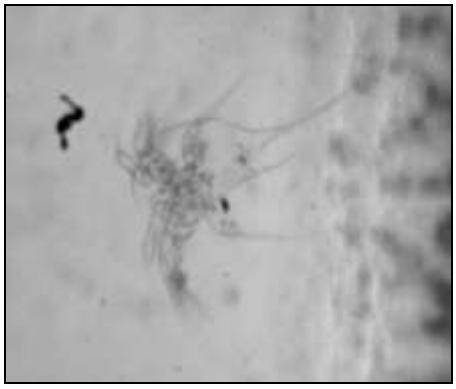


Plate 2: Crustacean nauplii 40X × 10X

Tintinnids

Plate 3: *Parafavella sp.* 10X × 10X

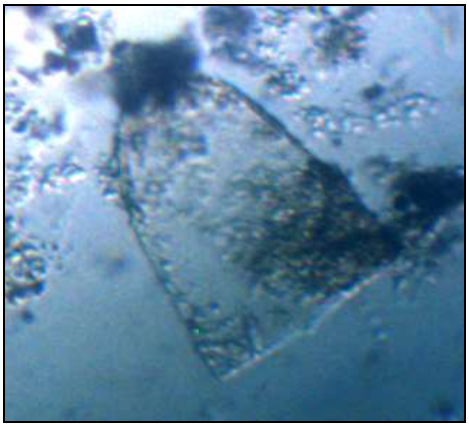


Plate 4: *Favella sp.* 10X × 10X

Plate 5: *Tintinnopsis sp.* 10X × 10X

Chaetognatha

Plate 6: *Sagitta sp.* 10X × 10X

Cnidarian

Plate 7: Jellyfish *sp.* 40X × 10X

Plate 8: Actinula larvae 10X × 10X

Dinoflagellates

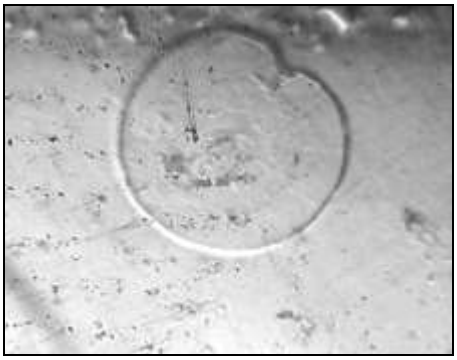


Plate 9*: Noctiluca sp.* 40X × 10X

Limacinidae

Plate 10: *Limacina sp.* 40X × 10X

Others

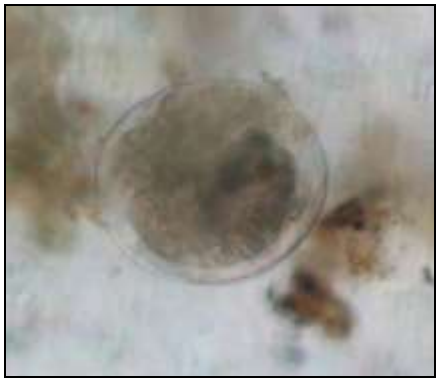


Plate 11: Fish egg 40X × 10X

Plate 12: Polychaete larvae 40X × 10X

Conclusion

The present investigation suggest that the baseline information on the zooplankton is useful for preparing data sheet on fish production report of Shirgaon area. The present report on zooplankton provides the baseline information for future ecological assessment and monitoring of the Shirgaon, Ratnagiri coastal area.

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