Seasonal variations of Zooplankton distribution with relation to water quality parameters off Godavari Estuary, Andhra Pradesh

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Abstract: Zooplankton abundance and diversity of zooplankton with relation to physicochemical parameters in five stations at off Godavari estuary, Bay of Bengal during October 2010 to May 2011. A total of 29 samples were collected from the five stations, whereby 19 zooplankton groups belonging to six phylum were identified. Among the groups, Copepoda was the most dominant and abundant group which contributed 54.17%-72.73% of the total zooplankton population. Zooplankton holds a key position in the food web as it was directly related to the consumption of organic energy produced by phytoplanktonic photosynthesis and then by transforming it to the higher tropical levels of hetirotropes such as fish. This disappearance may be due to the fact that some species occur in spores, under favorable conditions spore germinate and appear as zooplankton. Plankton diversity and physicochemical parameters of water are important criteria for evaluating the suitability of water for culture practices. Therefore, structure of different fish food organisms assumes greater significance to fisheries management.

Key words: Water Quality parameters, Zooplankton groups and Godavari Estuary

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1. Introduction

Zooplankton plays a vital role in aquatic food webs because they are important food for fish and invertebrate predators and they graze heavily on algae, bacteria, protozoa and other invertebrates. They are too small to be important as food for most fish. They might be important in diets of some larval fish. Plankton occupies a significant and exceptional position in the biotic world for their essential role in the aquatic ecosystem. Though they are very small or tiny their absence might show the way the entire life processes in the aquatic ecosystem specially the animal life to a halt. Phytoplankton play a vital role in synthesizing light energy into food while the zooplankton are consumers of phytoplankton and these zooplankton are subsequently being eaten by other animals in their trophic interrelationships. Zooplankton plays an indispensable role in the aquatic ecosystem. Zooplanktons are the primary consumers in the trophic level which directly or indirectly comprises major protein source of all fishes. The function of zooplankton in upwelling systems is receiving growing attention primarily because of its function in phytoplankton graze, carbon cycling and nutrient recycling. In coastal waters, zooplankton exhibit uneven distribution at scales of 10–100 km. This spatial variability reflects the complex physic-chemical and biological processes related with flow zones (Verheye et al. 1992). Though significant information is available on the interaction of zooplankton with upwelling/plumes from temperate waters (Bradford et al. 1993; Baduini 1997;

Vargas and González 2004;Foster and Battaerd 1985; James and Wilkinson 1988;), studies dealing with tropical systems continue to remain fragmented (Hitchcock et al. 2002; Lo et al. 2004;Boyd and Smith 1983). They participate an important role in the conservation of energy from primary producer (phytoplankton) to upper trophic levels. The zooplankton incidence and distribution influence pelagic fishery potentials. Thus, they are the initial prey for most fish larvae as well as for many plankton-eating adult fishes. In aquaculture sector, zooplankton is good food source for cultured fish especially fry, fingerlings and juveniles. Indeed, zooplankton is used as one of the bioindicators for accessing aquatic ecosystem health. The zooplankton are additional varied as compared to phytoplankton, their variability in any aquatic ecosystem is prejudiced mainly by roughness, diurnal vertical passage and seasons.

2. Materials and Methods

The Study was conducted two conjugative seasons i.e from October 2010 to May 2011. The sampling stations at Godavari Estuary at 10 to 21 km distance from Yanam at 20, 30, 50, 75 and 100 m isobaths. The latitude and longitude of stations 1-5 of 16° 45' 55" N and 82° 28' 44" E. Zooplankton samples were collected using a Bongo net hauled horizontally behind the boat at 2-3 knots. The Collected concentrated zooplankton samples were preserved by adding 5% formaldehyde for identification and counting (ind m^{-3}) (Wickstead 1965; ICES 2000). Water samples collected with a Niskin sampler from sub surface area. water temperature was measured using a mercury-filled thermometer (Brannan 0.1°C). Salinity (ppt), (Winkler) dissolved oxygen (ppm), and inorganic nutrients (µM) nitrate and nitrite-N (Azo dye method), phosphate-P (ascorbic acid) and silicate-Si (silico-molybdic acid) were analyzed using methods in Parsons et al. (1984).

Hydrographical parameters at Godavari estuary during October 2010- May 2011

	Chl a	DO	Salinity	SST	Tr.	pH	NO3-	NO2-	NH4+	PO4	SiO4
	3.4-12.4	220.5-225.1	0.9-1.3	28.9-29.9	0.4-1.0	7.6-8.0	1.3-3.6	0.3-2.7	5.5-6.1	0.4-0.8	167.4-235.1
Oct	(6.6±3.8)	(222.6±1.8)	(1.1±0.2)	(29.5±0.4)	(0.6±0.3)	(7.8±0.2)	(2.1±1.0)	(1.05±1.06)	(5.7±0.2)	(0.6±0.1)	(207.5±27.4)
	11.3-13.5	260.7-288.2	0.9-6.3	29.4-29.8	0.6-0.9	8.1-8.3	19.1-30.4	0.2-0.4	3.8-6.7	0.2-0.3	241.8-362.9
Nov	(12.6±0.9)	(271.8±11.4)	(3.3±2.1)	(29.6±0.2)	(0.7±0.1)	(8.2±0.1)	(22.6±4.9)	(0.3±0.1)	(5.2±1.2)	(0.2±0.1)	(295.7±54.5)
	11.2-13.8	207.0-303.5	1.8-23.9	27.3-27.9	0.7-1.2	8.0-8.5	5.5-6.2	0.4-1.0	3.0-4.8	0.28-0.34	47.7-207.3
Jan.11	(12.4±1.0)	(238.2±41.0)	(16.4±9.2)	(27.5±0.3)	(0.9±0.2)	(8.1±0.2)	(5.8±0.3)	(0.7±0.2)	(3.6±0.8)	(0.31±0.02)	(104.7±65.9)
	3.6-6.5	144.4-214.1	15.0-34.5	30.0-30.3	1.2-2.1	8.0-8.2	4.3-7.7	0.4-0.6	2.5-3.3	0.4-0.9	7.5-77.5
Mar.09	(5.0±1.3)	(175.5±27.5)	(29.2±8.8)	(30.1±0.1)	(1.6±0.4)	(8.1±0.1)	(6.3±1.4)	(0.5±0.1)	(2.9±0.4)	(0.6±0.2)	(25.2±32.3)
	4.8-7.4	159.4-209.2	13.9-29.1	31.5-32.0	0.7-1.1	7.9-8.1	2.2-3.6	0.4-1.2	2.6-5.2	0.6-1.2	17.7-86.0
Apr.	(6.3±1.0)	(177.4±21.2)	(24.6±6.7)	(31.7±0.2)	(0.9±0.1)	(8.0±0.04)	(3.0±0.5)	(1.0±0.4)	(4.3±1.1)	(0.8±0.3)	(36.7±30.5)
	4.6-12.2	179.3-194.2	1.7-22.1	31.0-32.5	0.6-1.3	7.9-8.4	2.7-4.1	0.2-1.2	1.0-3.9	0.4-0.7	14.2-222.2
May	(7.7±3.1)	(188.6±6.1)	(15.3±8.5)	(31.8±0.6)	(0.9±0.3)	(8.2±0.2)	(3.4±0.5)	(0.8±0.4)	(2.3±1.1)	(0.5±0.1)	(72.2±92.8)

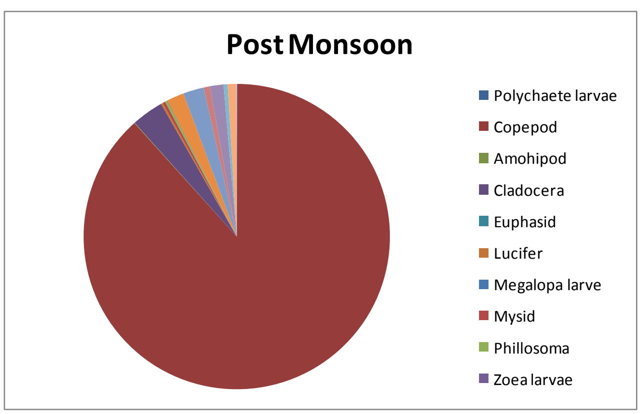
Zooplankton abundance (Mean, ind m^{-3}**) at off Godavari estuary during October 2010-May 2011**

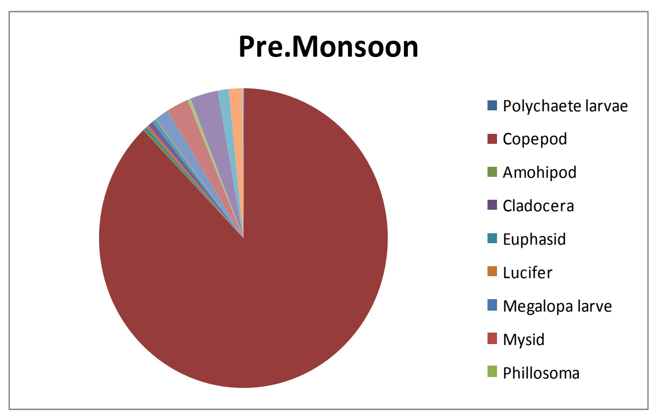
Phylum	Name	Post Monsoon Oct., Nov., & Jan	Pre.Monsoon March, Apr., & May
Annelida	Polychaete larvae	0.1	0.3
Arthropoda			
	Copepod	132.5	248.5
	Amohipod	0.1	0.4
	Cladocera	5.1	0.0
	Euphasid	0.0	0.8
	Lucifer	0.3	0.8
	Megalopa larve	0.0	0.1
	Mysid	0.4	0.0
	Phillosoma	0.4	0.0
	Zoea larvae	0.1	1.6
	Mysis	0.0	1.1
	Ostracoda	2.7	0.3
Mollusca	Gastropoda	3.3	4.4
	Pteropod	1.0	7.1
	Bivalves	0.0	1.0
Echinodermata			
Chaetognatha	Sagitta	2.1	8.8
Chordata	Oikoplura	0.6	3.5
	Fish eggs	1.4	4.3
	Fish larvae	0.1	0.3

3. Results and Discussion

The hydrographical parameters of zooplankton communities together form a inclusive environment and there is interaction between the zooplankton and phytoplankton. These communications are straight or indirectly subjected to the complex influences (Basawarajeshwari, *et al.,* 2015). Zooplankton was represented by Copepods, Cladocera and Gastropoda . Among the plankton Copepods was dominated and followed by Sagitta and Pteropod. In the phylum Arthropoda recorded 11 species and 3 species represented in phylum Mollusca. The second-largest phylum of invertebrate is Mollusca after the Arthropoda. During the study period quantitative and qualitative variations of zooplankton was observed (Table 1). Highest Zooplankton groups observed in the pre-monsoon periods whereas lowest number in the post monsoon period (Fig.1). Similar results observed by (Mukherjee, 2011). In the ecosystem, zooplankton plays a main role as they consume the phytoplankton and form a major food source for tertiary producers.

The zooplankton assemblage inhabiting brackishwater, mostly comprises representative of Arthropoda and Mollusca groups. The zooplanktons frequently respond straight away to environmental changes because most of the species have short production times. Zooplankton considered as the basic principle natural fish food for young and some adults of organisms, which hold fish production (El-Serafy *et al.*, 2009). Epifanio and Garvine (2001) studied by the variation of their spatial distribution, based on different factors. The higher population density of the zooplankton is during the pre-monsoon period while low population density observed in the post monsoon. Among the plankton Copepod is dominated. The zooplankton populations dominated by copepods in the dry season are observed by Egborge (1981). The high population density in the pre-monsoon period may be as a result of abundant food sources from the runoff. The increase of primary production (phytoplankton) is accompanied by increase in zooplankton abundance reported by Rocha *et al.*, 1999. Muylaert *et al.*, (2003) observed that the zooplankton abundance frequently reach their peak during the dry season in the estuarine ecosystem. Besides food source, low predation rate by fish during wet season caused by plankton growing activity, could support by high density of zooplankton (Ikpi *et al.*, 2013). Higher zooplankton population density in summer might be due to the temperature acceleration in the Godavari estuary (Ikpi *et al.*, (2013) reported that the seasonal variation in zooplankton condition could larger be due to the copepoda which normally constitute major food items of larger zooplankton. The air temperature ranged from 25.8°C -32.5°C and highest temperature recorded in the month of May, 2011(Fig.2). The one of the important environment factor is temperature, since it is influencing the distribution of plankton. The India in influenced by two monsoon i.e. south west monsoon and northwest monsoons.





Zooplankton abundance (Mean, ind m^{-3}**) at off Godavari estuary during Post Monsoon and Pre Monsoon 2011**

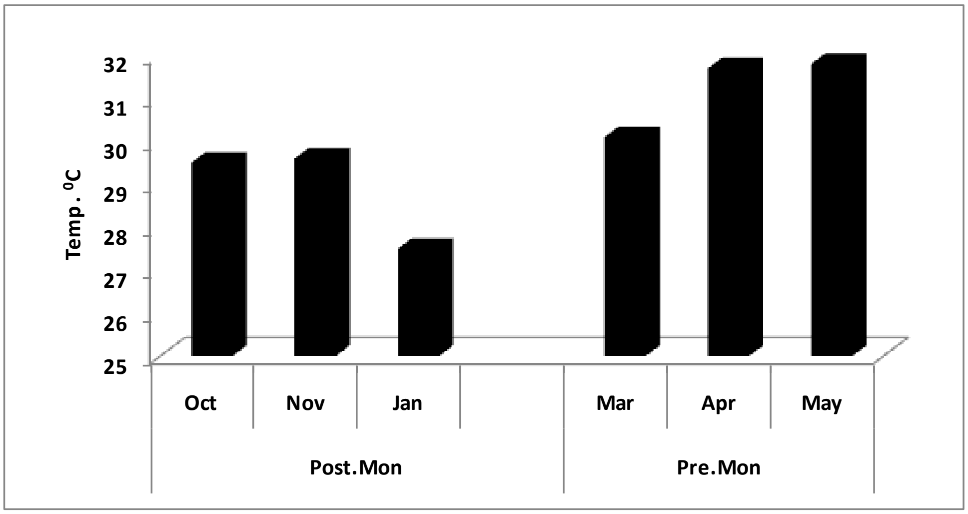


Fig.2Temperature (Mean) at off Godavari estuary during Post Monsoon and Pre Monsoon 2011

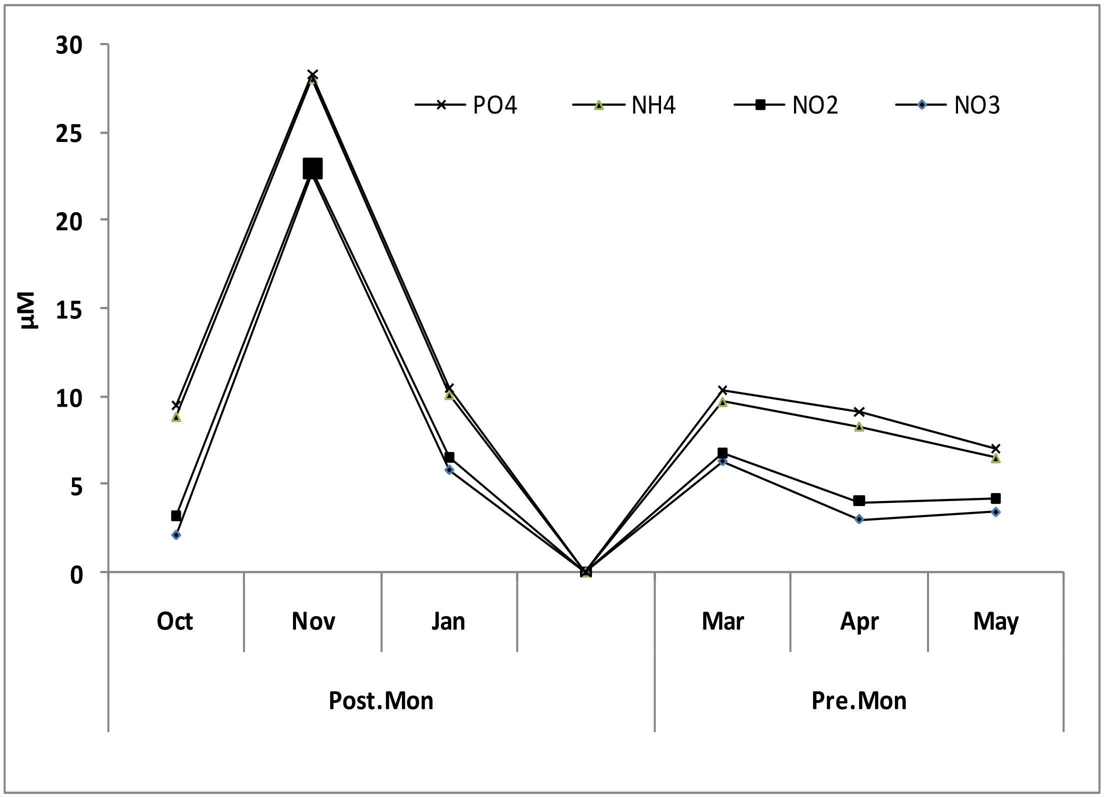


Fig. 3: Seasonal observations of Nutrients (NH_4, NO_2, NO_3 and PO_4) during Post Monsoon and Pre Monsoon 2011

The lowest value of reading observed during summer (October and November, 2010). The low species diversity was observed post monsoon season which could be attributed to heavy freshwater influx and low salinity (Godhantaraman, 1994). The turbidity during this season may also responsible for lower values.

Dissolved oxygen was observed in between 44.4 to 303.5 µM and lowest recorded in month of March, 2011. Lower dissolved oxygen values occurred during dry season could maybe due to higher temperatures during summer months. Dissolved oxygen distribution provides a good index of productivity and quality of surroundings. Consumption of high oxygen indicative of higher photosynthetic efficiency and plankton production. Rajgopal (2010) reported that the abundance of phytoplankton which enriched water with high dissolved oxygen during photosynthesis. Dissolved oxygen is a sole of the physicochemical parameters of the water which need to keep the organisms alive and health of the water body of ecosystem (Madhusudhana and Krishna, 2013).

The pH value ranged between7.6-8.5 lowest recorded in the month of October whereas highest recorded in the month of January (North East monsoon). Indication of low level of water and high photosynthesis resulting in high production of free CO_2 during the equilibrium towards high value of pH (Siddamalayya and Pratima, 2008). In the present, study months of January and November goes to above 8.5 pH which indicates that the water is a highly production of zooplankton population. In the environment inorganic nitrogen occurs in a range of oxidation status as Nitrate (NO3) and Nitrite (NO2), the ammonium ion (NH4+) and molecular Nitrogen (N2). It is under goes biological and non-biological transmission in environment as part of nitrogen cycle. In the present study Nitrite in between 0.1-2.7 µM; Nitrate in-between 1.3 to 30.4 µM and Ammonia goes to 1.0 to 15.3 µM in the study period.

Changes in water quality of water body have major effect on structure of zooplankton assemblages that can potentially affect the functioning of ecosystem (Sousa *et al.,* (2008). Seasonal distribution of the population structure of zooplankton in connection with physicochemical parameters Sarkar and Chaudhary (1999). Hence, Zooplankton communities of numerous water bodies have been used as indicators for the status of the ecosystem (Jeppensen *et al.,* 1999; Ramchandra and Solanki, 2007) and related with the concentration of total nitrogen, total phosphorus, algal biomass and the density and size of individuals (Giselle and Bruce, 2007). The inconsistency observed in the movement of zooplankton is due to abiotic parameters. In the aquatic ecosystem plankton play a critical role not only in converting plant food to animal food but also serves as source of food for their organisms (Rajashekhar *et al.,* 2010). In the present study observed that a total of 16 zooplankton species were recorded comprising of 9 rotifera, 3 cladocera and 4 coppepods. Copepoda The present preliminary study conducted that the various zooplankton composition. Copepoda constitute higher species abundance, the overall diversity index shows eutrophic nature. Further, detailed investigation through regular monthly sampling with more quantitative analysis to conform the exact status of water body is required which would help to conserve the zooplankton diversity and water quality.

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