Preliminary Studies on the Occurrence and Abundance of Zooplankton Major Taxa in Keamari, Karachi- Backwaters

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Abstract: A preliminary study was conducted on the occurrence and abundance of zooplankton in the Karachi backwaters. Zooplankton sampling was conducted on monthly basis and the study was carried out on the basis of three seasons including pre-monsoon (January to May), monsoon (June to September) and post-monsoon (October to December) from a permanent station Napier Mole bridge (24°50'34''.90 N, 66°59'17''.55 E) during June 1996 to May 1998. The hydrographic parameters including air temperature (°C), water temperature (°C), salinity (ppt), dissolved oxygen (mg/L), pH, and transparency (cm) were recorded. Total 14 groups of zooplankton were recorded; hydromedusae, copepoda, mysids, amphipoda, acetes, lucifer, chaetognath, penaeid pl, caridean pl, zoea, megalopa, squilla larvae, fish larvae, fish eggs and others. Pre-monsoon season shows highest number of individuals and copepods were found to be the dominant group in all seasons. Zooplankton diversity, equitability and margalef index were measured seasonally. Highest shannon – wiener diversity index H' = (1.83), equitability E= (0.69) and margalef species richness Index d= (1.37) were measured in post-monsoon season. Statistical analysis (ANOVA) was performed in between seasons and zooplanktonic groups. No significant difference (at P>0.05, 0.148) was observed between zooplankton and seasons.

Keywords: Zooplankton, abundance, major taxa, Keamari Karachi-Backwaters.

INTRODUCTION

The term zooplankton refers to minute organisms found in all aquatic ecosystems (oceanic and fresh water). They are the intermediate link in the aquatic food-web and responsible for transfer of energy derived from the phytoplankton to the higher trophic levels. Zooplankton community comprises of both primary consumers (those eat phytoplankton) and secondary consumers (those feed on the other zooplankton) [1]. Almost all fish groups depend on zooplankton for food during their larval phases and some continue to feed on zooplankton in their entire lives [2]. According to Murugan *et. al*., (1998) [3] and Dadhich zooplankton play an integral role and serves as bioindicators and it is a wellsuited tool for understanding water pollution status [4, 5]. In marine ecosystem zooplankton constitute an amazing and diverse group of organisms represented by most of the animal phyla – from porifera to chordate (Cnidaria, Annelida, Arthropoda, Mollusca and Chordata). Either they permanently spend their life span as zooplankton and termed as holoplankton (e.g. copepods, petropods, ostracods, euphausiids, salps and chaetognaths) or spend part of their life cycle, specially egg or larval stages as zooplankton and referred as meroplankton (e.g. shrimps, crabs, starfish, barnacles, squids and fish).

Zooplankton plays a major role in the functioning and the productivity of aquatic ecosystems through its impact on the nutrient dynamics and its key position in the food web [6]. Sea is believed to harbor one-third of the world's marine biodiversity [7], making it an important area for the ecosystem. The general feature of tropical zooplankton is that composition [8-10] but recent investigations in tropical regions have revealed the significance of zooplankton seasonal variation [11, 12]. The aquatic ecosystems are affected by several health stressors that significantly deplete biodiversity.

The Arabian Sea is bordered by Pakistan to the north, by India to the east, and the Arabian Peninsula to the west. As a part of the Northern Indian Ocean, is known for its seasonality characterised by reversing summer and winter monsoonal wind patterns and associated upwelling. Reversal in surface circulation during monsoons [13,14], seasonality in the nutrient distribution [14], and irradiance [15] have important effects on the primary production in the Arabian Sea. The reversal of monsoon winds changes the circulation pattern of the Arabian Sea, which can drive seasonality in abundance of phytoplankton, the primary producers of the marine food webs [16].

Many workers have studied the composition and structure of zooplankton in coastal waters of Pakistan including [17-33].

Species richness, or the number of species, is currently the most widely used diversity measure. The

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species diversity and abundance of the community structure of the zooplankton is necessary to assess the potential fishery resource of a place [34]. The global distribution of species diversity and richness has been of interest to naturalists for centuries and remains an important research topic in ecology today [35]. Quantifying patterns of biodiversity can be costly and challenging, particularly in the oceans where most taxa cannot easily be seen and many species are highly mobile with large ranges that extend far into the open oceans [36]. Diversity is a community attribute related to stability, productivity, trophic structure [37-39], and migration [40-42].

The present study was aimed to describe seasonal composition and abundance of major zooplanktonic groups from Napier Mole Bridge in the Karachi backwaters during June 1996 to May 1997.

MATERIALS AND METHODS

Sampling Strategy and Laboratory Methods

Zooplankton sampling was conducted on monthly basis and the study was carried out on the basis of three seasons including pre-monsoon (January to May), monsoon (June to September) and post-monsoon (October to December) Napier Mole bridge, 24°50'34''.90 N, 66°59'17''.55 E) during June 1996 to May 1997 (Figure **1**). Horizontal Towing of 10 minutes haul was done at a constant speed of 0.5 m/s in the surface waters during high tide, using a Hydrobios Ring trawl net of 500 µ mesh size. Hydrobios digital flow meter was used to record the volume of water filtered through the net. Samples were immediately preserved in 5% buffered formalin in the field and kept in plastic containers.

In the laboratory, samples were split into aliquots (sub samples) with the help of sample splitter. Sub samples were sorted out into different major taxonomic groups, identified and counted in counting tray under a stereomicroscope (Nikon SMZ 10). The keys and identification references used were obtained from (Newell and Newell, 1977) [43].

Statistical Analysis

Community Structure Analysis

i. Shannon and Weaver Diversity Index

The comparison of zooplankton diversity at both the stations were analyzed by using, the Shannon – Wiener diversity index (1949):

Diversity index = H = – ∑ Pi In Pi

where Pi = S / N

S = number of individuals of one species

N = total number of all individuals in the sample

In = logarithm to base e

ii. Margalef's Index

Margalef's index [44] was applied to analyze the relationship between the number of zooplankton

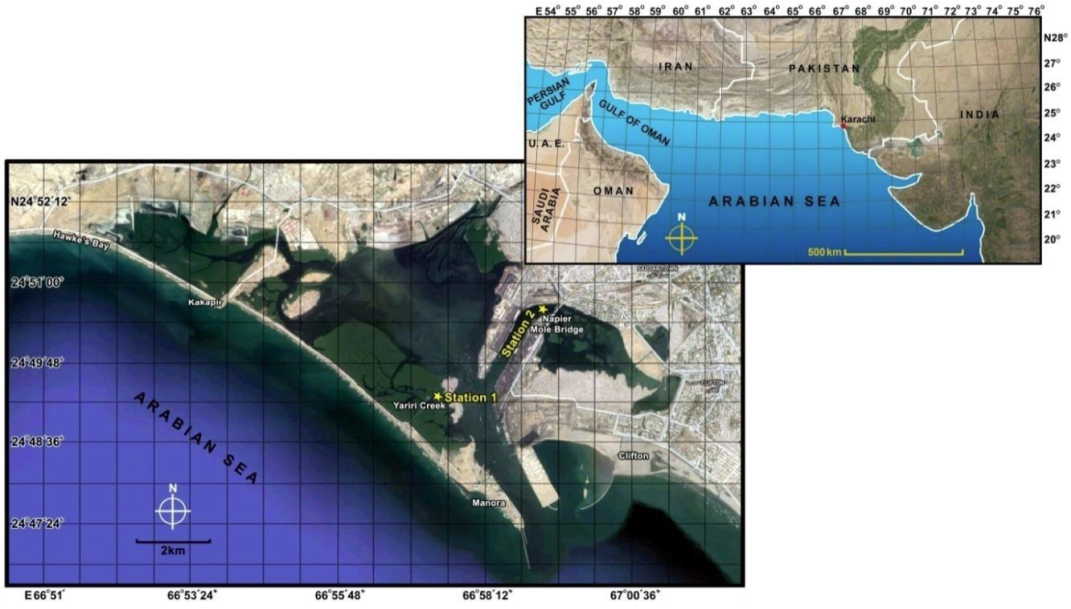

Figure 1: Map showing Karachi Back waters along with the station #: Napier Mole bridge (Lat 24°50'34''.90 N, Long 66°59'17''.55 E).

groups and individual numbers with their distribution based on abundance.

Margalef's index = (S – 1) / ln N

S = total number of species

N = total number of individuals in the sample

ln = natural logarithm

iii. Equitability or Equitability

The Pielou's Equitability Index (e) (Pielou, 1966) was applied to exemplify the pattern of distribution of individuals between major groups.

e = H / ln S

H = Shannon – Wiener diversity index

S = total number of species in the sample

Analysis of Variance (ANOVA)

IBM SPSS Statistics 20 version with a 5% significance level was used to determine possible seasonal and spatial differences in zooplankton. The difference between season and locatlites was performed through Tukey test (significant at $P< 0.05$) followed by Tukey post hoc comparisons for the source of statistically significant difference [46].

RESULTS AND DISCUSSION

Physico-chemical parameters and zooplanktonic groups were collected on seasonal basis including pre-monsoon (January to May), monsoon (June to September) and post-monsoon (October to December) from Napier Mole bridge, 24°50'34''.90 N, 66°59'17''.55 E) during June 1996 to May 1997. The results of physico-chemical parameters shown in (Table **1**). Highest mean value of air temperature (28.33±1.52 ºC) and water temperature (26.83±1.04 ºC) was recorded in monsoon season whereas lowest mean value (23.12±4.07 ºC) and (22.25±3.79 ºC) was measured in post-monsoon season. Highest mean value of salinity (38.60±1.34 ‰) was observed in pre-monsoon season and lowest mean (37.33±0.57‰) was recorded in monsoon season. In dissolved oxygen highest mean (5.68±0.75 mg/L) was recorded in pre-monsoon season and lowest (5.35±0.55 mg/L) were recorded in post-monsoon season. Highest mean of pH (7.95±0.10) were recorded in post-monsoon season and lowest (7.80±0.20) was measured in monsoon season. In transparency highest mean (53.25±26.62 cm) was recorded in post-monsoon season and lowest (41.66±7.63) were recorded in monsoon season.

Table **2** shows seasonal variation in abundance of major zooplankton groups in numbers /100m ^{3} Highest number of zooplankton (n=33713/100m^3) were collected in pre-monsoon season and lowest number (n=12702/100m^3) were collected in post-monsoon season. Highest number of individuals were recorded as; copepoda (n=10903/100m^3), mysids (n=1779 /100m^3), amphipoda n=477/100m^3), acetes (n=101/100m^3), chaetognath (n=8009/100m^3), penaeid pl (n=737/100m^3), zoea (n=4590/100m^3), megalopa (n=783/100m^3), squilla larvae (n=559/100m^3) and fish eggs (n=1068/100m^3) in pre-monsoon season however, hydromedusae (n=1266/100m^3), lucifer n=1823/100m^3), caridean pl (n=986/100m^3) and fish larvae (n=777 /100m^3) were recorded in monsoon season.

Relative abundance and composition (%) of zooplanktonic groups were presented in (Table **3**, Figure **2**). Copepod shows highest composition in all seasons of the year. Highest abundance (34.57%) was recorded in copepods and lowest (0.03%) was recorded in acetes during monsoon season.

Total composition of zooplanktonic groups following order as; Copepod=(32.81%)>chaetognath=(16.41%)> zoea=(14.41%)>lucifer=(7.19%)>hydromedusae = (5.44%)>mysids=(4.77%)>megalopa=(3.08%)>caridea n=(3.03%)>fish larvae =(2.46%)>fish eggs =(2.24%)> penaeid PL=(1.77%)>squilla larvae=(1.19%)> amphipoda=(1.18%)>acetes= (0.33%) (Table **3**, Figure **3**).

Table **4** shows mean and standard deviation in major zooplanktonic groups. Highest mean (6781.00±3630.98) were recorded in copepod and lowest (69.00±54.56) were recorded in acetes (Figure **4**). Zooplankton diversity, equitability and margalef index were measured seasonally from (Napier Mole Bridge). Highest shannon – wiener diversity index H' = (1.83), equitability E= (0.69) and margalef species richness Index d= (1.37) were measured in post-monsoon season, However lowest diversity index H' = (1.54), equitability E= (0.58) and margalef species richness Index d= (1.24) were measured in pre-monsoon season (Table **5**).

Statistical analysis was performed in between seasons and zooplanktonic groups. No significant difference (ANOVA, P>0.05, 0.148) was observed in between zooplankton and seasons. Tukey test (P>0.05) were performed in between zooplankton and

Table 1: Seasonal Mean (±) and Standard Deviation (SD) of Physico-Chemical Parameters Observed at Station (Napier Mole Bridge) during June 96-May 97

Seasons	Air Temperature (°C) Mean ± SD (Min-Max)	Water Temperature (°C) Mean ± SD (Min-Max)	Salinity (‰) Mean ± SD (Min-Max)	DO mg/L Mean ± SD (Min-Max)	pH Mean ± SD (Min-Max)	Transparency (cm) Mean ± SD (Min-Max)
Monsoon	28.33±1.52 (27.00-30.00)	26.83±1.04 (26.00-28.00)	37.33±0.57 (37.00-38.00)	5.46 ±0.50 (5.00-6.00)	7.80±0.20 (7.60-8.00)	41.66±7.63 (35.00-50.00
Post-Monsoon	23.12±4.07 (18.00-27.00)	22.25±3.79 (17.5-26.00)	38.00±1.63 (36.00-40.00)	5.35±0.55 (4.80-6.00)	7.95±0.10 (7.80-8.00)	53.25±26.62 (30.00-90.00)
Pre-Monsoon	24.2±3.96 (19.00-28.00)	22.7±3.91 (18.00-26.5)	38.60±1.34 (37.00-40.00)	5.68±0.75 (4.80-6.60)	7.88±0.10 (7.80-8.00)	43.60±13.68 (30.00-65.00)
Total	24.87±3.88 (18.00-30.00)	23.58±3.68 (17.5-28.00)	38.08±1.31 (36.00-40.00)	5.51±0.59 (4.80-6.60)	7.88±0.13 (7.60-8.00)	46.33±17.28 (30.00-90.00)

Table 2: Seasonal Variation in Abundance of Major Zooplankton Groups in Numbers /100m ^{3}at Station (Napier Mole Bridge) during June 96-May 97

MAJOR TAXA	No. of individuals/100m^3 in	No. of individuals/100m^3 in	No. of individuals/100m^3 in	Total no. of individuals/100m^3
	(Monsoon)	(Post-monsoon)	(Pre-monsoon)	
Hydromedusae	1266	939	1173	3378
Copepoda	5384	4056	10903	20343
Mysids	700	483	1779	2962
Amphipoda	29	226	477	732
Acetes	6	100	101	207
Lucifer	1823	1450	1185	4458
Chaetognath	741	1426	8009	10176
Penaeid PL	176	187	737	1100
Caridean PL	986	478	417	1881
Zoea	2485	1863	4590	8938
Megalopa	375	755	783	1913
Squilla larvae	170	14	559	743
Fish larvae	777	200	550	1527
Fish eggs	264	61	1068	1393
Others	388	464	1382	2234
Total no. of individuals	15570	12702	33713	61985

seasons for statistically significant comparison. Zooplankton shows no significant difference in between zooplankton to monsoon, post-monsoon and pre-monsoon season (Table **6**).

During the studies pre-monsoon season shows highest number of individuals in copepods. Abbasi *et al.,* (2017) [33] studies the distribution, composition and abundance of copepods during night and day time from Manora waters. Three groups, cyclopoid, calanoid and herpacticoid were included. Copepods were major parts of all zooplankton groups. The cyclopoid comprising 25.09%, calanoid comprising 64.05% and herpacticoid comprising 10.84% in night time and 21.32%, 69.70% and 8.97% in day time, respectively. This study reveals that copepod groups in Manora waters are most abundant during day time and their abundance enhances the fishing activities during day

Table 3: Seasonal Composition (%) of Zooplanktonic Groups at Station (Napier Mole Bridge) during June 96-May 97

MAJOR TAXA	Relative abundance (%) (Monsoon)	Relative abundance (%) (Post-monsoon)	Relative abundance (%) (Pre-monsoon)	Total (%)
Hydromedusae	8.13	7.39	3.47	5.44
Copepoda	34.57	31.93	32.34	32.81
Mysids	4.49	3.80	5.27	4.77
Amphipoda	0.18	1.77	1.41	1.18
Acetes	0.03	0.78	0.29	0.33
Lucifer	11.70	11.41	3.51	7.19
Chaetognath	4.75	11.22	23.75	16.41
Penaeid PL	1.13	1.47	2.18	1.77
Caridean PL	6.33	3.76	1.23	3.03
Zoea	15.96	14.66	13.61	14.41
Megalopa	2.40	5.94	2.32	3.08
Squilla larvae	1.09	0.11	1.65	1.19
Fish larvae	4.99	1.57	1.63	2.46
Fish eggs	1.69	0.48	3.16	2.24
Others	2.49	3.65	4.09	3.60
Total no. of individuals	15570	12702	33713	61985

Table 4: Mean and Standard Deviation (Mean ± SD, Std Error of Mean and Min-Max) in Major Zooplankton Groups Recorded at Station (Napier Mole Bridge) during June 96-May 97

MAJOR TAXA	Mean + SD	Min-Max	CV(%)
Hydromedusae	1126.00±168.49	939.00-1266.00	14.96
Copepoda	6781.00±3630.98	4056.00-10903.00	53.54
Mysids	987.33±694.13	483.00-1779.00	70.30
Amphipoda	244.00±126.54	29.00-477.00	51.86
Acetes	69.00±54.56	6.00-101.00	79.07
Lucifer	1486.00±320.51	1185.00-1450.00	21.53
Chaetognath	3392.00±2013.08	741.00-8009.00	59.34
Penaeid PL	366.66±320.76	176.00-737.00	87.48
Caridean PL	627.00±312.39	417.00-986.00	49.82
Zoea	2979.33±1429.12	1863.00-4590.00	47.96
Megalopa	637.66±227.90	375.00-783.00	35.74
Squilla larvae	247.66±280.67	14.00-559.00	44.01
Fish larvae	509.00±290.67	200.00-777.00	57.10
Fish eggs	464.33±332.55	61.00-1068.00	71.61
Others	744.66±553.25	388.00-1382.00	74.29
Total	2128.4±1377.44	6.00-10903.00	64.717

Table 5: Zooplankton Diversity, Equitability, Richness, Menhinick Diversity Index and Margalef Species Richness Index at Station (Napier Mole Bridge) during June 96-May 97

Seasons	Shannon – Wiener diversity index (Hs)	Equitability (E)	Margalef Species Richness Index (d)
Monsoon	1.74	0.65	1.34
Post-monsoon	1.83	0.69	1.37
Pre-monsoon	1.54	0.58	1.24

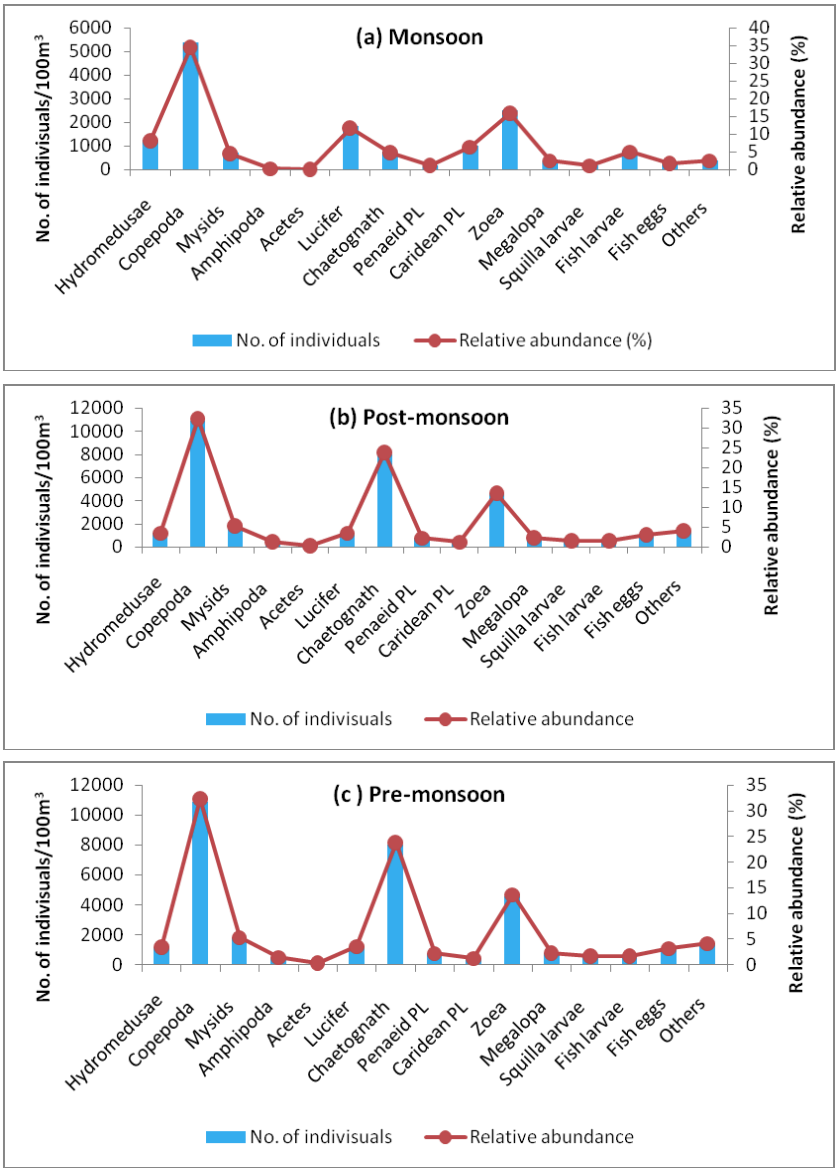

Figure 2: Relative abundance (%) in zooplankton groups during (**a**) Monsoon, (**b**) Post-monsoon and (**c**) Pre-monsoon season atNapier Mole Bridge during June 96-May 97.

time. Present studies also recorded highest abundance (32.81 %) in copepod groups. Abbasi *et al.,* (2016) [32] also studies on zooplankton population structure, distribution and abundance from Pakistani waters near-shore waters off of Karachi. Copepod (highest 67.74%) group was dominant in the zooplankton population. Ali and Ahmed, (2015) [47] study the occurrence and composition of zooplankton in two creeks of Port Qasim creek system during January to April 1998 (pre-monsoon season). Highest mean (%) compositions (38.96) were recorded in copepod. Ali and Ahmed, (2013) [48] investigate the zooplankton composition and abundance in Shahbunder creek system, Indus

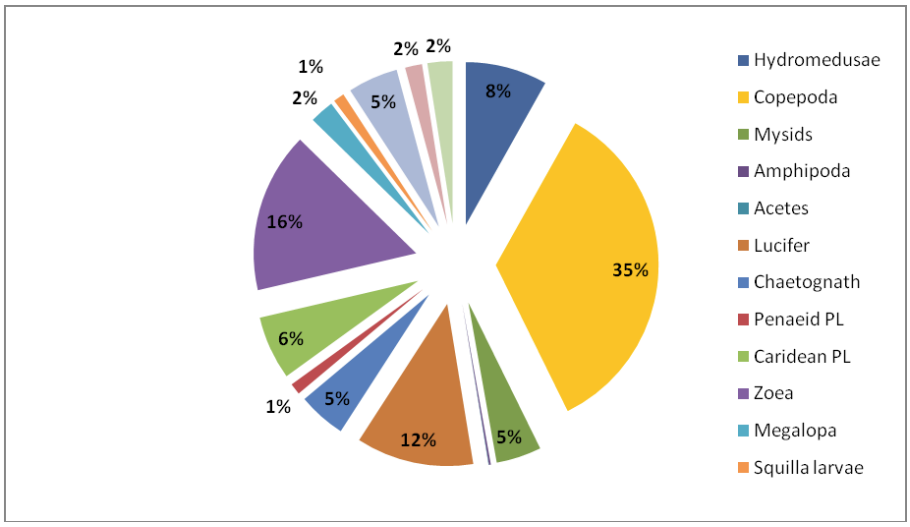

Figure 3: Percentage composition and abundance of zooplankton groups atNapier Mole Bridge during June 96-May 97.

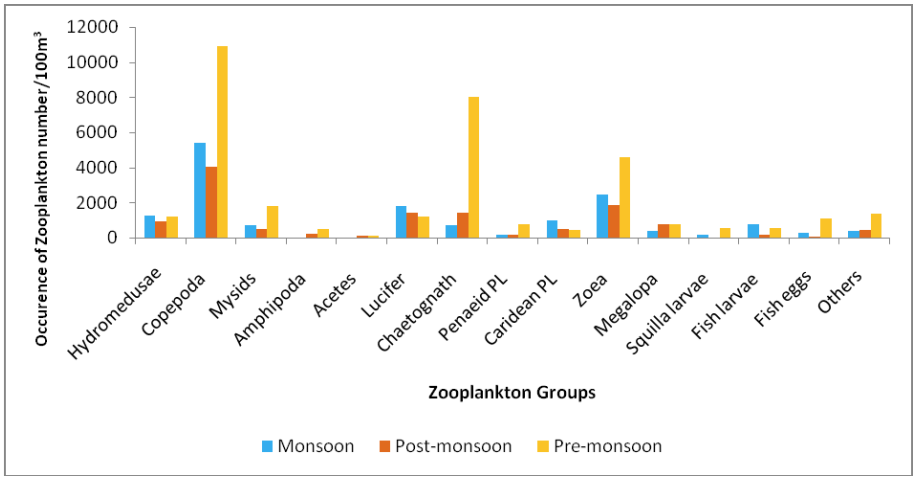

Figure 4: Seasonal spatial distribution of zooplankton groups in atNapier Mole Bridge during June 96-May 97.

Table 6: Tukey Test (P>0.05) was Performed in between Zooplankton and Seasons for Statistically Significant Comparison

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Zooplanktons	Monsoon	POST-M	191.20000	760.17800	.966	-1655.6477	2038.0477
		PRE-M	-1209.53333	760.17800	.261	-3056.3810	637.3144
	Post-monsoon	MON	-191.20000	760.17800	.966	-2038.0477	1655.6477
		PRE-M	-1400.73333	760.17800	.168	-3247.5810	446.1144
	Pre-monsoon	MON	1209.53333	760.17800	.261	-637.3144	3056.3810
		POST-M	1400.73333	760.17800	.168	-446.1144	3247.5810

*POST-M; Post-monsoon, PRE-M; Pre-monsoon, MON; Monsoon.

deltaic area to observe during October – December, 1997 (post monsoon period). Highest mean (15182.0±1402.14) were measured in copepods. Wimpenny (1966) and Omori and Ikeda (1984) [49,50] reported that copepods are the most abundant zooplankton communities sampled in the world ocean. Houde and Lovdal (1982) [51] reported that copepods are important components of larval fish food. Similar pattern was reported by (Biraja *et al.,* 2013) [52] from Gopalpur creek a tropical tidal backwater at east coast

of India. Previous data from Indian backwaters shows copepods as the dominant taxa from west coast [53] and east coast of India [54, 55]. Copepods form an important food item for chaetognaths [56] and they play an important role in energy transfer to higher trophic levels [57]. It has been found that approximately 10-30% of the copepod biomass is transferred by this pathway through chaetognath biomass [58].

The Karachi backwaters were used to be dynamic estuarine areas, providing excellent habitat and environmental conditions for the sustenance of biodiversity. The study area is the upper most part of the Karachi port channel, receiving untreated domestic sewage effluents from Chinna creek and the situation further aggravates due to bustling activities of cargo shipping and boating. And now the area is facing serious threat due to unabated flow of untreated urban runoff and effluents from port.

All the major zooplanktonic groups show a strong adaptation through flourishing in the area, tolerating extreme ecological conditions and its fluctuation. The occurrence and abundance of zooplanktonic groups and high standing stock in the study area is quite striking feature showing high turnover at the secondary level of the food web. The phenomenon supports the assumption that the entire recruitment of faunastic groups is probably from the neritic waters of Arabian sea entering the backwaters through tidal phases. Thus inundation of oceanic water and tidal incursion are the main factors controlling physico-chemical parameters and the occurrence and abundance of major zooplankton groups in the study area.

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