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PHYTOPLANKTONS AND ZOOPLANKTONS DIVERSITY IN KARACHI COASTAL SEAWATER UNDER HIGH AND LOW TIDE DURING WINTER MONSOON

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This paper represents the population density of phytoplanktons and zooplanktons recorded during the marine environmental studies at Karachi coast in the month of February 2011. Samples were collected by towing net, preserved and quantification and identification was carried out under light microscope. Twenty-three phytoplanktons species and nine zooplankton groups were recorded in the seawater from the sampling area of 10 square kilometers. Coscinodiscus and Copepods were dominant in the population of phytoplankton and zooplankton, respectively. Phytoplankton population density increased while zooplankton abundance decreased offshore from the coastline in the open sea.

Keywords: Arabian sea, Karachi, Phytoplankton, Zooplankton, Winter monsoon

1. Introduction

Karachi is located on the northern boundary of the Arabian Sea. It is the largest city of Pakistan with coastline extending up to about 30 km [1]. The Arabian Sea is constantly under the influence of Asian monsoon systems that affects ecological system and may alter population density of important aquatic species [2].

Phytoplankton forms the basis for the marine food-web process by way of fuelling energy to the higher trophic level organisms with their photosynthesis products. Without phytoplankton: the primary producers, there would be no life in the aquatic system. Many phytoplankton species belong mainly to the nano-plankton and micro-plankton fractions [3]. Zooplanktons are myriads of diverse floating and drifting animals with limited power of locomotion. In addition to size variations, there are differences in morphological features and taxonomic position and play an important role to study the faunal bio-diversity of aquatic ecosystems. They include representatives of almost every taxa of the animal kingdom and occur in the pelagic environment either as adults (holoplankton) or eggs and larvae (meroplankton). By sheer abundance of both types and their presence at varying depths, the zooplanktons are utilized to assess energy transfer at secondary trophic level. The zooplankton occurrence and their distribution influence pelagic fishery potentials. Fish mostly breed in areas where the planktonic organisms are plenty so that their young ones could get sufficient food for survival and growth. Zooplanktons, especially copepods and small species of Cladocerans are good ecological indicator because they respond changes in the nutrient level and fish population.

Population of phytoplankton is governed by numerous environmental factors. Banse and McClain [2] and Latasa and Bidigare [4] have discussed the seasonally varying rates of nutrients transport into the photic zone. This can affect the growth rates of phytoplankton in northern Arabian Sea due to vertical mixing during winter and add nutrients to the upper layers of the open sea, leading to enhanced algal growth. Some taxonomic and morphological studies have been carried out in the past on phytoplankton [5-9] and zooplankton [10-11] along Karachi Coast. However, there is a need to develop some understanding of the plankton major group population variation under high and low tide conditions and between coastline and offshore location. This study was therefore, carried out to evaluate the population density of phytoplankton and zooplanktons along the North-Western Coast of Karachi.

2. Materials and Methods

2.1. Sampling Locations

The study area was selected along North-Western Karachi Coast of Arabian Sea. The area

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is characterized by a temperate climate, with a maximum temperature of about 34^{o}C and humidity ranging between 50 to 80% and experiences low rainfall. For purpose of study, five sampling profiles were selected. Profile 1 ran along the coastal line while profile 2, 3, 4 and 5 extended towards the south in the same direction. Each profile was separated from the last profile by a distance of ~ 0.5 Km. Seawater was collected from five substations (1 Km apart from each other) in each of the five profiles. In short, twenty five sampling points in an area of 5 x 2 km were selected for study purpose (Figure 1). Location of each sampling points was monitored with the help of a Garmin Personal Navigator (M/S Garmin, GPSMAP 60CSx). Geographic coordinates of sampling points under Traditional (Lat., Long.) and UTM (Universal Transverse Mercator, Geodetic Datum; WGS 84) systems are given in Table 1.

2.2. Sample Preservation and Processing

Sea surface water samples were collected for planktons in the month of February 2011 using a motor boat from selected sampling points under both low and high tide. The time for occurrence of tide was deduced from standard tide table published by Pakistan Navy. Plankton net of 50-micron (for phytoplanktons) and 200-micron (for zooplankton) mesh size were used to collect samples. The plankton net was conical in shape and consisted of rigid, round ring at the end with filtering cone and the collecting bucket for collection of organisms which was easy to remove from the net. The net was towed at a slow speed usually for 5 to 10 minutes. The towing speed of the net was such that the maximum amount of water entered through the mouth of the net for better filtration. The towing speed was kept slow to avoid a static cone of water that diverts water outside the net. After each haul the plankton samples were transferred into a cleaned and dried glass beaker of half liter capacity. The debris or extraneous material was removed and transferred into plastic bottles and fixed with 4% un-buffered formalin for preservation.

2.3. Identification and Quantification of Planktons

In the laboratory, counting and identification was carried out using counting chamber under compound microscope. Each row of the counting chamber was examined and the numbers of individual species were recorded. Quantity per ml of each individual specie (for phytoplankton) and group (for zooplankton) for a sampling profile was calculated as the statistical mean of recorded observation of each substation of that specific profile.

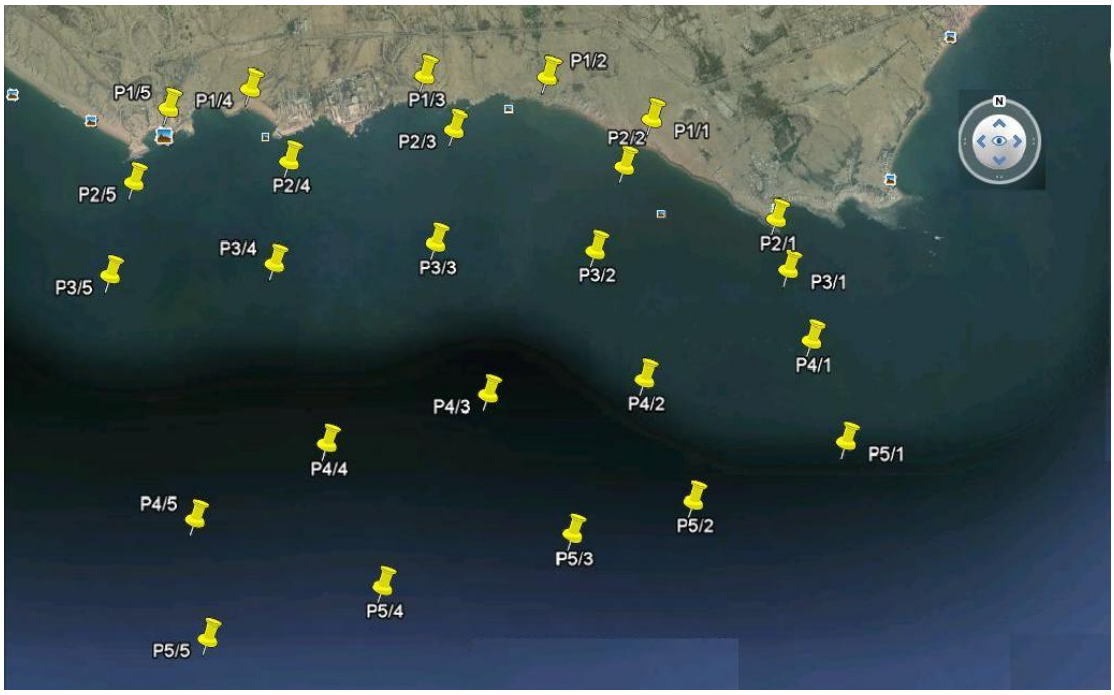

Figure 1. Coastal area map of Karachi showing sampling sites.

Table 1. Details of sampling points

S. No.	Code	Geographic Coordinates			
		Traditional		UTM	
		Latitude	Longitude	Northing (m)	Easting (m)
Profile 1					
1	P1/1	24°-50'-36.1"	66°-48'-25"	2749386.12	278384.40
2	P1/2	24°-50'-44.2"	66°-48'-1.5"	2749646.00	277728.56
3	P1/3	24°-50'-44.6"	66°-47'-34.6"	2749670.52	276973.43
4	P1/4	24°-50'-42.0"	66°-46'-55.7"	2749608.24	275879.86
5	P1/5	24°-50'-38.2"	66°-46'-37.4"	2749499.68	275364.10
Profile 2					
6	P2/1	24°-50'-16.4"	66°-48'-52.8"	2748767.37	279155.28
7	P2/2	24°-50'-26.8"	66°-48'-18.9"	2749102.69	278208.50
8	P2/3	24°-50'-33.9"	66°-47'-41.0"	2749338.35	277147.81
9	P2/4	24°-50'-27.8"	66°-47'-04.3	2749167.35	276114.24
10	P2/5	24°-50'-23.6"	66°-46'-29.6"	2749053.98	275137.75
Profile 3					
11	P3/1	24°-50'-06.3"	66°-48'-55.5"	2748455.36	279226.12
12	P3/2	24°-50'-10.1"	66°-48'-12.4"	2748591.74	278017.71
13	P3/3	24°-50'-11.6"	66°-47'-37.0"	2748653.95	277024.38
14	P3/4	24°-50'-07.5"	66°-47'-01.0"	2748653.95	277024.39
15	P3/5	24°-50'-05.2"	66°-46'-24.3"	2748462.78	276664.57
Profile 4					
16	P4/1	24°-49'-52.4"	66°-49'-00.7"	2748025.30	279365.30
17	P4/2	24°-49'-43.7"	66°-48'-23.4"	2747774.39	278313.53
18	P4/3	24°-49'-41.7"	66°-47'-48.7"	2747728.55	277338.07
19	P4/4	24°-49'-31.9"	66°-47'-12.7"	2747443.35	276322.19
20	P4/5	24°-49'-17.0"	66°-46'-43.2"	2746998.31	275486.26
Profile 5					
21	P5/1	24°-49'-32.7	66°-49'-08.4"	2746998.31	275486.26
22	P5/2	24°-49'-20.6	66°-48'-34.3"	2747113.16	275238.11
23	P5/3	24°-49'-14.1	66°-48'-07.3"	2746870.82	277846.72
24	P5/4	24°-49'-03.7	66°-47'-25.1"	2746569.932	276656.37
25	P5/5	24°-48'-53.3	66°-46'-45.9"	2746267.78	275550.21

3. Results

3.1. Phytoplankton Diversity

Phytoplankton species population that was observed in the seawater during the sampling, under both low and high tide conditions, is described in Table 2 and presented in Figures 2 and 3 respectively. During sampling a total of 23 phytoplankton species were recorded. Under low tide condition, concentration of phytoplankton in profile 1 was 412 per ml while in profile 2, 3, 4 and 5, it was 399, 495, 530 and 571 per ml, respectively. Under high tide conditions, concentrations of phytoplankton in profile 2, 3, 4 and 5 were 549, 612, 656 and 746 per ml of seawater, respectively. With the exception of profile 1, the most common phytoplankton was Coscinodiscus which contributed about ~18% of total phytoplankton in high tide and ~20% in low tide conditions. Other major dominating phytoplankton were Cyclotella, Dinothrix, Navicula and Gyrosigma.

Table 2. Phytoplankton population.

Phytoplankton species	Population (% of the total)									
	Profile 1		Profile 2		Profile 3		Profile 4		Profile 5	
	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide
Alexandrium	0.24	---	0.25	0.18	2.42	1.47	0.94	0.61	0.00	0.27
Cocconeis	0.24	---	4.01	4.92	5.25	5.23	5.09	5.18	5.25	2.68
Coscinodiscus	1.21	---	22.3	18.9	21.0	18.6	18.3	19.0	19.0	17.4
Ceratium	0.24	---	1.25	0.91	6.06	7.35	4.34	3.35	2.10	3.35
Chaetoceros	12.62	---	1.00	1.09	9.90	10.7	8.87	8.69	1.05	2.95
Cyclotella	18.45	---	3.51	4.37	4.44	3.76	5.28	5.49	0.88	0.80
Dinophysis	4.13	---	2.51	3.83	5.45	2.12	13.9	13.4	1.75	1.47
Dinothrix	2.67	---	9.52	7.65	2.02	2.94	3.21	5.34	11.3	12.2
Enteromorpha	0.97	---	1.25	1.28	2.83	2.45	3.96	0.61	8.76	6.97
Gyrosigma	0.97	---	6.02	4.92	5.86	4.25	4.34	4.27	7.53	12.4
Guinardia	3.40	---	3.01	3.64	2.22	2.61	4.72	3.35	0.35	0.40
Gymnodinium	19.42	---	3.26	2.19	3.03	2.29	5.09	5.18	1.75	2.14
Leptocylindricus	0.97	---	3.51	2.91	2.63	2.61	3.40	1.68	3.50	3.08
Melosira	0.97	---	1.00	1.46	1.21	0.82	1.13	0.61	1.23	0.54
Navicula	19.42	---	13.0	14.2	3.03	4.41	2.64	5.64	8.06	6.97
Nitzschia	3.88	---	5.26	8.74	3.64	4.58	2.26	3.81	2.98	4.16
Noctiluca	4.13	---	4.01	2.55	3.64	3.59	1.13	3.35	0.00	0.00
Oscillatoria	1.21	---	3.51	2.19	8.48	8.33	0.94	0.91	4.73	6.17
Prorocentrum	0.97	---	3.01	2.37	2.63	4.25	1.89	1.68	0.35	0.80
Protoperidinium	0.97	---	1.75	3.10	0.61	0.82	2.08	2.59	3.68	3.08
Synedra	1.46	---	1.75	2.00	1.62	2.29	3.02	3.20	7.01	6.03
Trichodesmium	0.97	---	2.01	2.00	1.21	2.78	1.32	0.91	2.10	2.28
Zykabikodinium	0.49	---	3.26	4.55	0.81	1.63	2.08	1.07	6.48	3.75
Total (no. per ml)	412	---	399	549	495	612	530	656	571	746
Population increase between two tides (%)			-----	37	-----	23	------	23	----	30

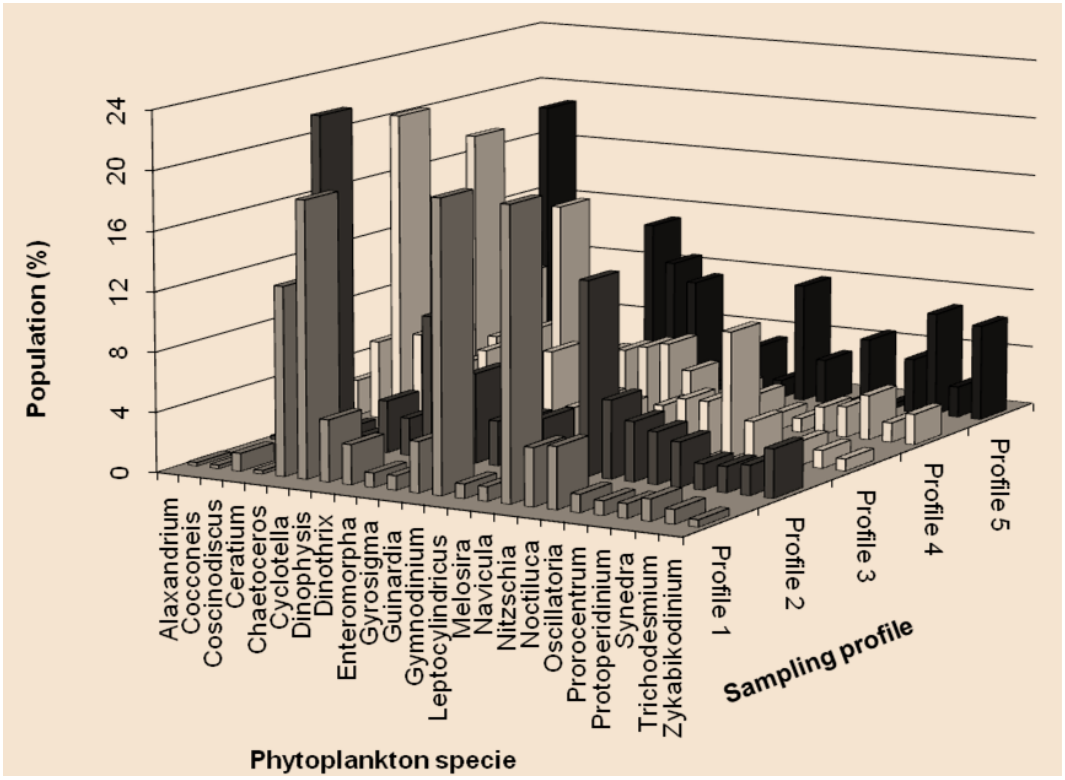

Figure 2. Phytoplankton population under low tide condition.

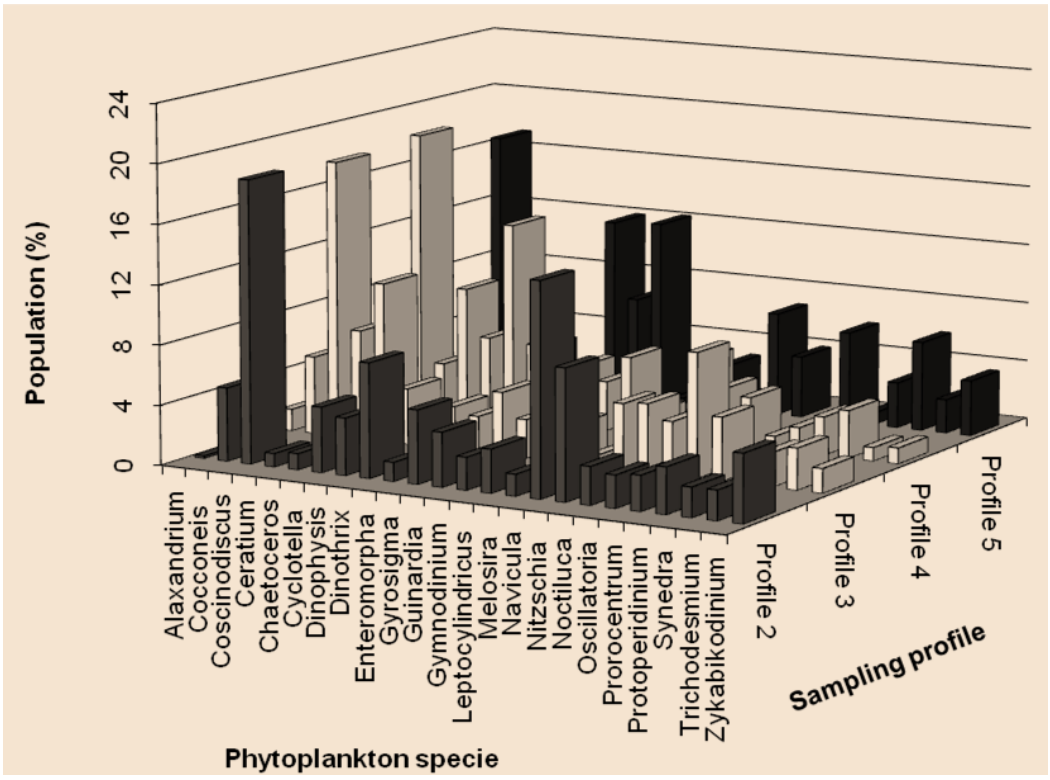

Figure 3. Phytoplankton population under high tide condition.

Table 3. Zooplankton population.

Zooplankton group	Population (% of the total)									
	Profile 1		Profile 2		Profile 3		Profile 4		Profile 5	
	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide
Copepods	29.03	---	21	18	16	50	18	21	18	18
Brachiopods	4.84	---	13	10	14	10	18	5	9	9
Cladocerans	19.35	---	11	10	14	6	15	21	14	18
Amphipods	12.90	---	8	12	13	9	9	11	14	18
Euphausiids	12.90	---	11	16	13	10	6	5	9	18
Ctenophora	0.00	---	5	2	4	1	3	5	5	0
Cnidaria	0.00	---	2	4	2	1	0	0	5	0
Pteropods	9.68	---	11	12	13	8	12	16	18	9
Radiolarians	11.29	---	16	18	13	4	18	16	9	9
Total (no. per ml)	62	---	61	51	56	78	33	19	22	11
Population increase between two tides (%)			19	-----	----	39	73	----	100	-----

3.2. Zooplankton Diversity

In total, nine groups of zooplanktons were found in seawater during the Karachi coastal sampling. Table 3 describes zooplankton groups that were recorded during the Karachi coastal sampling. Figure 4 and 5 present zooplankton concentration under low and high tide respectively. Zooplankton concentration under low tide in profile 1 was 62 per ml while it was 61, 56, 33 and 22 per ml in profile 2, 3, 4 and 5, respectively, under same conditions. During high tide, zooplankton concentration in profile 2, 3, 4 and 5 were 51, 78, 19 and 11 per ml of seawater, respectively. Copepods were found in majority in all the profiles. In profile 1, under low tide, its population consisted of 30% of the zooplanktons. Under low and high tide conditions, its population range was 16-21% and 18-50%, respectively.

4. Discussion

Change in one or more of the existing environmental conditions may render a habitat unsuitable as a breeding or nursery area of biota and it induces negative or positive effect on population i.e. population of species may be considerably reduced or enhanced. A population shift cannot compensate for the reduced size of the breeding or nursery areas if the remaining suitable area is already occupied by the species.

In the present study, twenty-three phytoplankton species were recorded from the sampling area seawater. With the exception of profile 1, under low tide conditions, phytoplankton composition was dominated by diatom Coscinodiscus. Diatom abundance peak was also recorded by Solak et al. [12] in the south-west monsoon period at Felent Creek, Turkey and reported that the species richness was mostly higher in winter than in summer. A number of studies have reported such phytoplankton abundance during the south-west monsoon season, along the south-west coast of India [13], in the coastal waters of south Kanara in India [14] and in waters of the Indo-Pakistan shelf [15]. Sarangi et al. [16] and Dwivedi et al. [17] reported the algal bloom development in the North Arabian Sea in February and correlated it to north-easterly trade winds and sea surface temperatures.

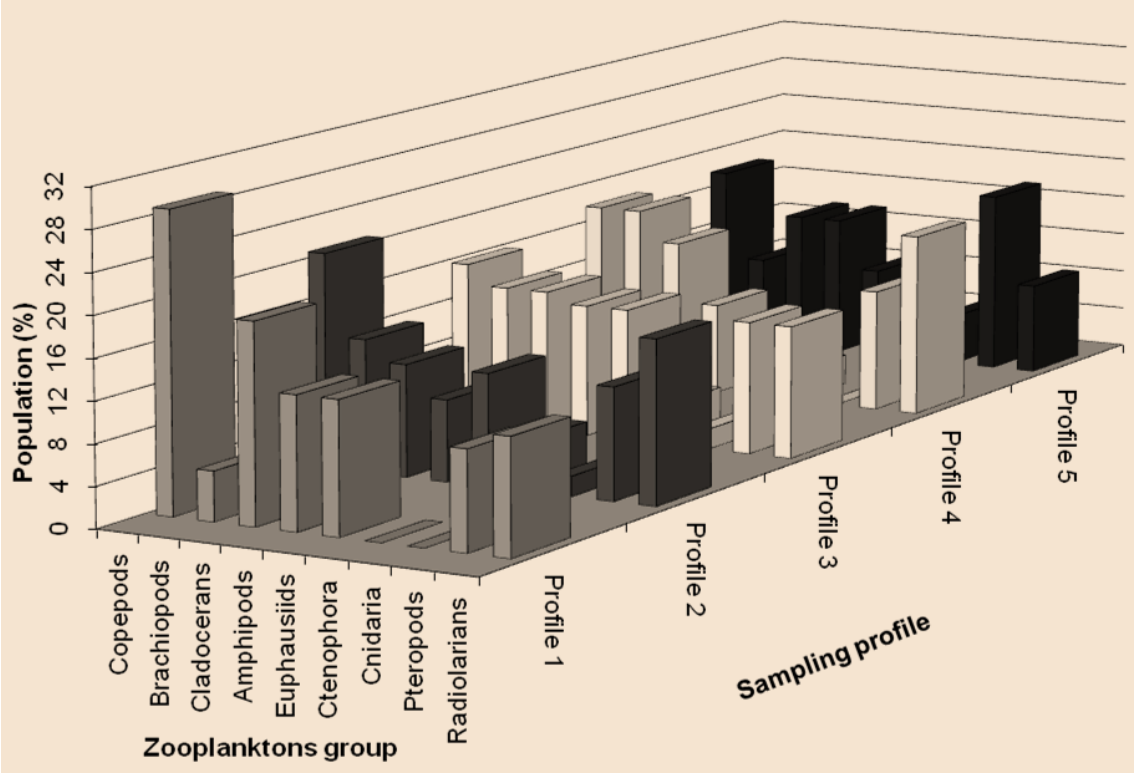

Figure 4. Zooplankton population under low tide condition.

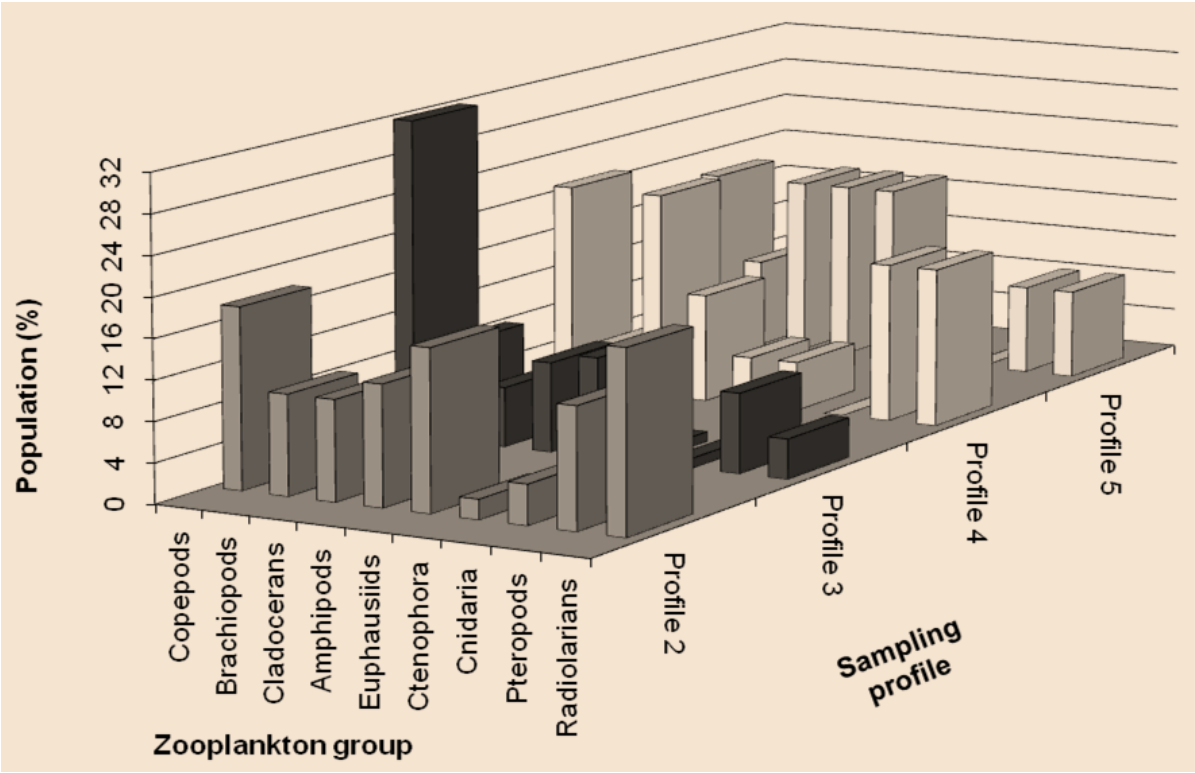

Figure 5. Zooplankton population under high tide condition.

From Table 2, it is quite obvious that the phytoplankton population density under both low and high tide conditions was minimum near the coastline and maximum at Profile 5. This shows that the phytoplankton population density increases gradually offshore from the coastline in the open sea. Also, it can be deducted from the data that there was 23 to 37% phytoplankton population density increase under high tide as compared to low tide conditions.

Nine major groups of zooplanktons were observed during this study. Members belonging to Copepod group dominated the population which was in agreement with the finding of Kidwai and Amjad [10]. They observed Copepods population abundance of 74.93% while carrying out study at the Karachi coast. Osore et al. [18] also recorded the copepods as a major group in seawater of Mida Creek, Kenya.

Table 3 describes the zooplankton population under both low and high tide conditions. With the exception of profile 3 under high tide, in contrast to the phytoplankton, the zooplankton abundance decreased from coastline to offshore. Also, with the exception of Profile 3, it was observed that the zooplankton population density was higher in the sampling profiles under low tide as compared to high tide conditions. This observation does not agree with the phytoplankton density trend under different tide conditions for phytoplankton. This behavior of the zooplankton maybe due to their movement towards the coastline to get nutrients from the seaweeds attached with the rocks. Additional surveys of the plankton abundance variation in the seawater of the North Arabian Sea along the coast of Pakistan are needed to better understand the dynamics of phytoplankton in this area.

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