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Spatial and temporal assemblage of *Potamides cingulatus* (Gmelin) found in the mangrove creek area of Karachi, Pakistan

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सार – इस शोध पत्र में जनवरी 1999 से दिसम्बर 1999 तक की अवधि में कराची तट के साथ सेंडस्पीट बैकवाटर और पोर्ट कासिम कोरंगी फीट्टी मैंनग्रोव क्रीक क्षेत्र के तीन स्थलों के निम्न ज्वार भाटा से पर्यावरणीय, जैविक प्राचलों तथा तलछट गुणों वाले *पोटामाइडस सिंगुलेट्स* (G मेलिन) समुच्चयों का वार्षिक अध्ययन किया गया। रन्ध्र और जल तापमान सहित मैंग्रोव क्रीक क्षेत्र में पर्यावरणीय कारक मौसम से प्रभावित थे जबकि लवणता, PH, Eh (mv) और केंकड़े के बिल व नीयूमेटोफोरस (अथवा जड़) जैसे जीवीय प्राचल आरम्भ में स्थलों से प्रभावित थे। *पो. सिंगुलेट्स* का कुल घनत्व 4 से 592 प्रति वर्ग मीटर के मध्य है। स्थलों ($F_{2,71}$.=15.14, P < 0.05) के घनत्व में उल्लेखनीय रूप में भिन्नताओं पाई गई हैं। कुल माध्य मौसमी वितरण से क्रमश: दक्षिण-पश्चिम मॉनसून ऋतु (141.8 ± 157.6) और मानसूनोत्तर ऋतु (129.1 ± 154.4) के दौरान *पो. सिंगुलेट्स* का उच्च घनत्व पाया गया।

ABSTRACT. An annual study on *Potamides cingulatus* (Gmelin) assemblages with environmental, biological parameters and sediment properties was carried out at low tide from three sites in Port Qasim Korangi Phitti mangrove creek area and Sandspit backwaters along the coast of Karachi from January 1999 to December 1999. Environmental factors in the mangrove creek area included pore and water temperature influenced by seasons whereas, the salinity, pH, Eh (mv) and the biotic parameters like crab burrows and pneumatophores (or roots) were preliminary influenced by sites. The total density of *P*. cingulatus ranged in between 4 to 592 per m^2. Significant variations were observed in density among sites ($F_{2, 71}$ = 15.14, P < 0.05). The total mean seasonal distribution showed a high density of *P. cingulatus* during SW monsoon (141.8 ± 157.6) and post monsoon (129.1 ± 154.4) respectively.

Key words – *Potamides cingulatus*, Environmental parameters, Seasonal dynamics, Mangrove, Karachi.

1. Introduction

Molluscs are comparatively recognized, dominated invertebrate groups and key component of mangrove communities (Smith and Nol, 2000). The Gastropoda is the most diverse class of molluscs in the marine environment (Strong *et al*., 2008; Kesavan *et al*., 2009 and Ghasemi *et al*., 2011) such as mangroves (Vermeij, 1973; Ahmadreza *et al*., 2012) and terrestrial habitats (Barker, 2001). Gastropods have a significant ecological role to play in the mangrove ecosystems which provides an ideal condition for higher productivity of gastropods which in turn serve as food (Morrisey *et al*., 2003; Kesavan *et al*., 2009; Ahmadreza *et al*., 2012). Gastropod assemblage has been shown to extremely contribute to feeding resources of waders within the mangrove environment (Al-Sayed *et al*., 2008). The role of mangrove gastropods in nutrient dynamics has been largely overlooked; studies (Fratini *et al*., 2008) have demonstrated their central ecological role. However, very little information is available on the gastropod diversity of mangrove ecosystem (Khade and Mane, 2012). Based on the structure of the molluscan assemblages, the pollution damage in mangrove forests can be assessed. Despite their importance, there are few specific quantitative data on the distribution spatial and temporal variations of molluscs in mangrove ecosystem (Wells 1984; Khan *et al*., 1999; Barkati and Rehman, 2005; Printrakoon *et al*., 2008; Rehman and Barkati, 2009; Afsar *et al*., 2012 and Jahangir *et al*., 2012). *P. cingulatus* is an extremely widespread gastropod species found in mangrove area of the world (Danehkar, 2001; Verma *et al*., 2004; Safa, 2006; Rohipour, 2007 and Kesavan *et al*., 2009) and present at the highest tidal mark in the sandy part of the polluted mangrove habitats of Pakistan (Tirmizi and Barkati, 1983; Huda and Khan, 1996; Khan *et al*., 1999; Barkati and Rehman, 2005). The *P. cingulatus* also serve as intermediate host for many trematode parasites. Therefore, the present study was

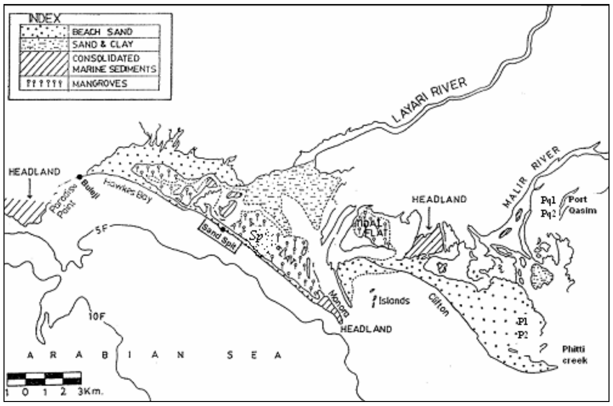

Fig. 1. Map of the Karachi coast showing sampling sites, Site 1. Port Qasim, Site 2. Phitti creek and Site 3. Sandspit mangrove areas during January1999 to December 1999

attempted to determine the temporal and spatial patterns of *P. cingulatus* in mangrove creek areas along with environmental, biological variables and sediment properties.

2. Data and methodology

2.1. *Study area*

The city of Karachi lies between 24° 61' North and 65° 55' East. One of the study areas is located in the Korangi Creeks, while the other is in backwaters of Manora Channel near Sandspit. Both areas are dominated with the dense vegetation of mangroves, the *Avicennia marina*. In Korangi creek two sites were selected within Kadiro creek, the main shipping channel. The site 1 was closer to the Port Qasim jetty more likely exposed to pollutants from the jetty and Steel mills and the site 2 was at the open end of the Kadiro creek the main shipping channel, but likely less polluted due to tidal flushing, dilution and effect of dispersion and the site 3 was located in the Sandspit backwater mangrove area (Fig. 1).

2.2. *Field sampling*

Samples were collected at the low tide from three sites Port Qasim, Phitti creek and Sandspit backwater mangrove area. The sampling of *Potamides cingulatus* was conducted at monthly intervals from January 1999 to December 1999. *P. cingulatus* were collected by hand picking, in 0.5 m^2 areas. A 0.5 m^2 quadrate was randomly placed (in replication of three) at each station. In each quadrate crab burrows and aerial roots (pneumatophore) of mangroves *A. marina* were counted.

Abundance and density of shells, crabs burrows and mangrove roots or Pneumatophores were estimated by counting within an area of 0.25 m^2 and extrapolating the data to estimate densities in per unit area. The salinity (ppt) was measured with an optical refractometer (with a correction of 1%). Temperature, pH and Eh (mv) were measured with the help of a pH meter (Hanna model 8314). Abundance and community structure data were grouped into seasons following (Naz *et al.*, 2012) northeast monsoon (December to February), pre-monsoon (March to May), southwest monsoon (June to August) and post-monsoon (September to November). Sediment sample cores were collected from each quadrate using a syringe corer (internal diameter was 2.7 cm) at each site.

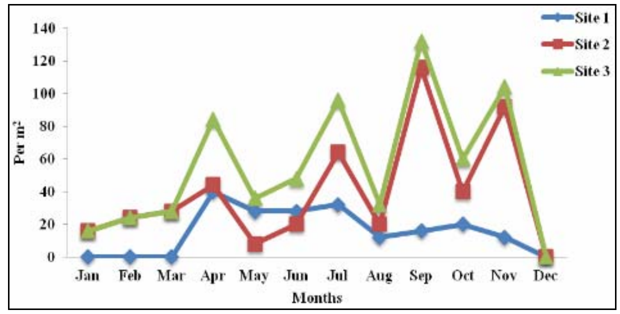

Fig. 2. Variations in density of crab burrows collected from Site 1. Port Qasim, Site 2. Phitti creek and Site 3. Sandspit mangrove areas during January1999 to December 1999

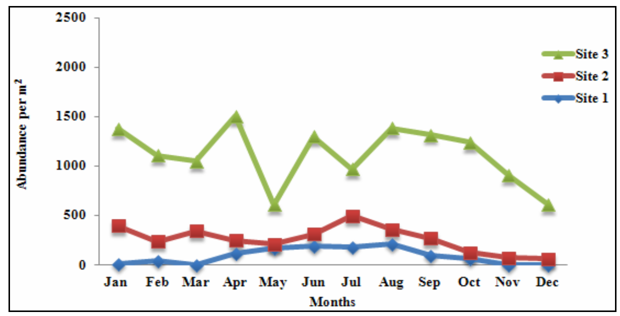

Fig. 3. Variations in root density of pneumatophores of mangrove (*A. marina*) collected from Site 1. Port Qasim, Site 2. Phitti creek and Site 3. Sandspit mangrove areas during January 1999 to December 1999.

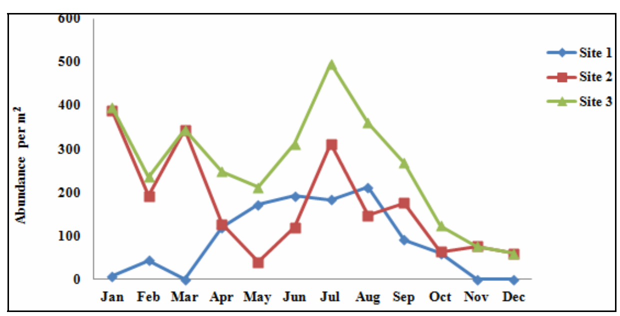

Fig. 4. Variations in density of *P. cingulatus* collected from Site 1. Port Qasim, Site 2. Phitti creek and Site 3. Sandspit mangrove areas during January1999 to December 1999

TABLE 1

Spatial variations in temperature, salinity, pH, Eh (mv) and organic carbon of overlying and interstitial water (mean ± SD)

	n	Site 1	n	Site 2	n	Site 3
Overlying water						
Temperature water (°C)	24	30.117 ± 3.369	24	29.863 ± 3.313	24	29.117 ± 3.792
Salinity ppt	24	42.043 ± 4.486	24	41.67 ± 8.19	24	37.250 ± 2.4
pH	24	7.9908 ± 0.333	24	7.8721 ± 0.4375	24	8.0771 ± 0.3409
Eh (mv)	24	-62.79 ± 21.21	24	-57.96 ± 22.18	24	-66.67 ± 22.54
Interstitial water						
	n	Site 1	n	Site 2	n	Site 3
Temperature water (°C)	24	27.742 ± 2.466	24	27.2583.429	24	27.721 ± 4.147
Salinity ppt	24	41.5 ± 4.22	24	40.71 ± 5.14	24	37.500 ± 3.336
pH	24	7.71 ± 0.300	24	7.4492 ± 0.1747	24	7.5408 ± .3915
Eh (mv)	24	-46.54 ± 17.70	24	-31.79 ± 10.33	24	-31.96 ± 30.10
Organics	24	4.135 ± 2.863	24	4.205 ± 2.137	24	3.460 ± 2.521

TABLE 2

Spatial variation in Sediment properties, Root density (m^2) and crab burrow (m^2) (mean ± SD) of three study sites during January to December, 1999

Sediment properties	n	Site 1	n	Site 2	n	Site 3
Mass of moisture	24	16.23 ± 2.466	24	15.903 ± 3.004	24	13.266 ± 2.395
Percent moisture	24	39.83 ± 10.29	24	36.82 ± 7.53	24	28.16 ± 12.53
Volume of water	24	15.834 ± 2.405	24	15.515 ± 2.930	24	12.934 ± 2.336
Volume of sediments	24	15.796 ± 1.949	24	16.441 ± 1.823	24	18.919 ± 2.958
Porosity	24	102.98 ± 26.60	24	95.19 ± 19.46	24	72.81 ± 32.41
Median	24	2.2060 ± 0.600	24	2.842 ± 0.724	24	1.216 ± 0.599
Graphic mean	24	2.1040 ± 0.536	24	2.589 ± 0.536	24	1.7222 ± 0.3605
Standard deviation	24	1.657 ± 1.159	24	1.5651 ± 0.2841	24	4.42 ± 7.50
Skewness	24	-0.0611 ± 0.3150	24	-0.2793 ± 0.2919	24	0.3803 ± 0.4801
Kurtosis	24	1.208 ± 1.169	24	0.997 ± 0.538	24	6.69 ± 13.37
Organics	24	4.315 ± 2.863	24	4.205 ± 2.137	24	3.460 ± 2.521
Root density	24	7.83 ± 12.62	24	21.0 ± 31.26	24	32.67 ± 26.84
Crab burrows	24	159.5 ± 179.1	24	389.0 ± 324.3	24	137.5 ± 153.9

2.3. *Laboratory analyses*

Undisturbed sediment core samples were brought to the laboratory and homogenized in a large petri dish. Three replicates of 1-2 g sediment samples were taken in pre-weighed crucible and wet weights were noted (using a microbalance, up to 0.001 g correction). The sediment samples were then dried for 24 hours at 70 °C and dry weights were noted. Dried sediment samples were then ignited for four hours in the muffle furnace at 500 °C and ash free dry weight was noted. Sediment properties like per cent moisture, porosity and per cent organic contents were estimated. Granulometric analyses (grain size) were carried out by dry sieving methodology following Folk (1974).

TABLE 3

Seasonal variation (mean ± SD) in density of *P. cingulatus* collected from (Site 1) Phitti creek, Port Qasim and (Site 2) Sandspit mangrove area during January to December 1999

	n	Total mean	n	Site 1	n	Site 2	n	Site 3
Seasons		(Mean ± SD)		(Mean ± SD)		(Mean ± SD		(Mean ± SD
N E monsoon	18	104.9 ± 126.7	6	8.67 ± 17.60	6	106.7 ± 152.7	6	199.3 ± 95.4
Pre monsoon	18	104.0 ± 138.4	6	48.7 ± 72.7	6	85.3 ± 136.1	6	178.0 ± 175.0
SW monsoon	18	141.8 ± 157.6	6	98 ± 105.1	6	96.7 ± 86.1	6	230.7 ± 227.5
Post monsoon	18	129.6 ± 154.4	6	25.3 ± 40.5	6	52.7 ± 44.4	6	310.7 ± 134.1

Completely randomized design (CRD) analysis of variance (ANOVA) with nested treatment arrangements were used to test all parameters for differences at a station, level and seasons. Density was log (x+1) transformed after testing for heterogeneity of variances.

3. Results

The salinity of the overlying water showed considerable fluctuation. The highest salinity reached up to 75 ppt. at site 2. Temperature of water varied in between 22.2 °C to 40 °C, being high in summer and low in winter, indicated typical seasonal pattern (Table 1). Highest pH values were observed at site 3 in July. The maximum mean densities of crab burrows were observed at site 2 whereas site 1 and site 3 showed minimum burrow density as compared to site 2. The number of burrows ranged from 4 to 1200 burrow m^{-2} (Fig. 2). The Pneumatophores of mangrove (*A. marina*) or root density ranged in between 4 to 116 m^{-2} (Fig. 3).

P. cingulatus commonly found in the studied intertidal areas and ranged from 4 to 664 individual m^2. The spatial variability in the density of mollusks was significant in between sites ($F_{2, 83}$ = 26.79, $P < 0.05$) but the difference was not significant among seasons. The collective mean seasonal distribution of all the three sites showed a high density of *P. cingulatus* during SW monsoon (141.8 ± 157.6) and post-monsoon (129.6 ± 154.4) respectively. Lowest density was observed in NE monsoon (104.9 ± 126.7) and pre monsoon (104.6 ± 138.4). A similar trend was also observed at Site 1, where maximum density was observed in SW monsoon (98 ± 105.1) and lowest during NE monsoon (8.67 ± 17.60). At site 3, the highest density was observed during post monsoon (332.9 ± 114.4) and lowest in pre monsoon (261.8 ± 213) (Table 3) but the opposite trend was observed at site 2 where maximum density was observed from NE monsoon (310.7 ± 134.1) and minimum in the post monsoon (178.0 ± 175.1).

4. Discussion

Seasonal variation was observed in the mangrove environment (fundamentally concerning temperature, salinity pH and Eh). The water temperature was high in summer and low in winter indicating a typical seasonal pattern as also reported by Dye, (1983a) and Alongi (1987b). The seasonal or temporal variations in the distribution of *P. cingulatus* were demonstrated to be closely related to the monsoon pattern and input of organic matter and consequently changes in the sediment structure. The mean highest density of *P. cingulatus* was observed during SW and post monsoons. Minimum density was observed in the pre monsoon at Sandspits area, but at Phitti creek maximum density was observed during the NE monsoon and minimum was in post monsoon. However, moderate to low densities had been reported from Sandspit backwater mangrove areas during the southwest and post-monsoon seasons, whereas high densities have been reported in the northeast and pre-monsoon seasons (Khan *et al*., 1999). The high densities were likely related to high phytobenthic biomass of benthic macroalgae, (like, *Enteromorpha*) and microalgae (pennate diatoms) that were observed during northeast monsoon season (Saifullah and Elahi, 1992, Chaghtai and Saifullah, 1992). The marked effects of biologically produced structures like crab burrows, plant stems and roots have been documented and regarded as a localized effect on the abundance of gastropods (Thistle, 1980). Verma *et al*. (2004) also recorded *P. cingulatus* as a common gastropod and were abundantly found during monsoon season at Mahi creek, Mumbai, India. Sultana, (2001) reported high density of *P. cingulatus* from February to May, during pre-monsoon season in Sandspit area and annually ranged from 52 to 632 individual m^{-2} significant difference was also observed in seasons.

Highest abundance of *P. cingulatus* observed at Sandspit might be due to the area not being subjected to the direct wave action and richness of mangroves in the area reflected high productivity of mollusks. Population of benthic fauna has a direct relationship with the population of mangrove stands, sediment form, tidal flow, current, temperature, salinity, pollution and over exploitation (Barkati and Rehman 2005). Lowest abundance of *P. cingulatus* at the Korangi creek area as compared to Sandspit back waters could be due to the discharge of untreated sewage water and industrial discharge from major industries and ships, including oil spills and waste. The pollution causes a high nutrient content in the water, which likely caused eutrophication in some creeks. This in turn has resulted in excessive growth of algae, which can smother the young mangrove seedlings, thus regeneration of mangroves and suffocation the pneumatophores. The disparity aggregation patterns of *P. cingulatus* that might be due to the result of differential pattern mortality or predation by predators like sea gulls and crabs (Khan *et al*., 1999).

Ahmadreza *et al*. (2012) also have reported highest gastropod species in the Persian Gulf with significant impact on benthic animal communities, included sediment particle size, salinity, water currents and pollutants. The present study not only provided spatial and temporal variations in the distribution and abundance of the *P. cingulatus* in the coastal mangrove area.

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