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Diversity and Abundance of *Donax* Species at two Sandy Beaches of Karachi Coast

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Abstract: Three species of family Donacidae, *Donax cuneatus, D. denticulatus and D. scalpellum* were recorded from Sandspit and Clifton. A total of 3446 organisms were reported from Clifton and 22 from Sandspit during studied period. A total of 32 samples were collected in duplicate from 04 stations at both sites in Pre-monsoon and during Southwest monsoon period. All the species of *Donax*were most abundant in Pre-monsoon season at both sites and scarce in late SW monsoon season. The total abundance of *D. cuneatus, D. denticulatus and D. scalpellum*is relatively higher at Clifton. *Donax* species was the most abundant species among macro benthic fauna at Clifton mainly at sea view which is relatively a disturbed site. The present study revealed the greater variability in relative abundance of *Donax* species at both sites and influenced by monsoon season rather than morphological characteristics of the sediment.

Keywords: Donax, Southwest Monsoon, Sandy beaches, Macrobenthos,

1. INTRODUCTION

The exposed sandy beaches are physically dynamic benthic environment and one of the more extended intertidal systems worldwide (Lecari *et al.*,2003). Macro benthos provide ideal measures to environmental disturbances and is an effective indicator of the extent and magnitude of pollution impact in the local environment (Perus *et al*., 2007) and considered as good indicator of pollution (Dauvin, 2006; Dauvin *et el*., 2009; Kennedy *et al.*, 1999; Kennish, 1997; Magni, 2003; Ray *et al.*, 1990).

Bivalves are widely used as bio indicators for organic health of coastal areas as their distribution helps to study time integrated ecological contamination (Hussain *et al.*, 2009), because most of them are sessile, sedentary, and stationary. Bivalves also possesses very simple kind of enzyme system which cannot tolerate any pollutants in the environment than fish and crustaceans. That is why bivalve abundances measured as a tool to indicate environmental health (Phillips, 1980,1990). Bivalves of the family Donacidae occupy the exposed intertidal sandy beaches and considered the major group existing in such extremely dynamic environments (Ansell, 1983). Species of the genus *Donax* are commonly found in the soft bottom communities where they are the main primary consumers and predated by extensive variety of invertebrates, fish, birds, and mammals (Luzzatto *et al.*,2001; Peterson *et al.*, 2000; Salas *et al.*, 2001). Henceforth, they establish a significant trophic link in surf zone food webs (McLachlan *et al.*, 1996). In Pakistan, among the mollusks, numerous species of gastropods and bivalves are usually caught for food and shell, predominantly in littoral zones. *D. cuneatus* is widely dispersed from shoreline of Australia to Indian Ocean. The reports on the diversity and abundance of *Donax* species is scarce. The aim of this study is to identify the species diversity and abundance of this important bio-indicator genus at two exposed sandy beaches.

2. MATERIALS AND METHODS

Study area

Sands pit is a 14.5 km long barrier bar which connects the rocky head end of Manora with the main land and at places it is less than 305 m wide. The beach on the seaward side of the bar is backed by low dunes. Clifton beach is located on the south of Karachi city (**Fig.1**). The long beach of Clifton has adjacent tidal mudflats backed by sand dunes. These dunes are of fine to medium grained sand susceptible to wind and wave induced erosion. The main beach is gently sloping and sandy, having very fine brown colored sand.

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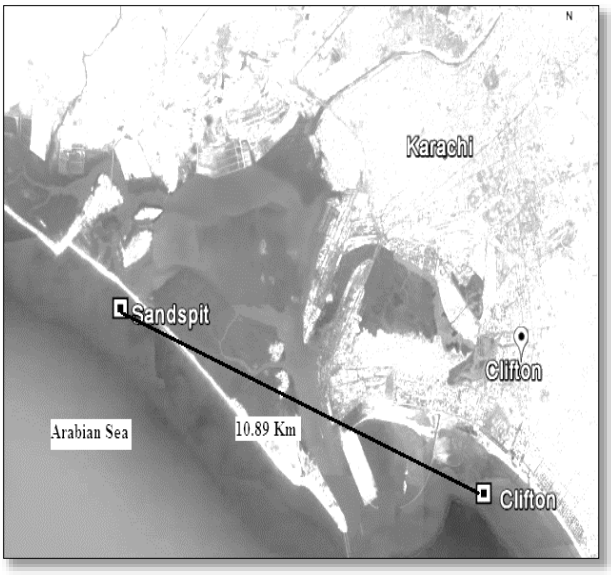

Fig. 1: Study area and schematic position of studied sites of Karachi coast, Pakistan. Satellite image extracted from 2003 Google Earth.

Sampling and Analysis

A total of 32 samples were collected in duplicate from 04 stations (S1, S2, C1 & C2) at both sites in pre-monsoon (March and April) and during Southwest monsoon (May-September) period. In the text PSW stands for pre- monsoon, ESW for early Southwest monsoon, MSW for mid-Southwest monsoon and LSW for late Southwest monsoon season. The samples were collected along a vertical transect at high tide mark (HT) and low tide mark (LT). At each station 2 replicate quadrates of 0.25m^{2}were excavated up to a depth of 10 cm and the collected sand was immediately sieved by using 0.5mm mesh sieve. All fauna retained on sieve were preserved in 4 % formalin. Water temperature was noted with the help of digital thermometer and Salinity by hand held refract meter (Atago, Japan). Samples for the determination of dissolved oxygen were immediately fixed on site and were later determined by Winkler method. For moisture content sediment samples were collected from each station at high tide and low tide mark. The undisturbed samples were taken into clean plastic bags and later dried at 80ºC in electric oven for 24 hours. The loss in weight was used to calculate percentage of moisture content in the sediments. The cluster analysis was performed to visualize the similarities between sites and monsoon season.

3. RESULTS AND DISCUSSION

Physicochemical parameters

The highest concentration of dissolved oxygen was recorded in PSW (8.11mg L^{-1}) from Sandspit, salinity in PSW (48 ‰) from both sites and water temperature in LSW (21 ºC) from S. Overall the highest concentration of dissolved oxygen was obtained from Sandspit (**Table 1**).

Table 1: Physical parameters (mean values) at Sandspit (S1, S2) and Clifton (C1 &C2) during Pre-monsoon (PSW) and SW monsoon season (ESW, MSW and LSW).

	Sandspit				Clifton			
	PSW	ESW	MSW	LSW	PSW	ESW	MSW	LSW
T °C	11	14	18	20	10	13	19	20
S %	47	41	35	37	48	41	34	37
DO mg/L	7.9	6.1	5.7	4.2	8.1	3.5	4.9	1.8

The sediment color at Sandspit was light brown and dark gray to light gray at Clifton. The highest moisture content at Sandspit (18.45%) was recorded from S2 at low tide mark (LT) and lowest (2.41%) from S1 high tide mark (HT) during SW monsoon season (**Fig. 2**). The lowest (22.4%) moisture content at Clifton was recorded from C1 at high tide mark (HT) during pre-monsoon season and highest (29.06%) from C2 low tide mark during SW monsoon season (**Fig. 2**).

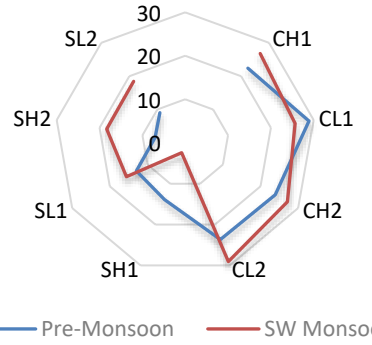

Fig. 2: Moisture Content (%) of sediments from S1, S2, C1 and C2 at low tide (L) and high tide (H) during Pre-monsoon season & SW monsoon season.

Sediment has different effects on benthic communities based on size fraction (Donoghue and Irvine, 2003; Gray, 1981). The concentration of fine sand sediments shows little variation at both studied sites. The sediment characteristics do not appears to control the abundance of *Donax* at studied beaches.

Donax Distribution and abundance

A total of three *Donax* species were reported from studied sites during SW monsooon season (**Table 2**). All the three species were more dominant at Clifton than Sandspit. The highest mean abundance was recorded at C2 from LT mark. Most abundant species was *Donax cuneatus* at both sites during the study (**Table 2**). All the three species were absent at Sandspit during MSW and LSW however comparative abundance was also lower at Clifton during that time. Overall the cumulative abundance of *Donax* was higher at Clifton (**Fig. 3**).

Table 2.Density of three *Donax* species (0.25 m^2) at stations and high and low tides (H & L) from Sandspit and Clifton.

Donax sp.	Season	SH1	SL1	SH2	SL2	Mean	CH1	CL1	CH2	CL2	Mean
Donax cuneatus	PSW	0	12	0	0	3 ± 6	0	0	40	1098	284.5 ± 542.661
Donax denticulatus		0	4	0	0	1 ± 2	0	0	12	78	22.5 ±37.42993
Donax scalpellum		0	0	0	0	0	0	0	2	21	5.75 ± 10.210
Donax cuneatus	ESW	0	0	5	1	1.5 ± 2.380	18	1	3	900	230.5 ± 446.397
Donax denticulatus		0	0	1	1	0.5 ± 0.577	6	1	1	68	19 ± 32.752
Donax scalpellum.		0	0	1	0	0.25 ± 0.5	0	1	1	6	2 ± 2.708
Donax cuneatus	MSW	0	0	0	0	0	8	8	45	507	142 ± 243.957
Donax denticulatus		0	0	0	0	0	1	2	14	93	27.5 ± 44.064
Donax scalpellum.		0	0	0	0	0	0	0	2	5	1.75 ± 2.362
Donax cuneatus	LSW	0	0	0	0	0	3	0	0	161	41 ± 80.012
Donax denticulatus		0	0	0	0	0	1	0	0	20	5.25 ± 9.844
Donax scalpellum.		0	0	0	0	0	0	0	0	10	2.5 ± 5

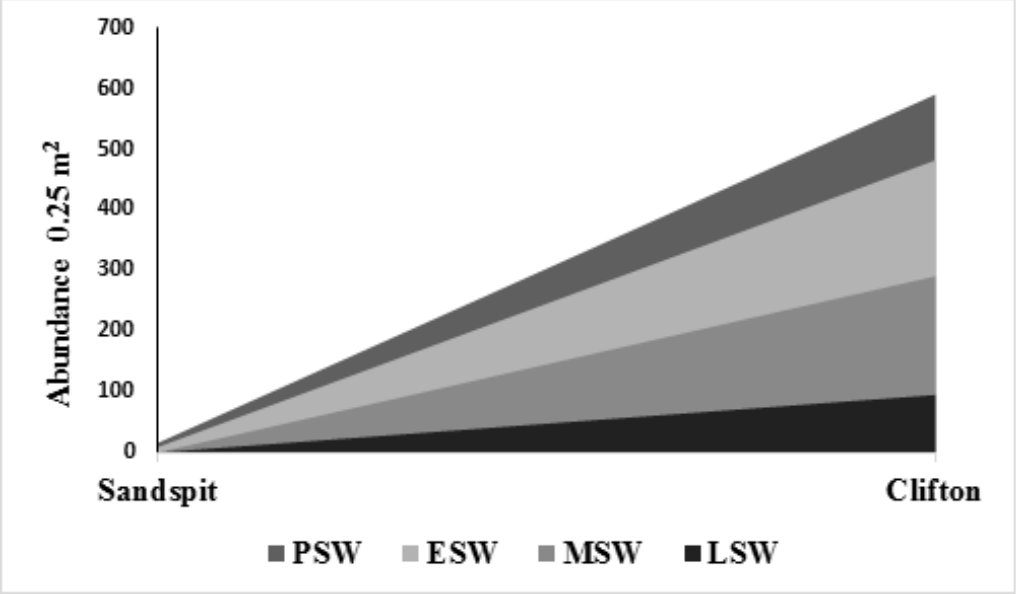

Fig. 3: Cumulative abundance of three species of *Donax* at Sandspit and Clifton during studied monsoon season (PSW = pre- monsoon, ESW = early southwest monsoon, MSW = mid-southwest monsoon and LSW = late southwest monsoon season).

Both sites have shown similar Donax species but with great variability in abundance. There are prominent changes in community structure such as diversity, abundances, dominance, biomass, and others when a benthic community subjected to stress due to unfavorable environmental conditions (Pearson & Rosenberg 1978). More abundance of all the three species of *Dona* was recorded at Clifton which is subjected to greater extent of pollution and anthropogenic activities in comparison to Sandspit which is relatively a clean and undisturbed site (**Fig. 4 and 5**). shows the cluster analysis of the data which clearly indicates the grouping of monsoon season at both sites.

The study showed that the mean highest number of animals were present in low tide zone mainly in PSW when salinities were high, temperatures were low and concentration of dissolved oxygen were high. Similar observations were given by Ahmed and Hameed,1999 for Clifton. Higher *Donax* spp. abundance at Clifton in this month was in

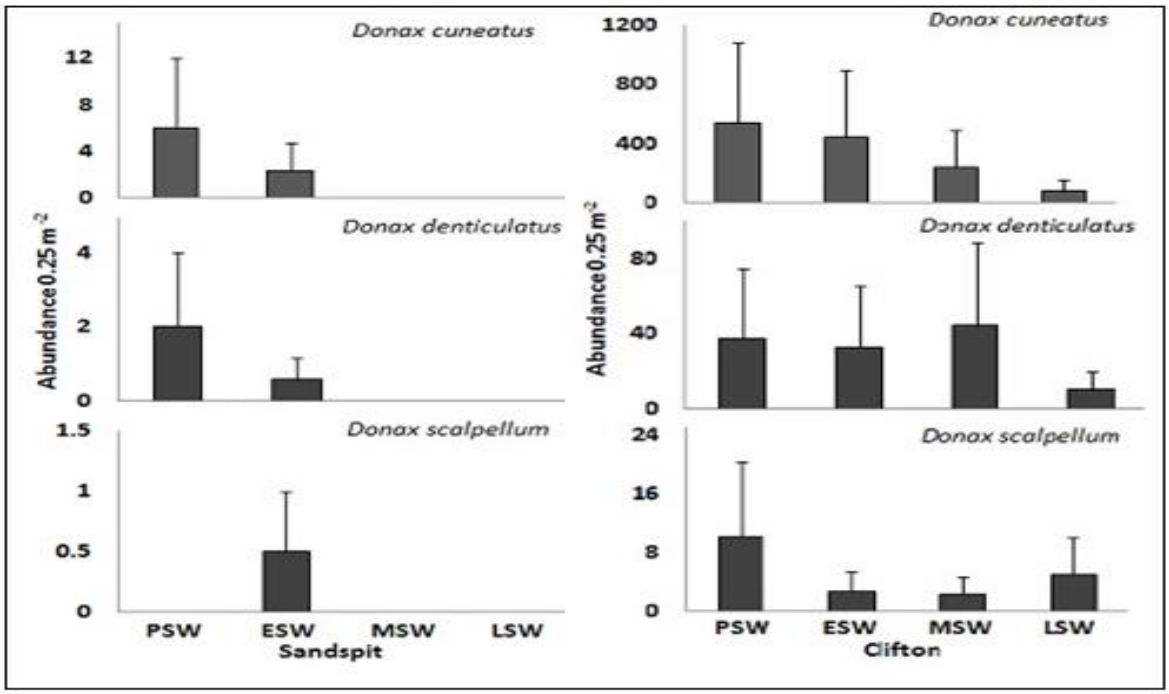

Fig. 4: Abundance of *Donax* species at Sandspit and Clifton during South-West monsoon season (PSW = pre- monsoon, ESW = early southwest monsoon, MSW = mid-southwest monsoon and LSW = late southwest monsoon season).

response to favorable pre-monsoon conditions (Ahmed and Hameed, 1999). The concentration of oxygen was reported to affect the benthic invertebrate communities (Diaz and Solow, 1999). Fluctuation in temperature affects the concentrations of dissolved oxygen and salinity in sea water which ultimately changes microbenthic community structure. The low dissolved oxygen concentration and turbid conditions during SW monsoon season may also be the possible cause of gradual less abundance of *Donax* species during this season at both sites.

The macro benthic community structure is determined by several ecological factors (McLachlan *et al*., 1996; Brazeiro, 2001) physiochemical conditions of the environment (Bilyard, 1987; Clarke & Warwick, 1994) particularly temperature, salinity, light and sediment characteristics (Kennish, 2001) and water content of the sediment (Bally, 1983; Wendt and McLachlan, 1985; Defeo *et al.*, 1992).Some of the *Donax* species also reported to inhabit the environments with high organic loads by several researchers i.e. *D.*serra (Soares *et al.*, 1997), *D.denticulatus* (Sastre,1984), *D. trunculus* (Fishelson, 1999) and *D. cuneatus* (Hussain *et al.*, 2009) which appear to be higher at Clifton as compare to Sandspit. None of the Donax species reported by Ahmed and Hameed, 1999 during their study of macro fauna of Clifton. However, the *Donax cuneatus* was reported prior to their report in abundance in different sections of Clifton beach (Ahmed, 1977).

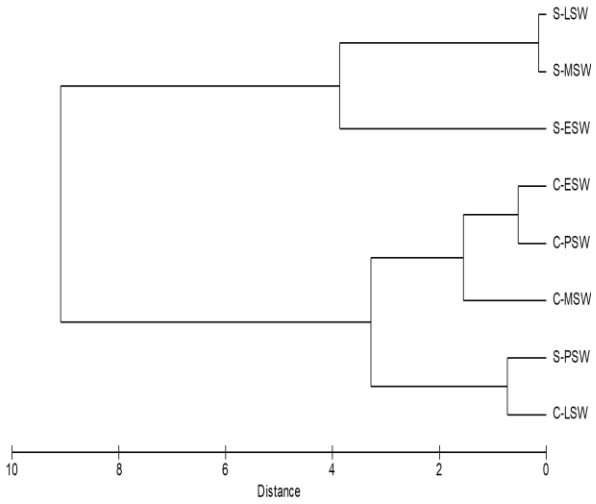

Fig. 5: Cluster analysis of *Donax* species and environmental variables at Sandspit (S) and Clifton (C).

4. CONCLUSION

The present study revealed that the greater variability and relative abundance of *Donax* species at Sandspit and Clifton and there abundance is not influenced by physicochemical properties and morphological characteristics of the sediment. Rather their abundance is influenced by monsoon season and stressed environmental conditions at Clifton. We propose *Donax cuneatus* as an indicator species to monitor health of theses beaches in future.

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