

Article

Diversity, distribution and seasonal abundance of mangrove associated brachyuran crabs along the Karachi Coast

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Abstract

Crabs are referred as keystone species of mangrove ecosystem and are essential as their burrowing habit promotes bioturbation and organic matter degradation that sustain the health of mangrove forests. The present research is an attempt to review the diversity of crabs in two mangrove areas of Karachi: Sandspit backwater and Korangi-Phitti creek, emphasizing the importance of mangrove ecosystems as habitats for brachyuran crabs and highlights the intricate interplay between seasonal variations and species composition. The sampling was conducted on seasonal basis pre-monsoon (January-February), monsoon (August-September) and post-monsoon (November-December). By documenting 14 species and analyzing upto species level distributions across the Sandspit backwater and Korangi-phitti creek areas, this research provides a comprehensive baseline for future ecological and conservation focused studies in Pakistan's coastal mangroves.

Keywords diversity; distribution; seasonal abundance; mangrove; Brachyuran; Karachi coast.

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1 Introduction

The mangrove ecosystem is an area with high biodiversity and is a type of forest ecosystem able to grow and develop in tidal areas, especially in the flooded part of the river. The mangrove ecosystem boasts lush and dense vegetation, with mangrove species displaying remarkable resilience in the face of challenging conditions, including: high salinity, high temperature, frequent water fluctuations, windy conditions and mud and silt flats between low and high tides (Macnae, 1966). Mangrove forests are confined to tropical and subtropical coastlines, spanning latitudes between 32°N and 38°S, as they are sensitive to cold temperatures prevalent in higher-latitude regions of both hemispheres (Satyanarayana et al., 2011; Walter, 1977).

Brachyuran crabs are an important component of the mangrove ecosystem and are among the most

significant taxa in terms of species diversity and total biomass in mangrove swamps (Jones 1984, Macintosh 1984, Ashton et al., 2003, Satheeshkumar, 2012). Tropical and temperate regions of the planet are home to the highest diversity of brachyuran crabs (Rahman et al., 2008). Research on the variety of the local fauna is an extremely important since it sheds light on the various ecological processes and issues that the environment faces. The distribution of crab biodiversity in the past and the future is also significantly influenced by climatic change (Varadharajan et al., 2013).

In mangrove habitats, crabs perform a variety of essential functions that are essential to the stability and well-being of these ecosystems. According to Warren and Underwood (1986), this activity also aids in changing the topography and spreading grain sizes across the sediment, which in turn affects the mangrove habitat's structure. Their burrowing practices produce microhabitats that sustain a wide variety of different creatures, enhancing the ecosystem's overall richness (Bright and Hogue, 1972; Gillikin et al., 2001).

In Pakistan, the total area covered by mangrove on the coast of Sindh is approximately 160,000 ha while on the Balochistan coast the area is about 7,500 ha (Mirza et al., 1988). Mangroves are present in the whole stretch of coastal areas of Sindh, except some areas of Badin District. Studies on mangrove crabs of Pakistan includes Hashmi (1971), Tirmizi and Ghani (1983, 1985), Qureshi (2002), Saher (2008), Nazim et al. (2010), Seher and Qureshi (2010, 2011a, 2011b, 2012), Qureshi and Saher (2012), Khanam et al. (2014), Seher et al. (2014, 2015, 2018), and Qari et al. (2016).

This study aims to fill temporal and spatial gaps by quantifying diversity, distribution and seasonal abundance of mangrove associated brachyurans along the Sandspit backwater and Korangi-phitti creek mangrove areas of Karachi coast.

2 Materials and Methods

2.1 Study area

The Sandspit backwater area is located 18 km southwest of Karachi, stretching about 20 km along the northern Arabian Sea coast with extensive intertidal mudflats and 1640 ha of mangrove swamps behind the beach. Karachi Harbour Backwaters includes Chinna Creek and the Boat Basin Area. It has a wide enclosed wetland area with mangroves. It is potentially a very good area for recreational development (Rafique, 2018). Korangi is bounded on either side by Korangi creeks and situated opposite to the Korangi fish harbor. Geographically, the site is located in the northern creek mangroves of the Indus delta. Mangrove forest mainly comprises of *Avicennia marina* species.

2.2 Data collection

Monitoring and sampling were conducted at Sandspit backwaters and Korangi-phitti creek mangrove areas of Karachi coast were established in three designated stations. Data collection and sampling was performed during low tides at both the designated areas; Sandspit, stations: I ($24^{\circ}49'13''$ N $66^{\circ}56'26''$ E); II ($24^{\circ}49'51''$ N $66^{\circ}55'37''$ E); III ($24^{\circ}50'31''$ N $66^{\circ}54'40''$ E); Korangi-phitti creek, station I ($24^{\circ}47'25''$ N $67^{\circ}13'49''$ E); II ($24^{\circ}47'34''$ N $67^{\circ}13'34''$ E); III ($24^{\circ}47'46''$ N $67^{\circ}13'22''$ E) in low tide during July 2023 to February 2024 (Fig. 1).

The sampling was performed on seasonal basis pre-monsoon (January-February), monsoon (August-September) and post-monsoon (November-December). During low tide three transects were taken from each station, spanning from the low tide mark to the high tide mark with three fixed (0.5m x 0.5m) plots were setup in selected sites, with four points to mark a quadrat (low, mid, high) zone up to the difference between of each quadrat (30 to 50 m) to determine crab abundance and environmental parameters (Salleh-Mukri and Shuhaida,

2020). The difference between each station of Sandspit was approximately (400m), while the difference between stations at Korangi-phitti creek was 250 m. Collected crab specimens from each quadrat were kept in labeled polythene bags and transported to the laboratory for further analysis. Randomly captured crabs were stored in sealed plastic bags and taken to the laboratory for identification. The number of captured crabs were identified and recorded for each quadrat. A photograph was taken of all specimens in the field. The physico-chemical parameters water temperature ($^{\circ}\text{C}$); salinity ($\%$), and pH were measured.

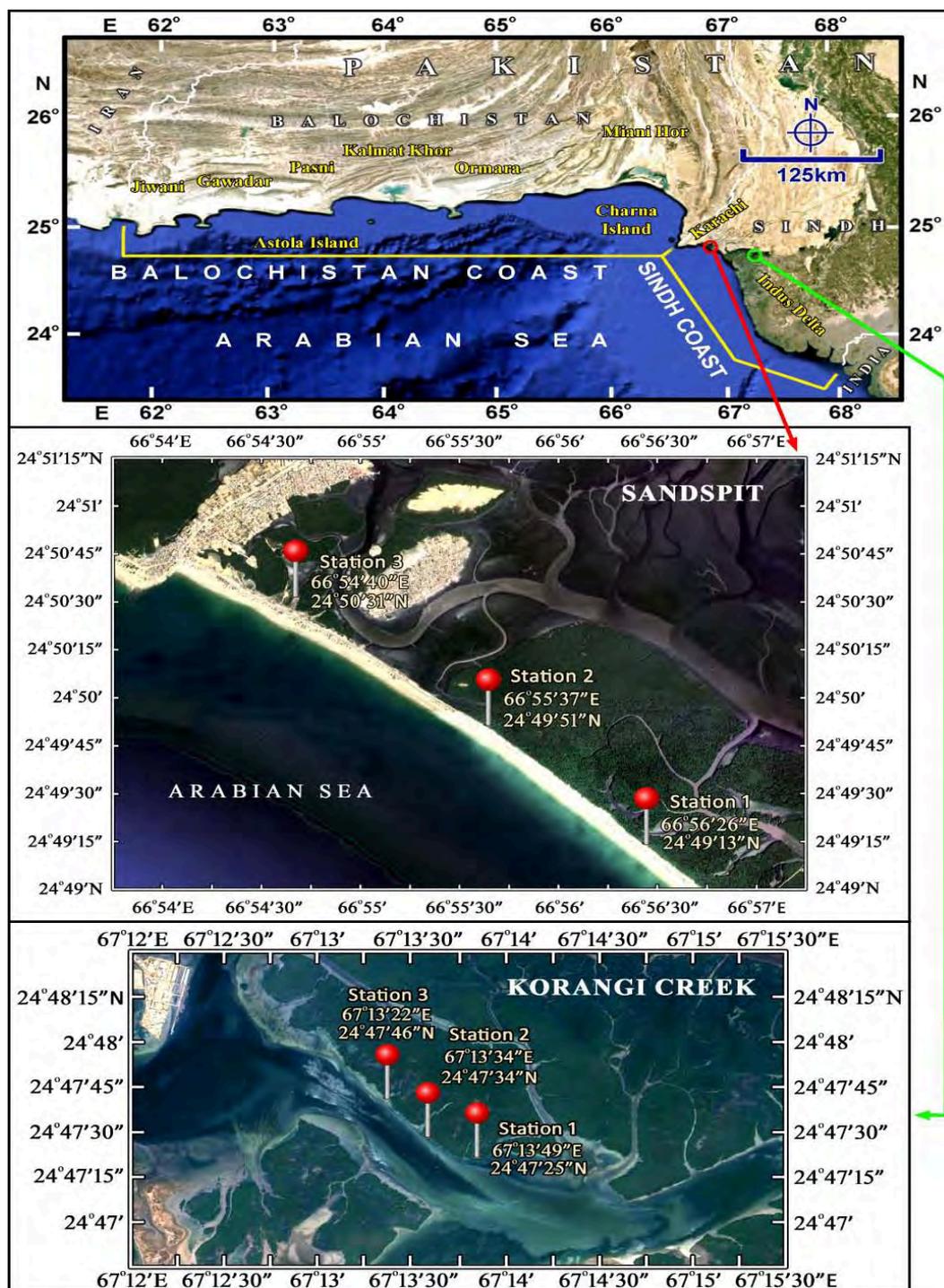


Fig. 1 Study area map, Sandspit backwater and Korangi-phitti creek.

2.3 Identification of samples

In the laboratory, the crab specimens were sorted and examined morphologically. All identifying characters such as the eyes and eye stalk, size, shape, texture and coloration of the carapace, claws, and abdominal segments were carefully examined for species identification. The samples were photographed. The specimens were identified up to species level followed by the taxonomic keys and available literatures (Tirmizi and Ghani, 1983, 1985; Tirmizi and Kazmi, 1996). The nomenclature was designated as per WoRMS (World Register of Marine Species, 2024) guidelines. Samples were preserved with 70% ethanol, tagged with date and location and deposited in the Marine Reference Collection and Resource Centre, University of Karachi (Cat. No. MRC&RC-UOK- BRAC- 467, 503, 509, 685, 698, 712, 721, 722, 731, 756, 758, 765, 766, 767).

2.4 Diversity index measurements

The comparison of the diversity of brachyurans crab at the station were analyzed by using, the Shannon-Wiener diversity index (1949): The Pielou's Evenness Index (J') (Pielou, 1966) was applied to exemplify the pattern of distribution of individuals between major groups. Margalef's index (Margalef, 1951) was applied to analyze the relationship between the number of other groups and individual numbers with their distribution based on abundance.

3 Results

Physico-chemical parameters air temperature (°C), water temperature, salinity (ppt) and pH were measured seasonally (pre-monsoon, monsoon, post-monsoon) from Sandspit and Korangi-phitti creek during low tide in July 2023 to February 2024 (Fig. 2).

The recorded air temperature (°C) at Sandspit ranged between 22 - 31°C and Korangi-phitti creek between 24 - 30°C. Water temperature (°C) at Sandspit ranged between 21-30°C and at Korangi-phitti creek ranged between 23 - 30°C. Salinity (‰) at Sandspit ranged between 36‰ - 42 ‰ and at Korangi-phitti creek ranged between 36‰ - 37‰. The recorded pH at Sandspit ranged between from 7.8-7.9 and at Korangi-phitti creek ranged between 7.9-8.0 (Fig. 2).

Total (n=429) crab specimens were collected seasonally in pre-monsoon (n=133), monsoon (n=159) and post-monsoon (n=137) at Sandspit backwaters mangrove area during July 2023 to February 2024. A total of seven (07) species *Austruca annulipes*, *Austruca lacteal*, *Tabuca urvillei*, *Ocypode rotundata*, *Macrophthalmus depressus*, *Chaenostoma boscii* and *Parasesarma plicatum* representing 6 genera and 3 families (Ocypodidae, Macrophthalmidae and Sesarmidae) were recorded from the entire study areas (Table 1, Fig. 4). Crab specimens collected from low (n=163), mid (n=138) and high (n=128). Highest numbers of crabs were collected from lowest zone. Sandspit (zone) =low=163>mid=138>high=128.

Total (n=310) crab specimens were collected seasonally in pre-monsoon (n=106), monsoon (n=63) and post-monsoon (n=141) at Korangi-phitti creek during July 2023 to February 2024. A total of nine (09) species *Austruca annulipes*, *Tabuca urvillei*, *Macrophthalmus laevis*, *Episesarma versicolor*, *Portunus pelagicus*, *Thalamita prymna*, *Scylla serrata*, *Dotilla blanfordi*, and *Pilumnopus convexus* representing 9 genera and 6 families (Ocypodidae, Macrophthalmidae, Sesarmidae, Portunidae, Dotillidae and Pilumnidae) were recorded from the entire study areas (Table 1, Fig. 4). Crab specimens collected from low (n=124), mid (n=122) and high (n=64). Highest numbers of crabs were collected from lowest zone. Korangi-phitti creek (zone) =low=124>mid=122>high=64.

Seasonal variations in percentage (%) composition of crab species at Sandspit backwaters shows (Fig. 3)

Pre-monsoon= Ocypodidae, 75.9%; Macrophthalamidae, 17.2%; Sesarmidae, 6.7%. Monsoon= Ocypodidae, 62.8%; Macrophthalamidae, 30.1%; Sesarmidae, 6.9%. Post-monsoon= Ocypodidae, 62%; Macrophthalamidae, 35.0%; Sesarmidae, 2.9%. Seasonal variations in percentage (%) composition of crab species at Korangi-phitti creek (Fig. 3) shows Pre-monsoon= Ocypodidae, 53.7%; Dotillidae, 7.5%; Macrophthalamidae 9.4%; Sesarmidae, 6.6%; Portunidae, 19.8%; Pilumnidae, 2.8%. Monsoon= Ocypodidae, 50.7%; Dotillidae, 19.0%; Macrophthalamidae 6.3%; Sesarmidae, 4.7%; Portunidae, 12.6%; Pilumnidae, 6.3%. Post-monsoon= Ocypodidae, 63.8%; Dotillidae, 2.1%; Macrophthalamidae 5.6%; Sesarmidae, 9.9%; Portunidae, 9.2%; Pilumnidae, 9.2%.

Diversity index (Shannon-Wiener) ($H' = 1.09$), Margalef's index ($D = 0.30$) and Evenness ($J' = 0.99$) were measured at and diversity index (Shannon-Wiener) ($H' = 1.03$), Margalef's index ($D = 0.34$) and Evenness ($J' = 0.94$) were measured at Korangi-phitti creek (Table 2).

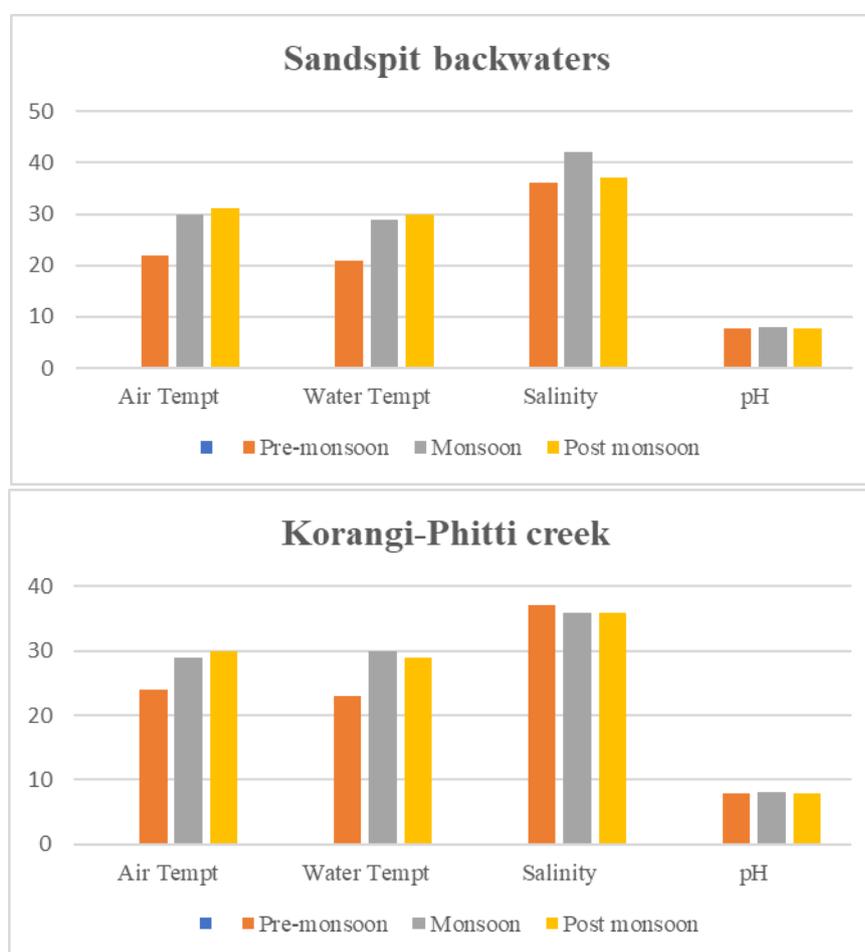


Fig. 2 Physicochemical parameters at Sandspit backwaters and Korangi-phitti creek during July 2023 to February 2024.

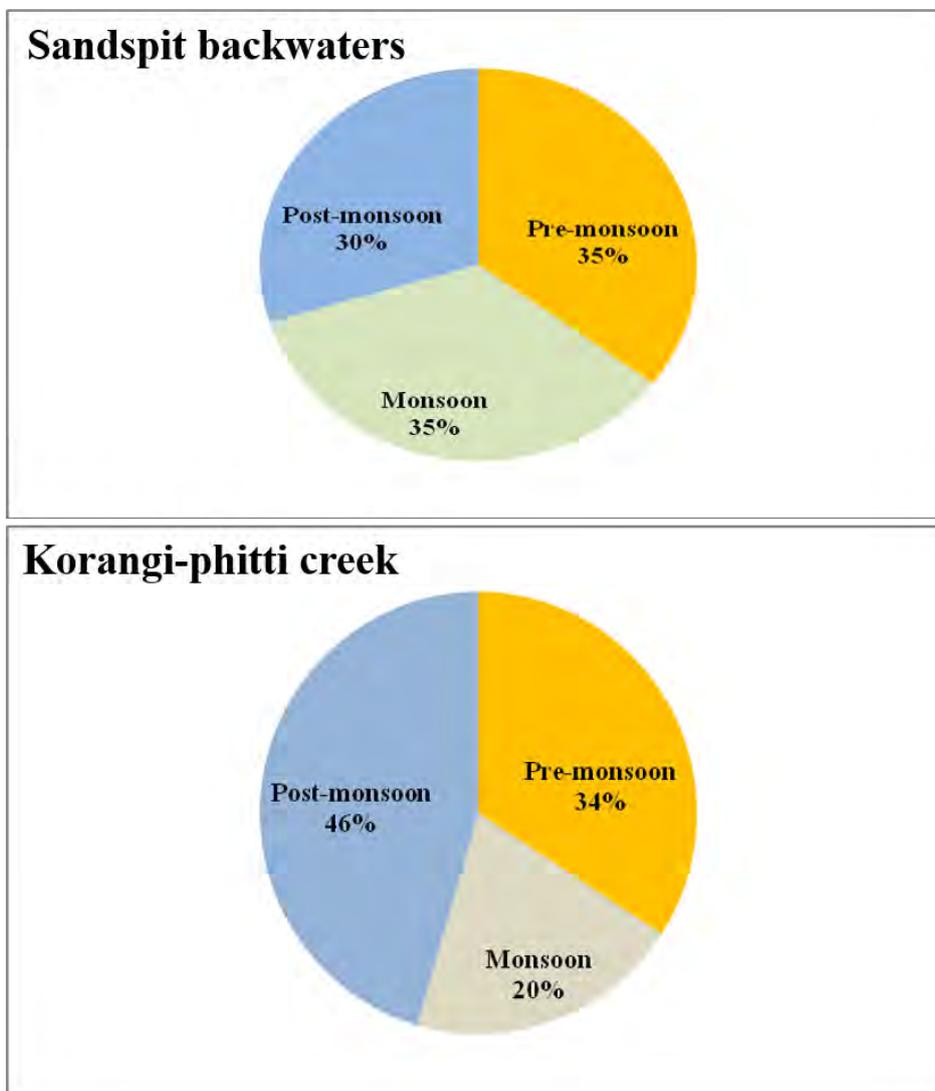


Fig. 3 Seasonal occurrence (%) of crab species collected from Sandspit backwaters and Korangi- phitti creek mangrove area, Karachi coast during July 2023 to February 2024.

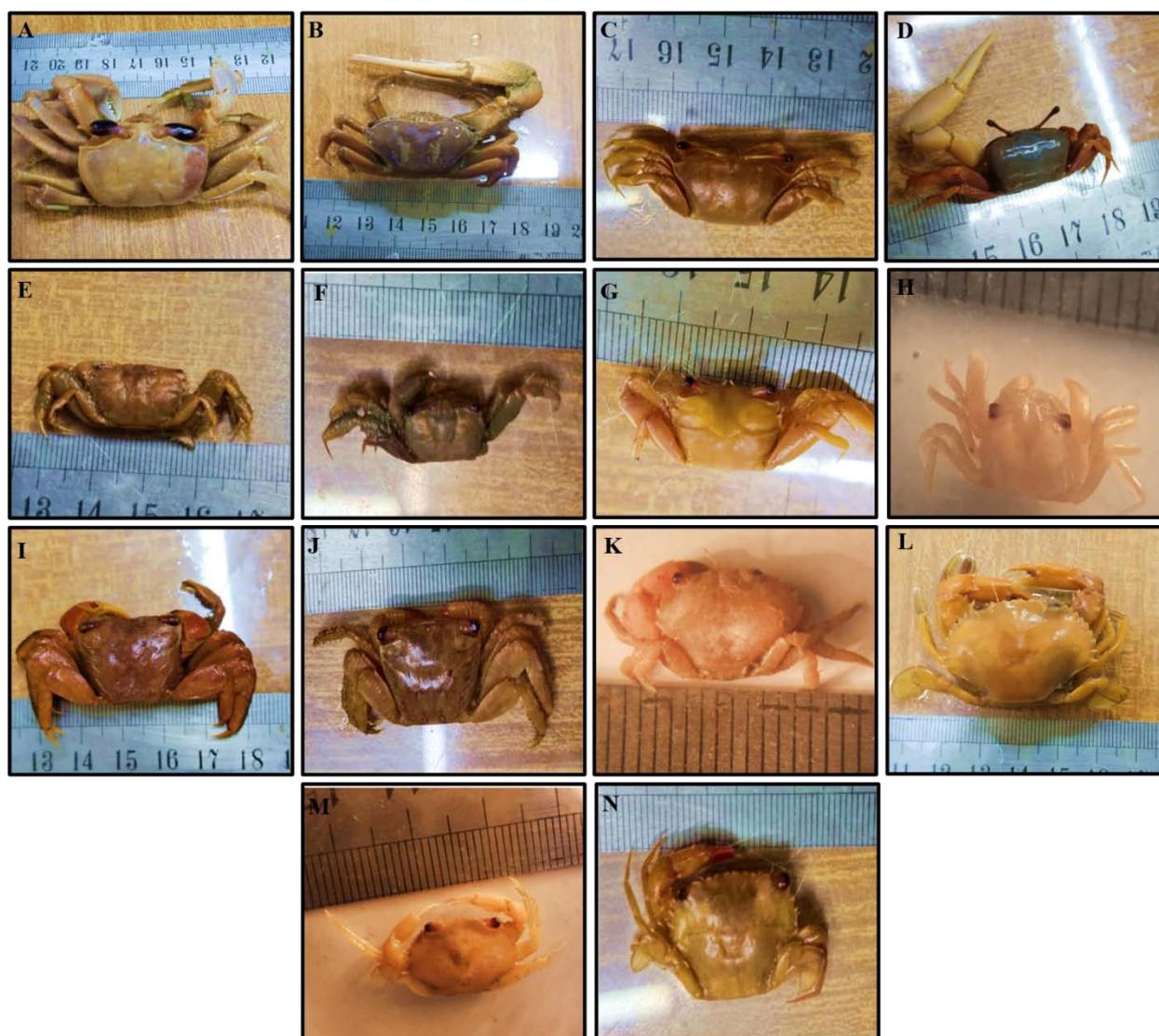


Fig. 4 A. *Ocypode rotundata*, B. *Tubuca urvillei*, C. *Austruca annulipes*, D. *Austruca lactea*, E. *Macrophthalmus depressus*, F. *Macrophthalmus laevis*, G. *Chaenostoma bosicii*, H. *Dotilla blanfordi*, I. *Parasesarma plicatum*, J. *Episesarma versicolor*, K. *Pilumnopus convexus*, L. *Scylla serrata*, M. *Portunus pelagicus*, N. *Thalamita prymna*.

Table 1 Crab species collected from Sandspit backwaters and Korangi-phitti creek mangrove area, Karachi coast during July 2023 to February 2024.

S.no	Species	Sandspit backwaters	Korangi-phitti creek
1.	<i>Austruca annulipes</i>	+	+
2.	<i>Austruca lactea</i>	+	-
3.	<i>Tubuca urvillei</i>	+	+
4.	<i>Ocypode rotundata</i>	+	-
5.	<i>Macrophthalmus depressus</i>	+	-

6.	<i>Macrophthalmus laevis</i>	-	+
7.	<i>Chaenostoma boscii</i>	+	-
8.	<i>Episesarma versicolor</i>	-	+
9.	<i>Parasesarma plicatum</i>	+	-
10.	<i>Portunus pelagicus</i>	-	+
11.	<i>Thalamita prymna</i>	-	+
12.	<i>Scylla serrata</i>	-	+
13.	<i>Dotilla blanfordi</i>	-	+
14.	<i>Pilumnopeus convexus</i>	-	+

Table 2 Diversity index Shannon – Wiener diversity index, Margalef’s index and Evenness from Sandspit and Korangi-phitti creek mangrove areas of Karachi coast during July 2023 to February 2024.

Season	No. Of Individual (N)	Shannon – Wiener Diversity Index H'	Margalef’s Index D	Evenness J'
Sandspit	429	1.09	0.30	0.99
Korangi-phitti creek	310	1.03	0.34	0.94

4 Discussion

This research is an attempt to review the diversity of crabs from mangrove areas of Korangi-phitti creek and Sandspit backwaters. A total of 14 crab species were identified during the study period at Sandspit backwaters and Korangi-phitti creek mangrove areas Karachi Pakistan. Seven crab species belonging to three families representing six genera were collected from the Sandspit backwaters, family Ocypodidae consists of four species, *Austruca annulipes*, *Austruca lactea*, *Tubuca urvillei* and *Ocypode rotundata*, family Macrophthalmidae consists of two species, *Macrophthalmus depressus* and *Chaenostoma boscii*, family Sesarmidae consists of only single species, *Parasesarma plicatum*. Nine crab species belonging to six families representing nine genera were collected from the Korangi-phitti creek mangrove area during the study. Family Ocypodidae consists of two species *Austruca annulipes* and *Tubuca urvillei*, family Macrophthalmidae consists of one species *Macrophthalmus laevis*, family Sesarmidae consists of single species *Episesarma versicolor*, family Portunidae consists of three species *Portunus pelagicus*, *Thalamita prymna* and *Scylla serrata*, family Dotillidae consists of one species *Dotilla blanfordi*, family Pilumnidae consists of one species *Pilumnopeus convexus*.

Qureshi (2002) studied the distribution and abundance of fiddler crabs and associated crabs and fauna in

the mangrove areas along the Karachi coast. Kazmi et al. (2005) reported 1 species *Cardisoma carnifex* from Korangi creek, Saher and Qureshi (2010) studied the zonal distribution and population biology of *Ilyoplax frater* in a mangrove mudflat area of Pakistan. Qari et al. (2016) studied the samples of Ocypodidae crab *Dotilla blanfordi* were collected of two different shores of Karachi coast i.e., Clifton and Korangi creek. Last reported work on mangrove crabs was conducted by Saher in 2018, she reported 18 species of crabs from Sindh mangroves, Keti bunder, Dhabeji Bhambore, Phitti Creek, Korangi Creek, Sandspit, Sonari Balochistan mangroves, Sonmiani Bay lagoon and Dham. Present study shows four species (*Ocypode rotundata*, *Thalamita prymna*, *Pilumnopus convexus*, *Dotilla blanfordi*) were reported first time from Korangi-phitti creek and Sandspit backwaters Karachi coast. Three species (*Tabuca urvillei*, *Parasesarma plicatum*, *Episesarma versicolor*) were found first time from Korangi-phitti creek and 1 species *Ocypode rotundata* first time reported from Sandspit backwaters. Now, present research study was conducted after a gap of 5 years as a review on diversity of mangrove crabs at two designated mangrove sites.

The present findings are comparable to those of Nazim et al. (2010) documented brachyuran crabs in mangrove forests across Sandspit backwaters, Port Qasim, and Agra Taj, emphasizing the importance of these habitats for brachyurans diversity. While Nazim et al. (2010), primarily focused on distribution and habitat assessment, the present study provides a more detailed account of seasonal variations and family level composition and reported a total of ten species of crabs belonging to four families Ocypodidae, Mennipidae, Portunidae, Grapsidae and Pilumnidae. Khanam et al. (2014) reported *Macrophthalmus depressus* as a significant species in the mangrove swamps, in contrast, the current study also highlighted the seasonal dynamics of these families occurrence at both sites during pre-monsoon, monsoon and post-monsoon periods, at Sandspit backwaters and Korangi –Pitti creek. A study by Saher and Qureshi (2011) documented 14 species of brachyuran crabs across three mangrove sites in Balochistan, namely Bhaira, Dam, and Miani. These species belonged to six families: Ocypodidae, Macrophthalmidae, Dotillidae, Camptandriidae, Grapsidae, and Xanthidae. In contrast to the present study, Saher and Qureshi's research found significant variation in crab diversity between sites and tide levels, with Ocypodidae being the most common family in both mangrove habitats. Their analysis of tidal levels provides additional insights into habitat preferences, complementing the seasonal perspective of the current research.

The crab abundance was significantly higher at Sandspit backwaters (n=429) compared to Korangi-Phitti creek. This disparity can be attributed to the relatively undisturbed state of the Sandspit backwaters area, a WWF-protected site, which offers a more favorable habitat for terrestrial and semi-terrestrial detritivorous decapod crustaceans (Mann, 1972). In contrast, the other location exhibits human disturbance, likely contributing to the lower species diversity. The findings indicate that *Sesarma plicatum* and *Uca* sp. were the dominant species across all areas. The limited tidal flooding in the area may have facilitated the colonization and establishment of fiddler crab populations (Nazim et al., 2010). Future research could build on this study by incorporating ecological indices to investigate community structure, explore relationships between ecological patterns and environmental factors, and advance understanding of ecosystem dynamics. This would complement the current research, which focuses on seasonal percentage compositions. Present results computed the diversity index (Shannon-wiener) ($H' = 1.09$), Margalef's index ($D = 0.30$) and evenness ($J' = 0.99$) were measured at Sandspit backwaters (mangrove areas) and diversity index (Shannon-wiener) ($H' = 1.03$), Margalef's index ($D = 0.34$) and evenness ($J' = 0.94$) were measured at Korangi-phitti creek (mangrove areas). This study reveals a higher species richness at Korangi-phitti creek and greater crab diversity abundance at Sandspit backwaters. Both studies emphasize the importance of vegetated habitats for supporting higher

species richness and diversity indices. Consistent with this, the mangrove rooted Korangi area in the current study exhibited a broader diversity of families, including Portunidae and Dotillidae, which were absent from Sandspit. While both studies observed spatial variability in crab assemblages, they differ in their findings on seasonal variations. This study reveals detailed seasonal variations, including changes in family composition percentages during the monsoon and post-monsoon periods, with Ocypodidae dominating throughout all seasons.

Present study shows the occurrence and abundance of crab species at Sandspit backwaters in zonation's was at Low=163>Mid=138>High=128 while at Korangi-phitti creek=Low=124>Mid=122>High=64. The results revealed that low and mid zonation shows greater numbers of crab specimens. The distribution of crab species varied along the coast, with smaller juveniles and females predominantly found in lower coastal areas. Species like *Uca annulipes*, *Macrophthalmus depressus*, and *M. erato* were found near the water edge, while *Thalamita chapatali* and *Portunus sanguinolentus* thrived in sand-dominated substrates.

By documenting 14 species and analyzing their distributions across Sandspit backwaters and Korangi-phitti creek, this research establishes a comprehensive baseline for future ecological and conservation focused studies in Pakistan's coastal mangroves. The findings align with regional and global research, emphasizing the ecological role of dominant families like Ocypodidae and Portunidae. The study suggests that the distribution of mangrove plants, tidal inundation, and substrate suitability may influence the zonation and abundance of crabs in these areas. Furthermore, it highlights the potential of these species as bio-indicators of environmental changes and habitat health.

5 Conclusions

Future research can build upon this foundation by incorporating ecological indices and molecular techniques to better understand crab population dynamics and their responses to environmental stressors. These initiatives will significantly contribute to the development of effective conservation plans for maintaining the biodiversity and ecological services provided by mangrove ecosystems.

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