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Some Physical Parameters of the Sandspit Backwaters, Karachi Coast

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Certain physical parameters like, salinity, temperature, dissolved oxygen, pH, rainfall, grain size analysis and organic content of the sediment from the Sandspit backwater, Karachi have been studied. The sampling was done on a fortnightly basis for a period of two years i.e. June 1987 to May 1988. The salinity of the backwater ranged between 16.99 to 45.00 ppt with an average value of 37.98 ± 4.32 ppt (S.D.) (n = 48). The open sea salinity varied from 34.30 to 39.48 ppt, with an average salinity value of 36.91 ± 0.97 ppt. (S.D.) (n = 48). The average temperature of the backwater was found to be 28.9 ± 3.9°C (S.D.) (n = 48) with a range of 19.5°C to 34.5°C. The average temperature of the open sea was found to be 27.2 ± 2.5 °C (S.D.) (n = 48). The lowest temperature was 22.0°C, whereas the highest temperature was 33.0°C. The monthly mean of daily maximum air temperature ranged between 25.6 to 36.4°C, while the monthly mean of daily minimum air temperature ranged between 10.5 to 28.4°C. Mean monthly temperature ranged between 18.1 to 32.3°C. The maximum rainfall was 85 mm in the month of August 1988, while the minimum rainfall recorded was 0.5 mm in the month of January 1989. The mean value of dissolved oxygen in the backwater was found to be 5.01 ± 0.97 ml/l (S.D.) (n = 48). The lowest value was 3.00 ml/l, whereas the highest value was 6.55 ml/l. The average value of dissolved oxygen for the open sea was found to be 5.25 ± 0.85 ml/l (S.D.) (n = 48). The average pH of the backwater was found to be 7.61 ± 0.46 (S.D.) (n=48), whereas, it ranged from 6.34 to 8.05. The samples collected from intertidal pool had greater percentage of sand fraction (79.70-89.84%) as compared to those collected from mud flat, which had 63.33 to 79.86 % of sand fraction. The organic content was found to vary from 3.19 to 8.32 %.

Key words: Salinity, Temperature, pH, Dissolved oxygen, Rainfall, Organic carbon, Karachi coast.

Introduction

Sandspit backwater is known as a nursery ground for various species of fish and shellfish. It is located between Manora and Hawks Bay at 24°50' N and 66°56' E i.e. southwest of Karachi. The backwater is connected to the Arabian Sea through Manora Channel (Fig 1). During high and low tides, water enters the Sandspit backwater area and drains back periodically to the Arabian Sea through Manora channel. It is estimated that an average volume of about 3.4 million m^3 of seawater enters and leaves the backwater area during the tidal cycle (Haq 1976). The backwater also receives discharge from the Lyaria river, which is not a perennial river. The Lyari river discharges freshwater during the rainy season, which lasts for two to three months (July through September), while during the rest of the year, it discharges mostly industrial and domestic effluents. It has been estimated that the Lyari river brings 120 million gallon per day of municipal and industrial wastewater with an organic load of 2000 tons of BOD per day. (Beg *et al* 1984).

Our knowledge regarding physical parameters of the Sandspit backwater is very limited. Some information is available through the work of Nooruddin and Khursheed-uddin (1968) Beg *et al* (1984), Qasim *et al* (1986), Khan and Saleem (1988), Siddiqui and Qasim (1988), Barkati and Tirmizi (1990), and Saifullah and Rasool (1998). While investigating the bionomics and population structure of the juvenile shrimps occurring in the Sandspit backwater it was felt necessary that a survey of the range of habitat in which these juvenile shrimps dwell should be examined. Hence data on the distribution and fluctuation of certain physical parameters like, salinity, temperature, dissolved oxygen, pH and rainfall were recorded for a period of two years. Grain size analysis and organic content of the sediment inhabited by the juvenile shrimps were also studied on some occasions.

Materials and Methods

For the determination of salinity, surface seawater was collected in screw-capped amber glass bottles, from the Sandspit backwater (station 1 in Fig 1), on a fortnightly basis, for a period of two years (June 1987 to May 1989). For comparison, another sample of seawater was collected from the open sea of the Sandspit beach (station 2 in Fig 1). The bottles were sealed immediately with parafilm. The salinity was measured in the laboratory by a conductivity salinometer (Model E-2,

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Fig 1. Map of the Karachi coast showing collection site: St. 1 Sandspit backwater; St.2, Open sea.

Ogawa Sieki Incorporation). The salinometer was calibrated with standard seawater and had a maximum range of 40 ppt. A portable salinity refractometer (Model S/Mill-E, Atago Co. Ltd.) was used for those samples whose salinity was found greater than 40 ppt. Temperature was recorded by a mercury thermometer. Dissolved oxygen and pH were recorded *in situ* by the use of a portable oxygen meter (Model 820, Orion Research Incorporated) and a portable pH meter (PICCOLO ATC), respectively.

For grain size analysis and organic content, sediment samples were collected on four occasions; 29th October, 1987, 13th April, 1988, 24th October, 1988 and 16th April, 1989 from the backwater area. The samples collected in the month of October represent the post-monsoon (southwest) period and the samples collected in the month of April, represent the pre-monsoon (southwest) period. On each occasion, two samples were collected. One of the samples was collected from the intertidal pond (hereafter referred as sub-station 1-A), while the other sample was collected from the nearby mud flat exposed during low tide (hereafter referred as sub-station 1-B). The sediment from each sub-station was collected with a plastic corer, having a diameter of 10cm. The corer was pushed about 15cm into the sediment and the core so obtained was placed in a plastic bag. For grain size analysis, the method described by Buchanan (1984) was followed. Based on the data cumulative curves were drawn and statistical parameters such as graphic mean (Mz), inclusive standard deviation (s), inclusive graphic skewness (Ski) and Graphic curtosis (K_G) were determined. The samples were categorized according to scheme proposed by Folk (1968). For estimation of the organic content, a modification of Schollenberger chromic acid oxidation technique was used. The analytical procedure is mainly taken from Walkley and Blake (1934). The data for air temperature and the rainfall were obtained from the Meteorological Department, Government of Pakistan.

Results and Discussion

Salinity. Figure 2 shows the fluctuation of salinity of the backwater and of the open sea from June 1987 through May 1989. The salinity of the backwater ranged between 16.99 ppt on 17th July, 1988 to 45.00 ppt on 14th December, 1987. The average salinity for the study period (24 months) was found

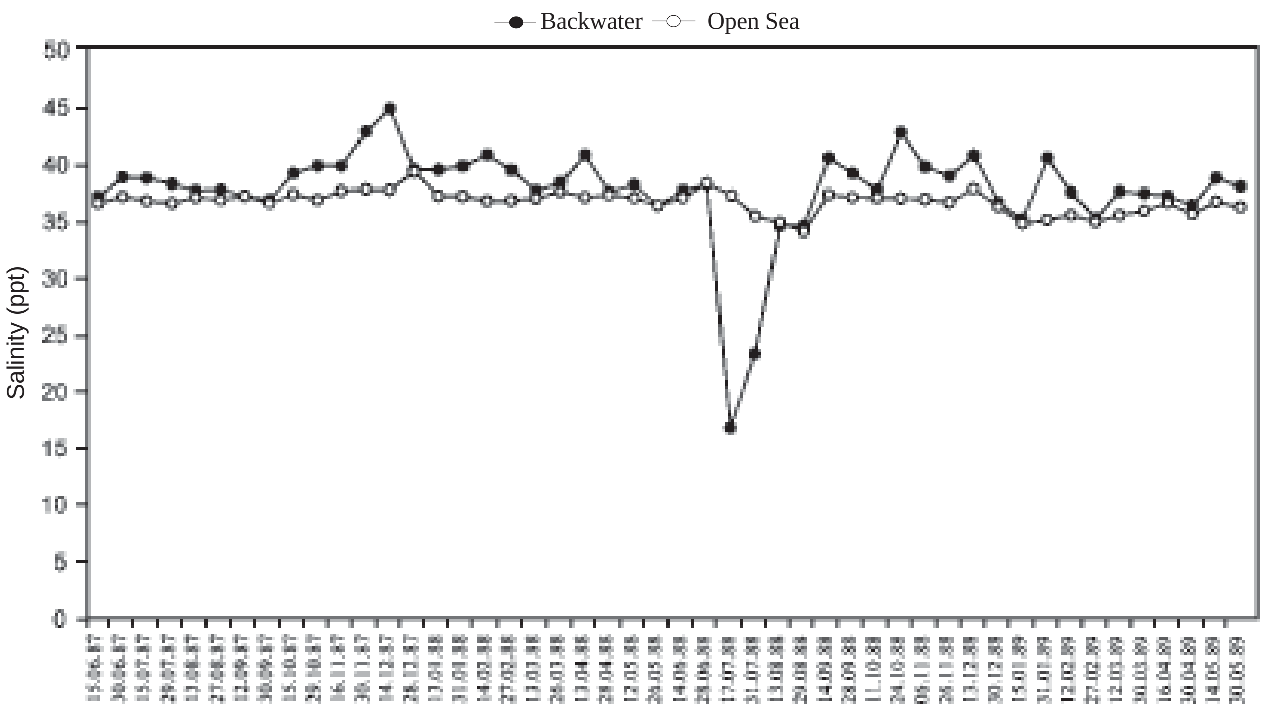

Fig 2. Salinity of the backwater and water from open sea during June 1987 - May 1989.

to be 37.98 ± 4.32 ppt (S.D.) (n = 48). During southwest monsoon period of 1987 (June to September), the average salinity of the backwater was 37.96 ± 0.75 ppt (S.D.) (n = 8)), whereas in the same monsoon period of 1988 (May to September), it was much lower i.e. 34.17 ± 7.73 ppt (S.D.) (n = 10). The average salinity of the backwater during the northeast monsoon period of 1987-1988 (November to March) was 40.44 ± 2.11 ppt (S.D.) (n = 10), while in the same monsoon period of 1988-1989 (November to March) the salinity was 38.22 ± 1.90 ppt (S.D.) (n = 10). The average salinity for the first year of study (June 1987 through May 1988) was 39.22 ± 1.92 ppt (S.D.) (n = 24), while for the second year of study (June 1988 through May 1989), it was 36.73 ± 5.55 ppt (S.D.) (n = 24).

The open sea salinity varied from 34.30 ppt on 29th August, 1988 to 39.48 ppt on 28th December, 1987. The average salinity for the study period was found to be 36.91 ± 0.97 ppt (S.D.) (n = 48). The average salinity during the southwest monsoon period of 1987 (June to September), was found to be 36.98 ± 0.27 ppt (S.D.) (n = 8), whereas, in 1988 southwest monsoon period it was 36.71 ± 1.30 ppt (S.D.) (n = 10). During the northeast monsoon period of 1987 - 1988 (November to March), the average salinity was 37.68 ± 0.73 ppt (S.D.) (n = 10). In the 1988-1989, northeast monsoon period (November to March), the average salinity was 36.20 ± 0.93 ppt (S.D.) (n = 10). During the first year of the study (June 1987 to May 1988), the average salinity was 37.33 ± 0.60 ppt (S.D.) (n = 24), whereas in the second year (June 1988 to May 1989), it was 36.51 ± 1.08 ppt (S.D.) (n = 24).

Seawater temperature. The variation in temperature of the backwater and of the open sea is presented in Fig 3. The values shown are only day temperatures recorded during low tides. The average temperature of the backwater for 24 months was found to be 28.9 ± 3.9°C (S.D.) (n = 48). The lowest temperature 19.5°C was recorded on 28th December, 1987, while the highest temperature 34.5°C was recorded on 30th June, 1987. The average temperature for the southwest monsoon of 1987 (June to September) was found to be 32.50 ± 1.04°C (S.D.) (n = 8), whereas in 1988 southwest monsoon (May to September) it was slightly lower, i.e. 30.90 ± 1.54°C (S.D.) (n = 10). During northeast monsoon of 1987-1988 (November - March), the average temperature was 25.20 ± 4.14°C (S.D.) (n = 10) and for the same monsoon period of 1988-1989 (November to March) it was slightly higher, i.e. 26.25 ± 2.62°C (S.D.) (n = 10). On the other hand, the average temperature of the open sea for 24 months was found to be 27.2 ± 2.5°C (S.D.) (n = 48) The lowest temperature 22.0°C was recorded on 14th December, 1987 whereas the highest temperature 33.0°C was recorded on 30th June, 1987. During the southwest monsoon of 1987 (June to September) and 1988 (May to September), the average values of seawater temperature was 29.88 ± 1.62°C (S.D.) (n = 8) and 28.95 ± 1.79°C (S.D.) (n = 10), respectively. Similarly during the Northeast monsoon of 1987-1988

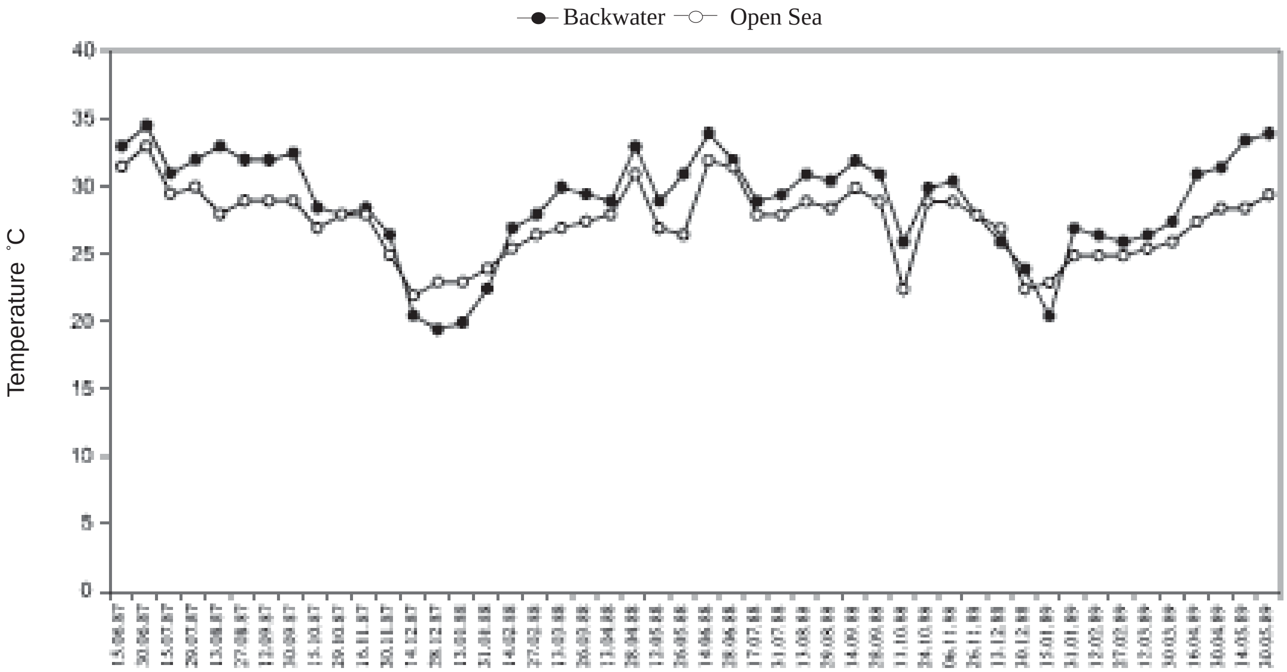

Fig 3. Temperature of the backwater and water from open sea during June 1987 - May 1989.

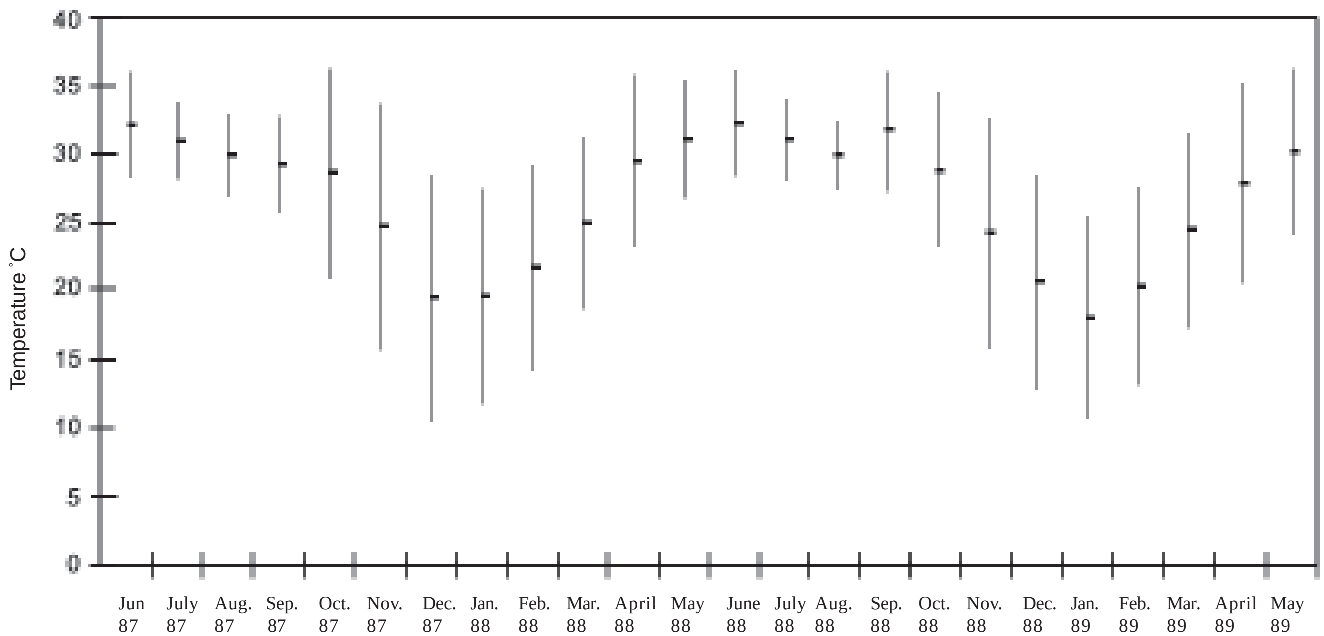

Fig 4. Air temperature at Karachi during the study period. Horizontal bar indicates mean monthly temperature and vertical iline shows range between monthly means of daily maximum and minimum temperature.

(November to March) and 1988-1989 (November to March), the average temperature was found to be 25.15 ± 2.10˚C (S.D.) (n = 10) and 25.60 ± 2.02˚C (S.D.) (n = 10), respectively.

Air temperature: Figure 4 shows the variation in air temperature of Karachi, from June 1987 through May 1989. The monthly mean of daily maximum temperature ranged between 25.6˚C in January 1989 to 36.4˚C in May 1989, while the monthly mean of daily minimum temperature ranged between 10.5˚C in December 1987 to 28.4˚C in June 1988. The mean monthly temperature ranged between 18.1˚C in January 1989 to 32.3˚C in June 1988. During the southwest monsoon of 1987 (May to September), the average air temperature was 30.58 ± 1.24˚C

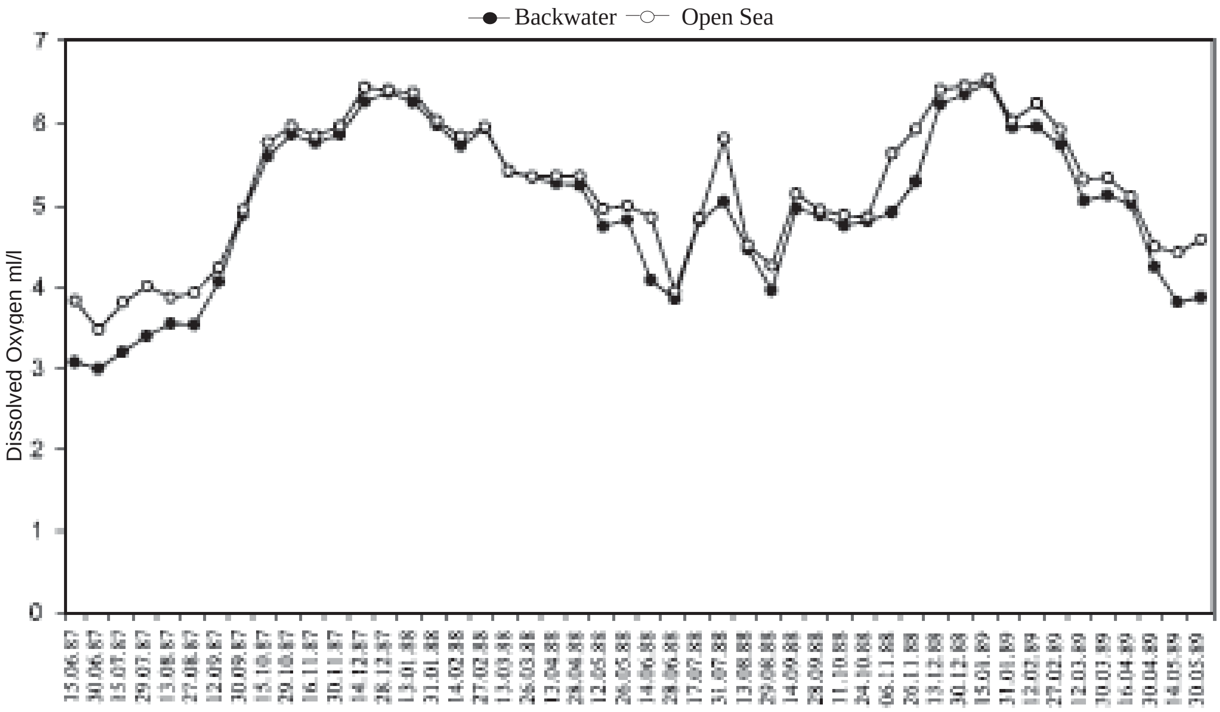

Fig 5. Dissolved oxygen in backwater and water from open sea during June 1987 - May 1989.

(S.E.) (n = 5), whereas in the same monsoon period of 1988 (May to September), it was 31.24 ± 0.90˚C (S.E.) (n = 5). In the northeast monsoon period of 1987 - 1988 (November to March), the average air temperature was 22.10 ± 2.66˚C (S.E.) (n = 5) and for the same monsoon period of 1988 - 1989 (November to March), the temperature was 23.22 ± 3.94˚C (S.E.) (n = 5).

Dissolved oxygen. Figure 5 shows the amount of dissolved oxygen found in the backwater as well as in the water from the open sea during the study period. In the backwater, the mean value of dissolved oxygen was found to be 5.01 ± 0.97 ml/l (S.D.) (n = 48). The lowest value 3.00 ml/l was found on 30th June 1987, whereas the highest value 6.55 ml/l was recorded on 15th January, 1989. In the period of the southwest monsoon of 1987 (June to September), the average value of dissolved oxygen was 3.60 ± 0.63 ml/l (S.D.) (n = 8), while in the same monsoon period of 1988 (May to September) the average value was 4.60 ± 0.44 ml/l (S.D) (n = 10). During the northeast monsoon of 1987-1988 (November to March) the average dissolved oxygen was 5.91 ± 0.34 ml/l (S.D.) (n = 10) and 5.76 ± 0.58 ml/l (S.D.) (n = 10) was the average value for the same monsoon period of 1988-1989. During first year of the present investigation (June 1987 to May 1989), the average value of dissolved oxygen was 4.98 ± 1.13 ml/l (S.D.) (n = 24), while in the second year, it was found to be slightly higher i.e. 5.03 ± 0.81 ml/l (S.D.) (n = 24).

The average value of dissolved oxygen for the open sea was found to be 5.25 ± 0.85 ml/l (S.D.) (n = 48) during the study period. The lowest value 3.48 ml/l was found on 30th June, 1987, while the highest value 6.58 ml/l was recorded on 15th January, 1989. The average value of dissolved oxygen during the southwest monsoon period of 1987 (June to September) and 1988 (May to September) was found to be 4.02 ± 0.44 ml/l (S.D.) (n = 8) and 4.86 ± 0.51 ml/l (S.D.) (n = 10), respectively. Similarly, during the northeast monsoon of 1987-1988 and 1988 - 1989 (November to March), the average value was 5.98 ± 0.37 ml/l (S.D.) (n = 10) and 6.03 ± 0.44 ml/l (S.D.) (n = 10), respectively. During first year of the investigation, (June 1987 to May 1988), value of dissolved oxygen was 5.19 ± 0.95 ml/l (S.D.) (n = 24), while during second year (June 1988 to May 1989), it was 5.39 ± 0.72 ml/l (S.D.) (n = 24), slightly higher than the first year.

Rainfall. Out of 24 months, it rained only in six months, while the remaining 18 months were dry. The maximum rainfall (85mm) was recorded in August 1988, while the minimum rainfall (0.5mm) was recorded in January 1989. The other four months, which received rainfall were January 1988 (1mm), July 1988 (74mm), February 1989 (8.3mm) and March 1989 (1.5mm). The first year of the present investigation was dry, only 1mm rain fell in the month of January 1988 (northeast monsoon period), the other eleven months were dry. The southwest monsoon period, which is the main rainy season was dry and there was no rain at all. However, in the second year, 160.5 mm rain was recorded. Of this, 159.0 mm rain fell in the month of July and August (southwest monsoon period), the remaining

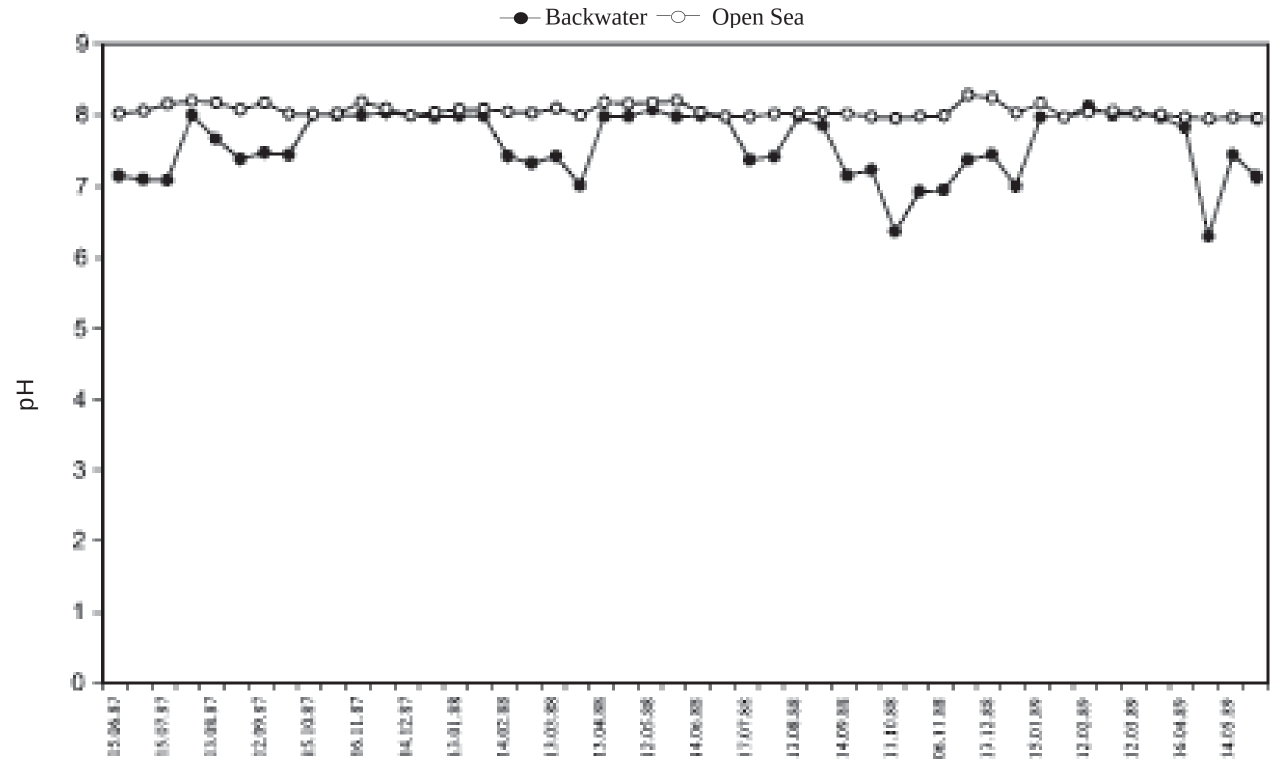

Fig 6. Variation in pH of the backwater and water from open Sea during June 1987 - May 1989.

1.5 mm rain fell in the month of March 1989 (northeast monsoon period).

Seawater pH. Figure 6 shows the fluctuation of pH values of the backwater and of the open sea, during the study period. The average pH was found to be 7.61 ± 0.46 (S.D.) (n = 48) for the period June 1987 to May 1989. The pH of the backwater ranged between 6.34 on 30th April, 1989 to 8.05 on 12th March, 1989. During the southwest monsoon of 1987 (June to September) and 1988 (May to September) the average value of pH was found to be 7.42 ± 0.31 (S.D.) (n = 8) and 7.73 ± 0.36 (S.D.) (n = 10), respectively. During the northeast monsoon of 1987-1988 and 1988-1989 (November to March), the average value of pH was 7.73 ± 0.37 (S.D.) (n = 10) and 7.71 ± 0.45 (S.D.) (n = 10), respectively.

The average value of pH was found to be 8.08 ± 0.08 (S.D.) (n = 48). The lowest pH was recorded on two occasions, first on 11th October, 1988 and then on 30th April, 1989. The highest pH 8.3 was recorded on 26th November, 1988. During the southwest monsoon period of 1987 (June to September) and 1988 (May to September) the average value of pH was 8.11 ± 0.08 (S.D.) (n = 8) and 8.07 ± 0.08 (S.D.) (n = 10), respectively. During the Northeast monsoon of 1987-1988 and 1988-1989 (November to March), the average value of pH was found to be 8.08 ± 0.06 (S.D.) (n = 10) and 8.11 ± 0.11 (S.D.) (n = 10), respectively. The average pH of the backwater was found to be 8.09 ± 0.52 (S.D) and of the open sea 8.08 ± 0.08 (S.D).

Grain-size analysis. Table 1 shows the grain size analysis of the sediment collected from the study area. The samples collected from sub-station 1-A (inter-tidal pool) had greater percentage of sand fraction (79.70-89.84%) as compared to those collected from sub-station 1-B (mudflat), which had 63.33 to 79.86% of sand fraction. During the post-monsoon (SW) period of 1987 and 1988, the sand fraction was 89.84% and 87.91% respectively for the samples collected from sub-station 1-A. From sub-station 1-B samples had 78.26% and 79.86% of the sand fraction for the post-monsoon (SW) period of 1987 and 1988, respectively. In the samples collected during the pre-monsoon (SW) period of 1988 and 1989, the sand fraction was found to be much lower. The two samples collected from station sub-station 1-A had 79.70 and 81.93% of sand in the pre-monsoon period of 1988 and 1989, respectively. Similarly in the same pre-monsoon periods, samples collected from sub-station 1-B had 66.80% and 63.33% of sand.

The highest percentage of silt (coarse and fine) i.e. 28.67% was found in the sample collected from sub-station 1-B on 24th October, 1988 (pre-monsoon), whereas, the lower percentage of silt (coarse and fine) 9.82 was found in the samples of sub station 1-A, collected on 29th October, 1987 (pre-monsoon). The

Table 2
Textural characteristics of the sediment samples collected from the Sandspit backwaters

Textural characteristis	29.10.1987		13.04.1987		24.10.1988		16.4.1989	
	Sub-station 1-A	Sub-station 1-B	Sub-station 1-A	Sub-station 1-B	Sub-station 1-A	Sub-station 1-B	Sub-station 1-A	Sub-station 1-B
M_Z (phi)	0.650	2.300	0.700	2.600	0.700	2.250	0.750	2.700
σ_1	1.280	2.464	1.950	2.560	1.540	2.290	2.290	2.800
Sk_1	0.609	0.423	0.789	1.000	0.690	0.440	0.780	0.390
K_G	2.950	3.684	1.410	0.860	1.440	1.800	1.770	0.760

Table 3
Organic carbon of the sediment collected from the Sandspit backwaters

	29.10.1987 post-monsoon (%)	13.04.1988 pre-monsoon (%)	24.10.1988 Post-monsoon (%)	16.04.1989 Pre-monsoon (%)
Sub-station 1-A Inter-tidal pool	6.06	3.19	5.87	4.05
Sub-station 1-B (Mud flat)	8.32	6.09	7.89	7.20

percentage of clay varied from 0.20 (substation 1-A) on 24th October, 1988 to 6.27 (sub-station 1-B) on 16th April, 1989.

The average grain size (Mz) of sub-station 1-A samples was found to vary from 0.65 to 0.75 ϕ (0.67500 to 0.61250 mm) and those of sub-station 1-B sample was found from 2.25 to 2.70 ϕ (0.21875 to 0.16250 mm) (Table 2). Mz values for the samples collected from sub-station 1-A during post-monsoon (SW) period, was found to be 0.650 ϕ (0.675 mm) to 0.700 ϕ (0.650 mm) for 1987 and 1988, respectively. Mz values for sub-station 1-B samples, was found to be 2.300 ϕ (0.21200 mm) and 2.250 ϕ (0.21875 mm), for post-monsoon period of 1987 and 1988, respectively. For pre-monsoon period of 1988 and 1989, the Mz values for samples collected from sub-station 1-B, was 2.600 ϕ (0.1750 mm) and 2.700 ϕ (0.1625 mm) respectively. The values of inclusive standard deviation, (σ_1) for sediment samples collected from sub-station 1-A were in the range of 1.280 to 2.290, while for the sample collected from sub-station 1-B, the values were found in the range of 2.290 to 2.800. Degree of graphic skewness (Sk_1) values were found from 0.609 to 0.789 for the samples of sub-station 1-A and 0.390 to 1.000 for the samples of sub-station 1-B. The value of graphic curtosis (K_G) varied from 1.410 to 2.950 for sub station 1-A samples; and from 0.760 to 3.684 for sub-station 1-B samples i.e. platykurtic to very leptokurtic (Table 2).

Organic carbon content. Table 3 shows the organic carbon content of the sediment samples collected from the study area on four different occasions. The organic carbon was found to range from 3.19% to 8.32%. The sample collected from sub-station 1-A (inter-tidal pool) had a low organic carbon as compared to those collected from sub-station 1-B (mud flat). In the post monsoon (SW) period of 1987 and 1988, the samples of sub-station 1-A had 6.06% and 5.87% organic carbon respectively, while samples from sub-station 1-B in the same period had 8.32% and 7.89% organic carbon, respectively. In the pre-monsoon (SW) period of 1988 and 1989, samples from sub-station 1-A contained 3.19% and 4.05% organic carbon, respectively. Samples from sub-station 1-B contained higher amount of organic carbon i.e. 6.09% and 7.20% in the pre-monsoon (SW) of 1988 and 1989, respectively.

The Karachi coast lies on the western margin of one of the major climatic regions of the world, the monsoon region. The southwest monsoon blows from May to September and brings rain, which is scant. The northeast monsoon lasts from November to March and the rain during this period is even less. October and April are transition periods.

Air temperature generally follows the typical pattern of the subtropical coastal zone. It reaches to its minimum in December and January, which gradually increases from February onward and attains a maximum reading in June. Temperature declines during July and August mainly due to the rain. If there is no rain in July and August even then the temperature is comparatively low due to the strong wind and cloudy sky. A second but comparatively small rise in temperature may occur in September-October (this rise is more prominent in monthly means of maximum temperature as shown in Fig 4), which again decreases from October onward. During the summer months, air temperature has a narrow range, whereas in winter it has a wide range, which may affect the mean value of temperature to some extent. These findings are more or less similar to those reported by Niazi (1993).

The surface temperature of seawater exhibits a more or less similar pattern to that of air temperature. The surface seawater temperature of the backwater is generally higher (by 2 - 4°C) than the open sea during summer months, but in winter the backwater temperature is lower (by 2 - 4 °C) than the open sea. The highest temperature was observed in May and June, while lowest temperature was found in December and January. The results of the present study, during which a range of 19.5°C to 34.5°C was observed for the backwater area, agrees well with the previous studies. In their study on the temperature and salinity of the Karachi coast (Keamari and Fish Harbour), Nooruddin and Khursheeduddin (1968) reported 30.4°C as the highest average value of monthly surface seawater temperature in June and the lowest 19.13°C in January. Similarly Javed and Mustaquim (1993) and Saeed *et al* (1995) reported a range of 20 to 28°C surface seawater temperature from Manora channel during December 1992 to May 1993 and 21 to 35°C from inter-tidal and near shore water of the Karachi coast during 1992-1993, respectively. According to Hussain and Samad (1995), seawater temperature from Manora channel (Baba and Chari Kund Channel) has a range of 21 to 32°C.

Salinity of the Sandspit backwater was found to be highly variable as compared to that of the open sea. The difference between the minimum and maximum value of the seawater was 28.01 ppt, whereas, it was 5.18 ppt only for the open sea. The variation in salinity of the backwater was most pronounced in the second year of study, where there was heavy rain in the months of July and August 1988. The lowest salinity of 16.99 ppt was recorded on 17th July, 1988, when the sampling was done just after the rain had stopped. However the salinity of the open sea was not much affected by the rain and it remained 37.48 ppt. Although it rained more in August 1988 than in July 1988, the lowest salinity was observed in July 1988 because of the reason mentioned above. The sampling in August was done when there was no rain for a period of three or four days. This shows that the rain and flood of the Lyari river can lower the salinity of backwater to great extent but this low value of salinity does not remain for a longer period and may disappear within a period of two to three days or even less, depending on the magnitude of tidal water which flushes the backwater area.

The highest salinity (45 ppt) observed during the present investigation from the backwater is not unusual. Ahmed and Rizvi (1981) mentioned that the salinity might rise to as high as 41 - 42 ppt in the backwaters and tidal creeks of the Karachi area. Saifullah and Taj (1995) while studying the macro-algae of mangrove swamps of the Korangi Creek, Karachi, found a range of 40 to 44 ppt salinity during October and November 1991. However, salinity values of the present investigation have a wider range as compared to those reported by Nooruddin and Khursheeduddin (1968) and also by Hussain and Samad (1995). They reported a range of 27 to 37 ppt from the Keamari coast and 32-38 ppt from Manora (= Baba) channel, respectively. This could be due to the fact that they obtained seawater sample from sub-tidal region and that too during the high tide.

The amount of free oxygen dissolved in water is one of the environmental factors that is of basic importance in the study of any aquatic ecosystem (Reid and Wood 1976). The range of dissolved oxygen (3ml/l to 6.55 ml/l) observed during present investigation compare well with the data of earlier workers like Khan and Saleem (1988) who recorded average oxygen values from Karachi Harbour of 2.09 to 6.41 ml/l, whereas Hussain and Samad (1995) reported a range of 2.4 to 6.7 ml/l of dissolved oxygen from Manora (= Baba) channel. The lowest values of dissolved oxygen such as 2.09 or 2.4ml/l may occur towards the mouth of the Lyari River where sewage is discharged and is attacked by decomposers. These lower levels of oxygen was not observed during present investigation from the sampling sites, which is far away from the mouth of the Lyari River.

Ghamrawy (1982) while studying the ecology and biology of penaeid shrimp in the region of Jeddah, Saudi Arabia found the surface seawater dissolved oxygen inversely related to the temperature. Similarly Mahmood, (1990) who undertook a study on immigration of penaeid shrimp post-larvae in the estuarine area of Chakaria, Cox's Bazar, Bangladesh mentioned that the dissolved oxygen content of surface seawater was inversely related to the rise and fall of temperature. He concluded that the temperature mainly regulates the seasonal cycle of dissolved oxygen. He considered other factors like biological processes; flood discharge and chemical degradation of organic matter are less significant in the estuarine area of Chakaria. The amount of dissolved oxygen found during the present investigation also shows that it is inversely related to the temperature. The lower values of dissolved oxygen were found during summer months or southwest monsoon, whereas higher values were observed during winter months or northeast monsoon.

It is well known that biological processes like respiration and decomposition producing carbon dioxide hardly affect the pH of seawater, nor does the removal of carbon dioxide in photosynthesis. The carbonate buffer system maintains the pH of seawater in a state of weak alkalinity. However, in diluted seawater and in an isolated basin when H_2S is produced, the pH may approach 7.0 or even fall in the acidic range. The presence of "acid sulphate soil" in the coastal areas of tropical and sub-tropical countries is another factor, which brings down the pH of seawater in the acidic range (Simpson and Pedini1985). In their study on acid sulphate soil of the coastal aquaculture ponds of Bangladesh, Mahmood and Saikat (1995) found mangrove soil pH as low as 4.36. However, during present investigation the pH of open seawater was found to be slightly alkaline, whereas, pH of the backwater had a range of 6.34 to 8.05. This is comparable with the data of Hussain and Samad (1995), who observed a pH range of 6.5-8.2 in the Karachi Harbour area. The lower values of the pH may be attributed to the dilution of seawater or presence of H_2S but it is quite unlikely that the values of pH are due to "acid sulphate soil", a condition that has never been reported from the Karachi coast.

The sediment as a habitat for animals can be characterized on the basis of grain size and sorting. The coarse interstitial sediment drains fast and retains less water or organic matter. Fine sediment such as mud has poor water circulation and often, low oxygen retention. Medium and fine sands usually have abundant meio-fauna and macro-fauna. Muds have more organic matter per unit area and faunal densities are frequently highest here. During present investigation, it was observed that the intertidal area of the Sandspit backwater is mostly muddy with some sandy patches. This being the case, two substations were selected for sediment analysis, one was apparently sandy (sub station 1-A) and the other one is soft and muddy (sub station 1-B).

During southwest monsoon (*i.e*. May to September) the high energy wave normally changes the composition of the sediment in the areas close to the shore. Hence, more sand fraction is expected in the backwater sediments just after the monsoon period. When the monsoon is over, the wave action calms down a great deal and this enhance the process of siltation especially in the creek areas and in the backwaters. This was observed in the present study, when more sand fraction was found in the sediment samples collected in the post-monsoon period.

While grain size and sorting are probably the two most important characteristics that can be determined for sediment samples, other biologically important properties include the organic carbon content of the sediment. Although organic carbon was studied only on four occasions during the present investigation, it can be seen from the results obtained that the organic carbon content of the sediment increases with the fineness of the deposit.

It is evident that the Sandspit backwater area is not a typical estuary for most part of the year. It only acts as an estuary during monsoon seasons when there is rain. In the remaining months, the salinity is much higher than the open sea and the area becomes a negative estuary. It looses more water by evaporation than the Lyari river is able to deliver. Such estuaries are usually low in biological productivity. The biological productivity of the Sandspit backwater is not known. Hence, there is a need to investigate the primary and secondary productivity of the area.

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