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PHYTOPLANKTON COMPOSITION IN A MANGROVE ECOSYSTEM AT SANDSPIT, KARACHI, PAKISTAN

MAHWISH SHOAIB, ZAIB-UN-NISA BURHAN*, SEEMA SHAFIQUE, HINA JABEEN AND PIRZADA JAMAL AHMED SIDDIQUE

Centre of Excellence in Marine Biology, University of Karachi, Karachi-75270, Pakistan
**Corresponding author's email: zaib.burhan@uok.edu.pk*

Abstract

The phytoplankton occurring in the mangrove habitat of Sandspit, Karachi was assessed qualitatively and quantitatively during a period from June 2013 to May 2014. Species of diatoms appeared to be more diverse and dominant forms. In contrast dinoflagellates exhibited very low species diversity and were observed in samples collected from June, August and September. Phytoplankton cell density varied seasonally and their abundance ranged from 0.25 $x10^6$-7.044$x10^6$ and 0.042$x10^6$-5.172$x10^6$ cells L^{-1} during high and low tide, respectively. Pennate diatoms were highly diversified when compare to centric diatoms (3 centric and 23 pennate). Centric diatoms were dominated by *Cyclotella* cf. *meneghiniana*, whereas *Cyilndrotheca closterium* was the most abundant species in the pennate group followed, by *Navicula* sp., *Nitzschia* sp., *Pleurosigma* sp. and *Gyrosigma* sp. respectively. The dinoflagellates were represented by very few species such as *Alexandrium* sp., *Prorocentrum micans* and *Gyrodinium spirale.* Seasonal variations in hydrographical parameters were also recorded and the data ranges for salinity (33-42 PSU), temperature (16-32˚C), pH (7.0-7.7), dissolved oxygen (0.08-6.18mg/L), total suspended solids (0.97-13.8 mg/L) and chlorophyll *a* (0.0006-0.431 µg/L). During the period of this investigation Sandspit backwaters received a load of pollution from the Layari River and therefore the resistant diatom species dominated and dinoflagellates occurred in very low abundance and diversity. Implication of pollution and changing hydrographical parameters in the coastal waters of Karachi with phytoplankton structure need regular monitoring and research.

Key words: Diatom, Phytoplankton, species composition, Mangroves, Pakistan

Introduction

Mangroves are known as one of the highly productive ecosystems of the world (Bouillon *et al*., 2008, Alongi 2009). These mangroves are intertidal forests confined to tropical and subtropical areas (Tomlinson, 1986). They have been valued for their services to ecosystem, for example soil building, protection against floods and hurricanes, as habitat and nursery grounds for many commercially important fishes and shellfishes (Odum & Heald, 1972). Their role as buffering zone between land and sea has also been recognized (Badruddin *et al*., 1996). These forests have also achieved increasing eco-tourism worldwide (Kathiresan & Bingham, 2001).

Pakistan has a coastline of about 1050 km long, including 250 km belonging to Sindh and 800 km to Balochistan coast, respectively (Siddiqui *et al*., 2008), lying in a sub-tropical area. The Indus delta of the Sindh coast is covered with dense growth of mangroves (Saifullah, 1982). The Indus River delta is categorized as the fifth largest mangrove area in the world (Mirza *et al*., 1988). These mangrove forests in the Indus Delta region constitute major mangrove covered area along the Sindh Coast. Miani Hor, Balochistan coast also have pockets of mangroves (Saifullah & Rasool, 2002). Mangrove forests of Pakistan seem to be altered from other mangrove areas in term of polluted waters, because they receive effluents from the Lyari and Malir Rivers, causing serious environmental degradation (Saifullah *et al*., 2004).

Phytoplankton are primary producer in estuaries and seas, enter into the aquatic food chain and thus support directly or indirectly in the production of fish and other animals living in marine habitat (Castro & Huber, 2003). The nutrient rich environment provides favorable conditions for primary production and may enhance phytoplankton growth (Faust & Gulledge, 1996). Eutrophication phenomenon occur where nutrients loads are high and ultimately favour the growth of phytoplankton (Nixon, 1984). Availability of nitrogen sources is related with nutrient concentration (Bradley *et al.*, 2010). Ammonia and nitrate are two main sources of dissolved nitrogen. Nitrate has been derived from land cleaning and usage of fertilizer and has great synergic effect (Bradley *et al.*, 2010) while ammonia is derived from waste water discharge (Nixon, 1984; Cloern & Jassby, 2010).

The distribution of phytoplankton in the North Arabian Sea bordering Pakistan has been described earlier (Shameel & Tanaka, 1992). Some recent work on seasonal variations in abundance, diversity and growth of phytoplankton community including diatoms and dinoflagellates has been reported from coastal waters of Karachi, Pakistan (Munir *et al.*, 2012, 2013a, b, 2015a, b; Naz *et al.*, 2010, 2012, 2013a,b, 2014; Khokhar *et al.*, 2016). However, mangrove ecosystems which are often subject to high nutrient loadings leading to eutrophication due to domestic discharge and effluents receive from the Lyari and Malir Rivers, causing serious environmental degradation (Harrison *et al.*, 1997; Saifullah *et al*., 2004) may reflect a different situation of phytoplankton community structure. Therefore, the objective of present investigation is to study effect of the environmental parameters with abundance and seasonal distribution of phytoplankton in mangrove habitat. Seasonal studies on distribution of phytoplankton also necessary to understand the situation of pollution and under stress environment which ultimately will be helpful for obtaining information relevant to the fishery resources.

Materials and Methods

Sampling and sample preparation: Monthly samples were collected from June 2013 to May 2014 from mangrove habitats at Sandspit (24˚50 N and 66º 56 E) southwest of habitats around Karachi (Fig. 1). Water samples were collected using bucket and analyzed for water quality and phytoplankton abundance. The water quality parameters of the study site were analyzed using respective instruments. Water temperature (mercury thermometer), salinity (refractometer; Atago, Japan) and pH (ELEMETRON CP-401 pH meter). Dissolved oxygen (DO) and nutrients (nitrate, nitrite, ammonia and phosphate), total suspended solids (TSS) and chlorophyll *a* was estimated according to previously described method (Strickland & Parsons, 1972).

Phytoplankton abundance and diversity: For diversity and distribution of phytoplankton duplicate water samples were collected and preserved in acid Lugol's (1%) solution (Utermöhl, 1958). Depending on the cell density, variable volumes (50 ml, 10 ml, and 1 ml) were settled in settling chamber (Hydrobios, Germany) for 24h, 12h and 10 min, respectively. Cells were observed and counted under inverted microscope (Olympus, IX-51 Japan). For qualitative assessment of phytoplankton community, taxa were identified on the basis of morphological characters (Tomas, 1997). Validity of taxonomic status was updated through Algae Base (Guiray & Guiray, 2016).

Results

Hydrographical parameters: Seasonal data collected for hydrographical parameters at high and low tide of the backwaters is presented in Table 1. There was not much variation in hydrographical characteristics of two tidal levels of the backwaters system. Surface temperature of both tides varied from 16.0°C in the month of January to 32°C in June (Table 1 & Fig. 2). Average Salinity value (38 PSU) was found at both high and low tide (Fig. 2 & Table 1). Over all pH values were neutral or basic (Fig. 2 & Table 1). DO values fluctuated at high tide (0.45-6.18 mg/L) and 0.08-2.94 mg/L (low tide) (Fig. 2 & Table 1). While TSS showed no variations at both tides (Table 1), with a high value (13.1 mg/L) was observed in the month of March at both tidal conditions.

Chlorophyll *a*: Chlorophyll *a* values showed slight variations during the study period. The values varied between 0.0009-0.431 μgL^{-1} to 0.0006-0.427 μgL^{-1} at high and low tide, respectively (Table 1). Maximum values of Chlorophyll *a* were reported in the month of February and minimum in July at both tides (Figs. 3 & 4).

Nutrient analyses: Highest value of ammonium ion concentration was found in January and lowest value was observed in the April (Fig. 5a; Table 1) at both tides. Slight fluctuations in nitrite ion concentration were observed with two pronounced peaks in the month of August and February (Fig. 5b). Average value of nitrite showed no significant differences (Table 1). In case of nitrate ion concentration a reverse peak was recorded during both tides in June, with several fluctuations (Fig. 5c). Lowest value of nitrate was found at high tide (Table 1). Same observation was noted for phosphate ion concentration (Table 1). Higher values were observed in April and low in July at both tides (Fig. 5d).

Fig. 1. Map of the study area Showing backwaters of Sandspit, at Karachi coast, Pakistan (with permission from Google Map).

Table 1. Water quality parameters and cell abundance of phytoplankton recorded at high and low tidal conditions at Sandspit backwaters, Karachi.

Parameters	Min and Max values (Average)	
	High tide	Low tide
Water quality		
Temperature (°C)	16-32 (24)	16-32 (24)
Salinity (PSU)	33-42 (38)	35-42 (38)
pH	7.1-7.6 (7.4)	7.0-7.7 (7.4)
Dissolved oxygen (mgL^{-1})	0.45-6.18 (2.19)	0.08-2.94 (1.12)
TSS (mgL^{-1})	1.10-13.80 (3.74)	0.97-13.08 (3.65)
Chlorophyll a (μg L-1)	0.0009-0.431 (0.067)	0.0006-0.427 (0.083)
Ammonia (μgL^{-1})	0.0498-18.07 (6.533)	0.088-17.75 (5.15)
Nitrite (μgL^{-1})	0.029-0.502 (0.1447)	0.033-0.284 (0.101)
Nitrate (μgL^{-1})	0.163-4.869 (1.874)	0.382-5.640 (2.26)
Phosphate (μgL^{-1})	0.11-2.66 (1.413)	0.56-2.95 (1.66)
Phytoplankton abundance		
Total (cell L^{-1})	$0.256x10^6$- $7.044x10^6$ ($1.84\ x10^6$)	$0.042x10^6$- $5.172x10^6$ ($1.101\ x10^6$)
Diatoms (cell L^{-1})	$0.256x10^6$- $7.04x10^6$ ($1.84\ x10^6$)	$0.042x10^6$-$5.17\ x10^6$ ($1.101\ x10^6$)
Dinoflagellates (cell L^{-1})	$0.0004x10^6$ -$0.004x10^6$ ($0.002.\ x10^6$)	0.00003-$x10^6$ -$0.002x10^6$ ($0.001\ x10^6$)

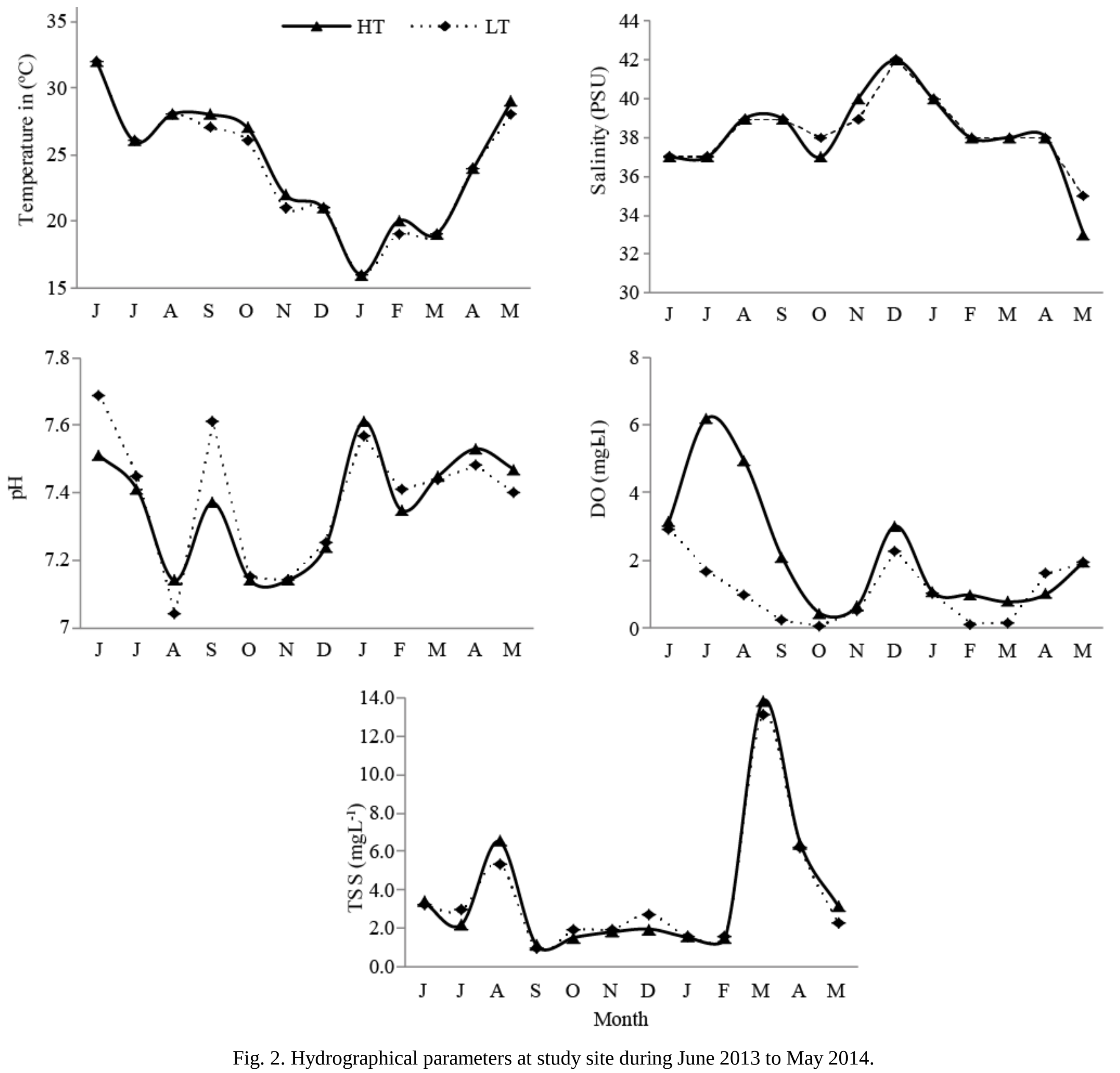

Fig. 2. Hydrographical parameters at study site during June 2013 to May 2014.

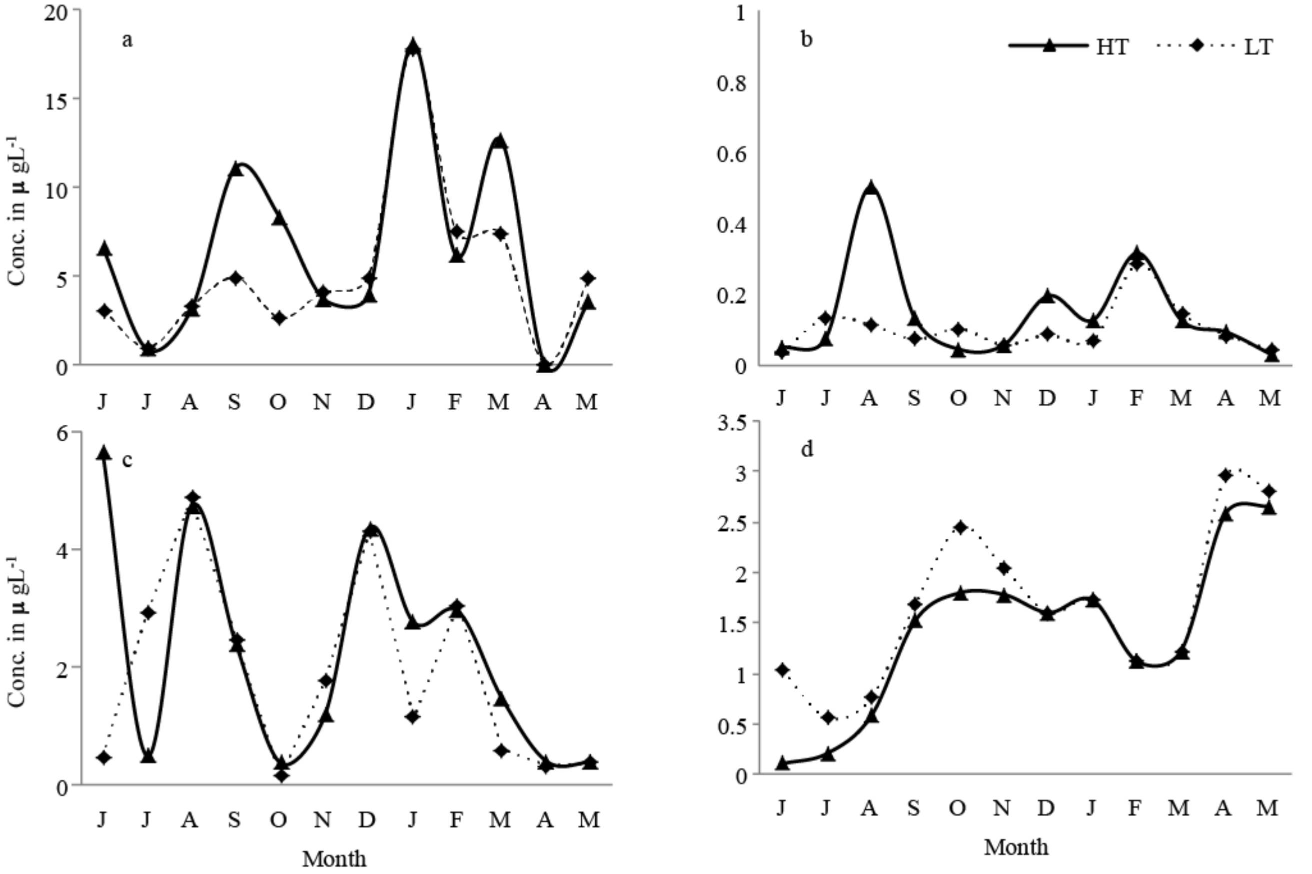

Fig. 3. Seasonal changes in the concentration of nutrients (a) ammonia (b) nitrite (c) Nitrate (d) phosphate during low and high tides at Sandspit backwaters, Karachi.

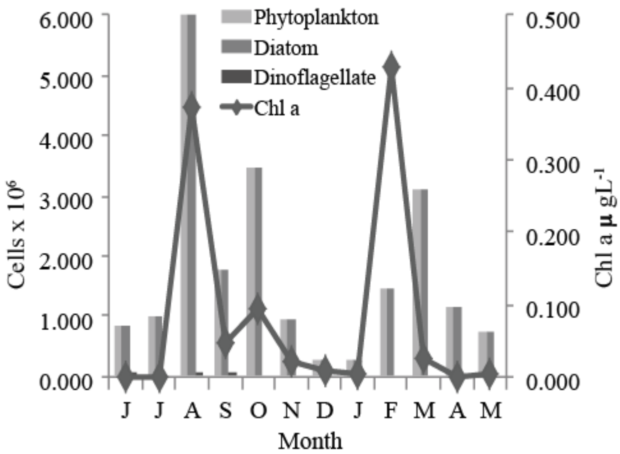

Fig. 4. Monthly variations in the composition of phytoplankton, diatom, and dinoflagellates and Chl *a* during the high tide at study site.

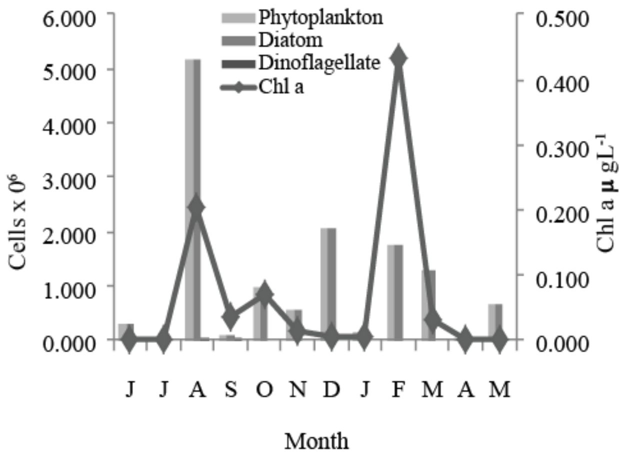

Fig. 5. Monthly variations in the composition of phytoplankton, diatom, and dinoflagellates and Chl *a* during the low tide at study site.

Phytoplankton distribution and abundance: Monthly variation in total abundance of phytoplankton was studied at low and high tidal levels. Phytoplankton abundance peak was observed in August at both tides. However, there was slight variation at both tides (Figs. 3 & 4). Annual mean abundance of phytoplankton community was 1.84×10^6cells L^{-1} at high tide and 1.101×10^6 cells L^{-1} at low tide (Table 1). Diatoms Cell density was highest during August at both tides (Figs. 3 & 4). Surprisingly, dinoflagellates were appeared only in June, August and September (Figs. 3 & 4). In phytoplankton community diatoms were the most abundant group as compare to dinoflagellates. Diatoms were comprised of 26 species in 18 genera (3 centric and 23 pennate) with only two dominating species namely *Cyclotella* cf. *meneghiniana* and *Cylindrotheca closterium* throughout the year (Table 2). *C.* cf. *meneghiniana* was highly abundant in August at both tidal conditions (79% and 59%) accordingly. *C.* cf. *meneghiniana* was high in cell density in the month of March and December (29% and 38%) consequently. Dinoflagellates contribued with only small proportion of phytoplankton community with 3 species in 3 genera (*Alexandrium* sp., *Prorocentrum micans* and *Gyrodinium spirale*). Some of the observed species of phytoplankton are set out in Figs. 6 & 7.

Table 2. Diatoms species recorded during the study period.

Species	Cell Abundance			
	High tide		Low tide	
	Mean value	Range M^a ,T^a(C°);S^a(PSU)	Mean value	Range M^a, T^a(C°),S^a(PSU)
Achnanthes brevipes	0.107×10^4	$20\text{-}0.505\times10^4$ March; 19; 38	0.144×10^4	$20\text{-}0.45\times10^4$ August; 28; 39
Chaetoceros compressus	0.379×10^4	$100\times\text{-}1.5\times10^4$ June; 32; 37	0.216×10^4	$20\text{-}2.8\times10^4$ August; 28; 39
Coscinodiscus sp.	0.011×10^4	$60\text{-}0.02\times10^4$ April; 24; 38	0.216×10^4	$0.028\times10^{4\text{-}0.}35\times10^4$ August; 28; 39
Cylindrotheca closterium	52.669×10^4	$0.15\times10^4\text{-}128\times10^4$ March; 19; 38	41.788×10^4	$0.995\times10^{34}\text{–}188\times10^4$ December; 21; 42
Cocconeis sp.	0.004×10^4	$10\text{-}0.005\times10^4$ June; 32; 37	0.018×10^4	$10\text{-}055\times10^4$ April; 24; 38
Cymbella sp.	0.022×10^4	$70\text{-}0.03\times10^4$ January; 16; 40 & Aug; 28; 39	0.016×10^4	$10\text{-}0.0310^4$ January; 16; 40
Cyclotella meneghiniana	$128.\times10^4$	$0.059\times10^4\text{-}687\times10^4$ August; 19; 39	70.8×10^4	$0.02\times10^4\text{-}474\times10^4$ January; 28; 40
Diploneis sp.	0.001×10^4	$0.015\text{-}0.015\times10^4$ June; 32; 37	0.005×10^4	$0.055\times10^4\text{-}0.055\times10^4$ April; 24; 38
Entomoneis alata	5.246×10^4	$20\text{-}19.8\times10^4$ November; 22; 40	0.020×10^4	$10\text{-}0.055\times10^4$ June; 32; 37
Gyrosigma spp.	0.085×10^4	$40\text{-}0.245\times10^4$ February; 20; 38	0.164×10^4	$50\text{-}0.52510^4$ March; 19; 38
G.fasicola	0.178×10^4	$10\text{-}0.55\times10^4$ January; 16; 40	0.089×10^4	$10\text{-}0.33\times10^4$ January; 16; 40
Halamphora coffeaeformis	0.851×10^4	$50\text{-}3.03\times10^4$ March; 19; 38	0.072×10^4	$10\text{-}0.3\times10^4$ April; 24; 38
Navicula sp.1	0.353×10^4	$80\text{-}1.15\times10^4$ March; 19; 38	0.277×10^4	$50\text{-}1.0\times10^4$ July; 26; 37
Navicula sp.2	0.045×10^4	$10\text{-}0.236\times10^4$ July; 26; 37	0.145×10^4	$100\text{-}0.6\times10^4$ August; 28; 39
Navicula delicatula	0.075×10^4	$20\text{-}0.22\times10^4$ February; 20; 38	0.329×10^4	$85\text{-}1.05\times10^4$ July; 26; 37
Navicula transitans var. *derasa*	0.074×10^4	$20\text{-}0.22\times10^4$ January; 16; 40	0.078×10^4	$10\text{-}2.95\times10^4$ August; 28; 39
Nitzchzia acicularis	0.008×10^4	$50\text{-}0.04\times10^4$ June; 32; 37	0.028×10^4	$20\text{-}0.085\times10^4$ August; 28; 39
Nitchzia cf. *obtusa*	0.011×10^4	$50\text{-}0.02\times10^4$ August; 28; 39	0.007×10^4	$5\text{-}0.0\times10^4$ January; 16; 40
N. longissima	0.037×10^4	$10\text{-}0.072\times10^4$ July; 26; 37	-	-
Nitchzia sp. 1	0.01710^4	$100\text{-}0.024\times10^4$ October; 27; 37	0.005×10^4	$50\text{-}0.005\times10^4$ October; 26; 38
Nitchzia sp. 2	-	-	0.085×10^4	$0.085\times10^4\text{-} 4.2\times10^4$ October; 26; 38
Odontella aurita	0.508×10^4	$60\text{-}1.01\times10^4$ November; 22; 40	0.015×10^4	$50 – 0.042\times10^4$ March; 19; 38
Pinularia viridis	-	-	0.015×10^4	$50 – 0.005\times10^4$ October; 26; 38
Pleurosigma elongatum	0.091×10^4	$20\text{-}0.505\times10^4$ March; 19; 38	0.131×10^4	$50\text{-}0.81\times10^4$ May; 28; 35
Rhizosolenia imbricata	-	-	0.052×10^4	$70\text{-}0.168\times10^4$ March; 19; 38
Surirella fastuosa	-	-	0.029×10^4	$10\text{-}0.06\times10^4$ July; 26; 37

[a] M= Month of highest density; [a] T= Temperature of highest density; [a] S= Salinity of highest density

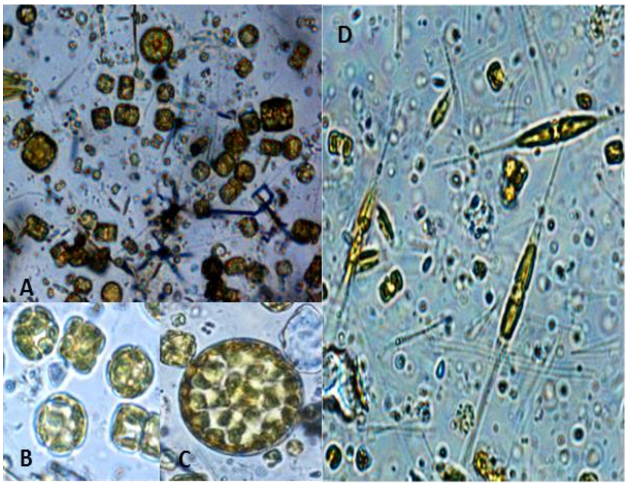

Fig. 6. Light microscopic images of bloom forming species. (A) *Cyclotella* cf. *meneghiniana* (B & C) *C.* cf. *meneghiniana* in valve and girdle view (D) *Cylindrotheca closterium*.

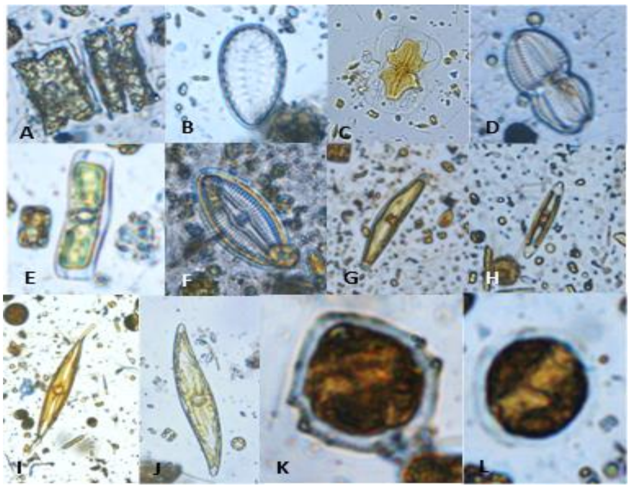

Fig. 7. Images of other phytoplankton observed during the study period. (A) *Odontella aurita*, (B) *Surirella fastuosa* (C), *Entomoneis alata*, (D) *Diploneis* sp. (E) *Achnanthes brevipes* (F) *Cocconeis* sp. (G) *Cymbella* sp. (H) *Navicula transitans* (I) *Gyrosigma fasicola* (J) *Pleurosigma elongatum* sp. (K & L) *Alexandrium* sp.

Table 3.Correlation (Pearson) of total abundance of phytoplankton with water parameter at high tide.

	Abundance	Chl a	Temp	Salinity	pH	DO
Chl *a*	0.381					
Temp	0.245	-0.159				
Salinity	-0.010	0.030	-0.54			
PH	-0.527	-0.287	-0.148	-0.293		
DO	0.224	-0.061	0.432	-0.032	-0.08	
TSS	0.426	-0.070	-0.154	-0.088	0.169	-0.071

*= Significant, **= Highly significant at p value >0.05

Table 4. Correlation (Pearson) of total abundance of phytoplankton with water parameter at low tide.

	Abundance	Chl a	Temp	Salinity	pH	DO
Chl *a*	0.723**					
Temp	0.062	-0.056				
Salinity	0.282	0.047	0.511			
PH	-0.673	-0.401	0.068	-0.249		
DO	-0.121	-0.414	0.453	-0.113	0.302	
TSS	0.209	-0.063	-0.159	-0.082	-0.018	-0.115

*= Significant, **= Highly significant at p value >0.05

Table 5. Correlation (Pearson) of total abundance of phytoplankton with nutrients at high tide.

	Abundance	Ammonia	Nitrite	Nitrate
Ammonia	-0.057			
Nitrite	0.671*	-0.081		
Nitrate	0.327	-0.258	0.777**	
Phosphat	-0.279	0.013	-0.33	-0.416

*= Significant, **=highly significant at p value > 0.05

Table 6. Correlation (Pearson) of total abundance of phytoplankton with nutrients at low tide.

	Abundance	Ammonia	Nitrite	Nitrate
Ammonia	-0.066			
Nitrite	0.295	0.079		
Nitrate	0.489	0.186	-0.022	
Phosphat	-0.384	-0.082	-0.398	-0.561

*= Significant, **=highly significant at p value > 0.05

Pearson correlation coefficient was applied to observe the relationships between phytoplankton communities with hydrographical parameters. Phytoplankton abundance was positively correlated with Chl *a*, temperature, DO and TSS at high tide, whereas, at low tide it was highly significantly correlated Chl *a* (Tables 3 & 4). In case of nutrients, abundance was positively correlated with nitrite (0.671; 0.295) and nitrate (0.327; 0.489) only at high and low tidal level respectively. However, inverse correlation was observed with ammonia and phosphate (Tables 5 & 6).

Discussion

The present investigation was the first observation on annual distribution and abundance of phytoplankton communities in the mangrove habitat at Sandspit, backwaters. Present study revealed seasonal variation in temperature with highest values in summer and low in winter season. The sea surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb currents and flow from adjoining neritic water (Desai, 1992; Arthur, 2000). Increases in temperature can cause the deoxygenation and ultimately converted into eutrophic zones for most marine organisms in coastal and estuarine ecosystems (Carstensen *et al.*, 2014).

The salinity acts as a limiting factor in the distribution of living organism, and variation caused by dilution and evaporation influences the community. Generally, salinity variation in the brackish water habitats such as estuaries, backwaters and mangrove are due to influx of fresh water from land run off caused by monsoon or by tidal variation (Gibson, 1982; Costa-Böddeker *et al*., 2016). These back waters also confirmed same patterns for salinities in previous studies at other site (Harrison *et al*., 1997; Saleem *et al*., 2014). Changes in salinity concentration may affect the growth and production of the phytoplankton biomass in tidal creeks. Hydrogen ion concentration (pH) in surface water remained alkaline at both (high and low) tides and minor fluctuation observed due to removal of CO_2 by photosynthesis through bi-carbonate uptake , dilution of sea water by fresh water influx, reduction of salinity and temperature and decomposition of organic matter (Caldeira & Wickett, 2003; Kalaikathir & David, 2016). Dissolved oxygen concentration is an indicator of prevailing water quality and ability of water body to support a well-balanced aquatic life (Lewis & Gilmore, 2007). Relatively, low dissolved oxygen was observed during the study period due to reduced agitation and turbulence of the creek system. Average value of sewage and industrial effluents entering in to the mangrove habitats is approximately 3.4 million m^3 during the tidal cycle (Haq 1976; Wahid *et al.,* 2007). Suspended particulate matter is often the primary cause of turbidity of the water (Dawes, 1981). Increased value of TSS in few months observed in this study ultimately showed decreased light penetration and caused reduction in the phytoplankton abundance (Lacuna *et al.*, 2012).

Furthermore, it is also apparent that high chlorophyll *a* occurred in summer months in the northern part of the Arabian (Schiebel *et al*., 2004). Unfortunately no fresh water input and no rainfall were observed except few months of monsoon and as a result high salinity was observed i.e., 42. Chlorophyll *a* had a maximum value in the month of February. This type of trend has also been observed with slight variations (February) at Isaro creeks of the lndus River delta (Harrison *et al*., 1997) while in northern and central Arabian sea, and this brings nutrient rich cold water to the surface, resulting in a phytoplankton bloom (Rejomon *et al*., 2013).

Phytoplankton play a vital role in marine food chain, and get considerable attention to understand the processes, which regulate primary production in the marine habitat. They need nutrients for their growth and nourishment. Seasonal changes in nutrients may affect on phytoplankton production. Coastal upwelling wind induced mixing and nutrient rich water are the major factor for phytoplankton abundance in the northern Arabian Sea during northeast (winter) monsoon period (Banse & Mc Clain, 1986; Levy *et al*., 2007). However, these phenomenon was opposed in the backwaters area due to high load of domestic and industrial effluents (Harrison *et al.*, 1997; Mashiatullah *et al*., 2004; Saifullah *et al*., 2004; Iftikhar *et al*., 2015). High value of nitrate and nitrite was detected in the month of August at both tides which coincide with high phytoplankton biomass. The nitrogen specific correlation with phytoplankton abundance was greater for nitrite and nitrate (Table 5) which is in agreement with previous study from mangrove habitat (Harrison *et al*., 1997). According to Malone (1980), larger phytoplankton (diatoms), mainly prefer nitrate whereas smaller cells favor to utilize ammonium ion. Present study shown negative correlation of phytoplankton abundance with ammonium and is confirmed the above statement.

Several marine habitat are seems to be supportive for phytoplankton community but in this study mangrove habitat at Sandspit backwaters does not provide favorable condition and therefore, phytoplankton occurred in low diversity and density. Diatoms were found as dominant group of phytoplankton, while dinoflagellates were present in very low abundance, or some time totally absent from the study area. Harrison *et al*. (1997) reported the same phenomenon at Indus delta mangrove ecosystem. In the present study it was also reported that *Cyclotella* cf. *meneghiniana* and *Cylindrotheca closterium* occur in high abundance throughout the year which was reflected in previous studies from other part of the world (Carpelan, 1978; Najdek *et al.*, 2005). These above research work were reported that these species are cosmopolitan and form bloom in wide range of salinities i.e. 40-60 PSU and also in fresh waters (Ohgai *et al*., 1986; Najdek *et al.,* 2005). *C. closterium* were present throughout the year, but moderately more abundant in spring and summer in Northern European seas (Ohgai *et al*., 1986) which is again support present data. There are several factors (grazing pressure, degradation etc.) involve in phytoplankton community survival. These factors may enhance or suppress the growth of microplankton communities (Strom & Strom, 1996).

Cyclotella cf. *meneghiniana*, planktonic specie was recorded in both seasons (summer and winter) and showed preference for higher nutrient levels. *C.* cf. *meneghiniana* has also been reported as bio-indictor of many metal pollutants in aquatic ecosystem. High abundance of this species was also recorded from both marine and fresh water area and their association with low DO concentration suggests poor water quality (Bestawy, 2000; El-Kassas & Gharib, 2016).

Cylindrotheca closterium has ability to survive in high salinity and poor nutrient environment (Najdek *et al.*, 2005). In Sandspit back water *C. closterium* was found throughout the year in high densities. The increased number of *C. closterium* cells in already nutrient poor high salinity waters has also been reported by several other studies (Alcoverro *et al*., 2000; Najdek *et al*., 2005).

This study clearly revealed that there is no remarkable difference between observed physicochemical and biological parameters at low and high tide. *Cylindrotheca clostam* and *Cyclotella* cf. *meneghiniana* are most dominant species of phytoplankton. Dinoflagellates were found only in monsoonal months, but very few in numbers. Further investigations are required to understand why dianoflagellates are low in diversity and abundance in mangrove habitats. Although previous studies in adjacent coastal water showed preponderance of both diatom and dinoflagellates communities. Global warming, heavy metals and pesticides may cause the limited species dominance and ultimately other species diversity decreases. Heavy metals and persistent organic pollutants (POPs) detection would give more reliable predictions of changes occurred in this particular area. Extensive research is needed to evaluate the complexity of mangrove ecosystem, particularly considering primary productivity assessment, as well as the contribution of nutrient loadings and their causes.

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