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SPECIES COMPOSITION AND SEASONAL OCCURENCE OF CENTRIC DIATOMS IN A POLLUTED MARINE ENVIRONMENT*

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Abstract

Marine centric diatoms comprising of 101 species and 30 genera were recorded from highly polluted Lower Harbour, Karachi. *Chaetoceros* and *Rhizosolenia* were the most diverse genera. The temporal and spatial distributions of species were irregular and species diversity high, which may be the result of extremely unstable environmental conditions in the Harbour. The species composition was also significantly different from that of the shelf.

Introduction

Coastal areas differ significantly from open sea in their physical, chemical and biological attributes. They are characterized by instability of environmental conditions because of proximity to land, whereas the environment is relatively uniform in open ocean. Thus annual phytoplankton cycle is bimodal in open sea (Lillick, 1940; Bigelow et al, 1940) but polymodal in coastal areas of temperate latitudes (Saifullah & Steven, 1974; Patten et al, 1963).

Kuzmenko (1975 a, 1970 b) carried out intensive studies on phytoplankton of the North Arabian Sea, the areas on the shelf and open seas but excluded the coastal areas. The coast-line of Pakistan, especially that of Sind, is very heterogenous. It comprises of a number of creeks, embayments, estuaries. Besides, the increasing rate of industrialization in Karachi is polluting the adjacent coastal waters and threatening the important marine life. In the present study an attempt is therefore made to study the seasonal changes in the species composition of marine planktonic centric diatoms in Lower Harbour of Karachi.

Description of Area

The area of study is shown in Fig. 1. The Lower Harbour, Karachi is actually a channel which is 2.5 Kilometers long, 900 meters wide and on an average 8.2 meters deep. On the northern side of the harbour lies the mouth of the Lyari River, which is very shallow and is characterized by mangrove swamps. The pollutants emanating from about 800 industrial units of Karachi are dumped into Lyari river which later pass through the Lower Harbour into the sea. At the same time shelf water gets into the mouth of Lyari river through the lower Harbour at high tide. The other sources of pollution in the Harbour are the international port of Karachi (Upper Harbour in Fig. 1) and the Fish Harbour, both situated on its northern side. As a result of these, thousands of ships are known to pollute the Harbour with oil as they pass through it each year.

*Dedicated to the memory of late Dr. Rahimullah Qureshi who died on 21st July, 1977. Dr. Rahimullah Qureshi was Director of Department of Marine Fisheries and Professor of Institute of Marine Biology.

Materials and Methods

Phytoplankton were collected by horizontal net hauls from sail boats at surface (Hassan & Saifullah, 1971) at three stations about a kilometer apart from each other in the Harbour (Fig. 1).

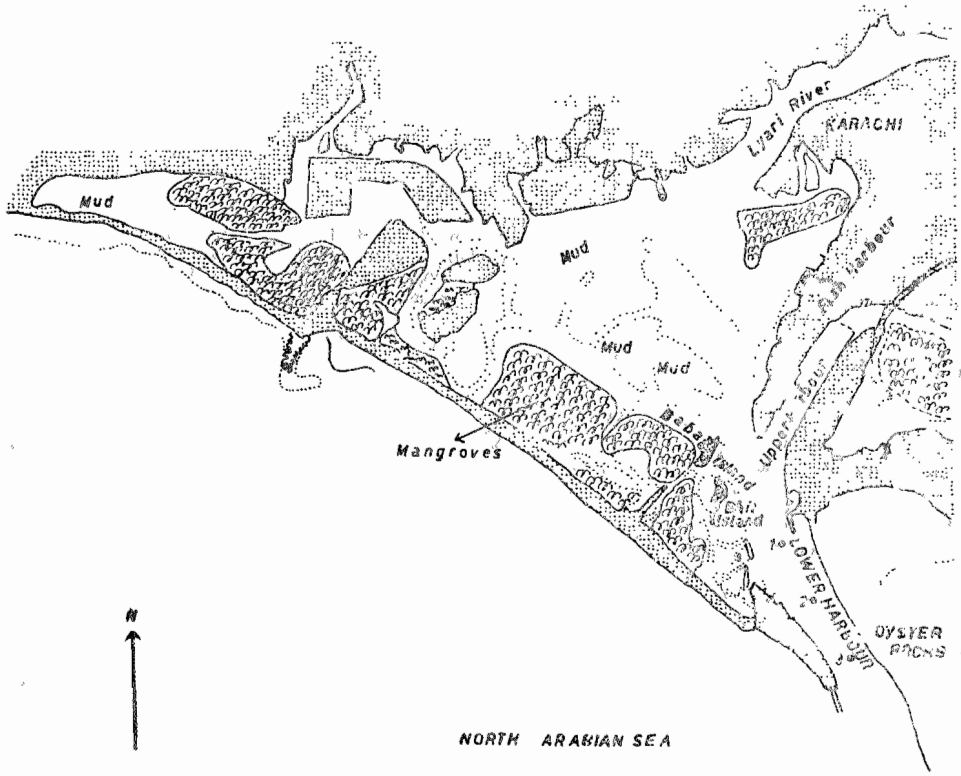

Fig. 1. Lower Harbour with its surroundings and location of stations.

Salinity values varied generally between 34 to 36 parts per thousand, but lower values of the order of 28.1, 29.4 and 31.7 parts per thousand were recorded in August and September, 1970 because of intense rain showers. Surface temperatures also varied between 21°C to 29°C with lower vaues being recorded in winter.

Sampling was carried out in two periods; one extended from April, 1970 to November 1971, the other from October 1972 to June 1973.

The relevant works of Brunel (1962), Cassie (1961), Cupp (1943), Curl (1959), Durairatnam (1964), Hustedt (1956), Karsten (1928), Peragallo and Peragallo (1897-1908), Sournia (1968), Simonsen (1974), Subrahamanyan (1946) and Wood (1963) were referred for identification of taxa.

Observations and Discussion

The species composition of marine centric diatoms in Lower Harbour is given in Table I. A total of 101 species and 6 varieties belonging to 30 genera were recorded as compared to 25 genera, 81 species and 9 varieties reported from Pakistan shelf and Arabian Sea (Kuzmenko 1975 a, 1975 b), the difference in total number of species between the two localities is thus negligible. It may be mentioned that Subrahmanyan (1958, 1960) reported 147 species and 14 varieties belonging to 40 genera of centric diatoms from the west coast of India. This particularly large number of taxa recorded on the west coast of India may be because 1) the area studied was coastal, 2) both net and bottle samples were used and 3) period of observations extended for 5 years. The number of species collected by net hauls from different localities on the Indian coasts other than Bombay (Gopalakrishnan, 1972) were smaller than the numbers recorded in the Harbour, when compared seperately. The richness in species diversity may account for the fact that the Harbour is a meeting place of two different water masses, one from the Lyari River and other from the Shelf. According to Margalef (1958) such heterogeneous areas are rich in species diversity. Moreover the Harbour is highly polluted (Beg et al, 1975).

The seasonal change in species composition and total number of species was irregular (Table I). Thus the peak noted in November, 1970 was totally absent in 1971 and 1972 (Fig. 2). Such seasonal irregularity is common also on Indian Coasts (Gopalakrishanan, 1972), and is perhaps due to different physical, chemical and geological nature of the localities concerned. The maximum number of species recorded in any given sample was 85 and that was recorded in November 1970. Gopalakrishnan (1972) observed a maximum number of 26 species of diatoms including both centric and pennate forms, which shows the poverty in species diversity of centric diatoms in that area.

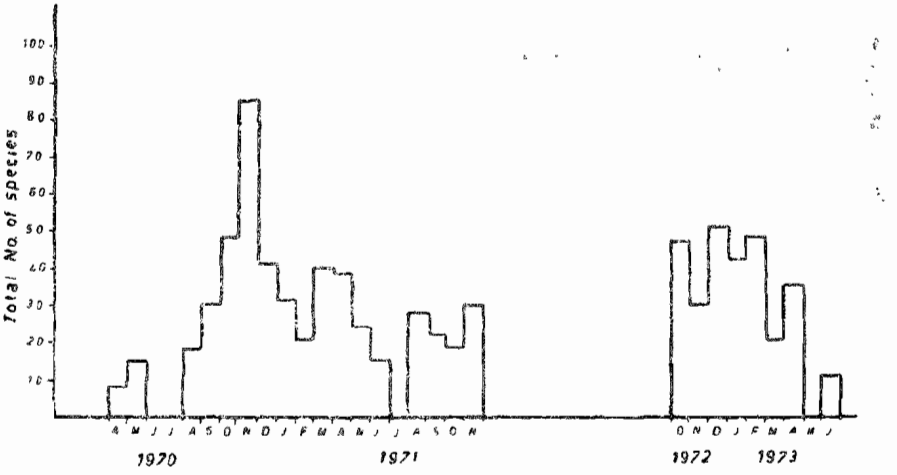

Fig. 2. Temporal distribution of total number of species of centric diatoms.

TABLE 1. Species composition and seasonal succession of planktonic diatoms from Lower Harbour, Karachi, from January to December.

SPECEIES	J	F	M	A	M	J	A	S	O	N	D
Actinoptychus senarius				d					a	b	
Asterompahlus flabellatus										a b	
Bacteriastrum comosum		d								a	
B. delicatulum									a		
B. elogatum				b					a	a	
B. hyalinum	b	d	b	b d d					a b c	a b	a
B. minus									a		
B. varians	d	d	b	d			b		a b c	a b	a c
Bellerochea melleus										c	
Biddulphia longicruris			b	b					c		
B. pulchella	b		b d	d	b			a		b	a c
B. tridens				b d			a				
Cerautalina bergonii	d	d		d			b		c	a	
Chaetoceros affine		d								a	
C. affine v. circinalis										a	
C. atlanticum var. neapolitana.										a	
C. coarctatum	b d	d	b	b d					c	b c	a c
C. compressum										a	
C. confusum										a c	c

C. curvisetum	d	d		d					c	a	c
C. decipiens	d		d						a c	a c	a c
C. denticulatum	b d		b	b	b				a c	ab c	a c
C. didymum			b					b	a c	a	
C. didymum v. protuberans										a	
C. diversum	d	d	b						c	c	
C. eibenii	d	d	b						a	a c	c
C. lauderi	d			d					c	a	
C. lorenziznum	d	b d	b d	b d	a b	b	a b	a b	a c	a b c	a c
C. messanense	d	d								a	a
C. pelagicum					a						
C. peruvianum	d	b		b e						a	c
C. peruvianum var. robusta											a
C. sociale										a	
C. teres	d		b						c	a c	c
C. vanheurckii										a	
C. wighamii	d			d							c
Climacodium biconcavum		d									
C. frauenfeldianum			a	d	b		b	b	a	a	a
Corethron cirophilum		d		b d					a	a	
Coscinodiscus asteromphalus	b d	d	b	a	b	b	a b	a	a c	a c	a
C. centralis	b d	d	d	b d	b	b d	a	a	b c	a c	

C. concinnus		b			a		a	a	e	a c	a c
C. gigas	b d	b d	d	a bd			a	a	b c	a c	c
C. grani		b		b d					c	a c	c
C. janischii			d	a b		b	b	a b		a	a
C. jonesianus	b			b			a	a b	a	a c	a
C. lineatus		d						a		a b	c
C. marginatus	d							a	c	b	
C. oculus iridis	d	d	b d	b	a b		a b	a	a b c	a b c	a c
C. perforatus	b d	b d	b d	a d	b	b	a	a b	a b c	a c	a c
C. radiatus			b				b		b	a b	a
Cyclotella striata		d	d		d	d			c	a	c
Detonula pumila	d		b	b				a b	a c		
Ditylum brightwellii				b	b	b	a b	a	c		
D. sol	d										
Eucampia cornuta		d		b			b		a	a c	a
E. zodiacus	b	d		b	a		b		a	a b	a c
Gossleriella tropica	b	d	b			b d	a	a b	a	a	a
Guinardia flaccida		d	b	b d	b			a b	a b c	a b	a c
Hemiaulus sinensis	d		b				b		a	a	

Lauderia annulata	b d	b d	b d	b d	a			a	a b c	a b c	a c
Leptocylindrus danicus	d	d	b	d			b	b	b c	a c	c
L. mediterraneous	b							b	a	a	c
L. minimus		d								a b	
Lithodesmium undulatum				a	a	b		a	a	a	
Odontella aurita			b	b	a	d	a	a	a	b	c
O. mobiliensis	b		b	b d	b	b d	a b	a b	a bc	a c	a c
O. rhombus		d		b d	b	b d	a b	a b	a c	a b c	a
O. sinensis	b d	b d	b d	a b	a b	b	a b	a b	a c	a	a c
Palmeria hardmaniana	b d	d	b	b d	b	b	a b	a b	c	b	a
Planktoniella sol	b d	b d	b	a b d	a b		a b	a b	a	a	a c
Podosira montagnei	b		b	d					a	a	
Rhizosolenia acuminata	b d	d	b	b	a					a	a c
R. alata	b	b	b d	b d	b			b	a c	a b c	c
R. alata v. gracillima	b d	b	d	d	b				c	a b	a
R. alata var. indica	d						b			a	
R. arafurensis										a	
R. bergonii	d	d		d	b					a	a
R. clacar-avis		d	b	b					a c	a	a c
R. castracanei		d								a	
R. cochlea	b		b	b				b	c	a	c

R. crassipina	b d	d		d						a b	a c	
R. cylindrus			b			d				a		
R. delicatula										a		
R. fragillissima							b		a	a	c	
R. hebetata f. semispina		b d	b d				b		a c	a c		
R. imbricata	d	b d	b d	b d			b		a c	a c	c	
R. imbricata v. shrubsolei	b	b	b	b			b		a b	a b	a	
R. pungens										a	c	
R. robusta	b	b	b d	a b	a b	b	a b		a b c	a b	a a	
R. setigera	d	b	b	b			b	b	a c	a	a c	
R. stolterfothii	d	d		b d					a c	a b	a c	
R. styliformis	d		d						a c		c	
Skeletonema costatum	b	d	b	d					a c	a		
Stephanopyxis turris	b d	d		d					a c	a	a	
S. palmeriana	b d	b d	b	b d				b	a b c	a b c	a c	
Streptotheca indica	b d	b d	b d	b d	b	b d	b		a c	a b c	a c	
Thalassiosira coromandeliana		d	b				b			a	c	
T. decipiens	d	d							a c		c	
T. eccentrica			b	d		d		a	a b c	a c	c	

T. hyalina						b				
T. subtilis						b	a	b c	a	a
Triceratium antediluvianum									c	c
T. dubium							a			
T. favus	b	b d	b d	a bd	b	a	a		a c	a c
T. pentacrinus var. quadrata		d		b			a		a c	
T. robertsianum			d				a	a	c	

a — 1970 (April to December).
b — 1971 (January to December).
c — 1972 (October to December).
d — 1973 (January to June).

No samples taken in July of all years due to extremely rough weather resulting from SW monsoon.

Although the total number of species in the Harbour did not differ very much from that other Shelf and Sea (Kuzmenko 1975 a), the species composition of the two areas showed great variation. When Barkman's index of similarity (Goodall, 1973) was applied between the species composition of the two areas it was found that they were only 56% similar. All the genera in the two localities differed in their species composition except for *Rhizosolenia*, *Chaetoceros* and *Bacteriastrum*. This marked discrepancy in the species composition suggests that there is a significant difference in the environmental nature of the two localities.

The species composition of the Harbour depicted its typical coastal neritic nature. Thus, whereas, tycopelagic or littoral species were absent from the phytoplankton of the Shelf they were present in the Harbour. Such species were *Podosira montagnei*, *Biddulphia pulchella*, *Odontella aurita*, *O. rhombus*, *Triceratium favus*, *T. robertsianum*, *T. dubium*, *Actinoptychus sinuris* (*A. undulatus*) and *Cyclotella striata*. A large number of species were neritic which showed influx of open seawater into the Harbour.

The most diverse genera were *Chaetoceros* and *Rhizosolenia* in Lower Harbour and the shelf as well (Kuzmenko, 1975 a) but the difference was noted in respect of *Coscinodiscus*, which was the third most diverse genus consisting of 13 species in the former area but was represented by 3 species in the latter locality. The three genera were also dominant on the west coast of India (Subrahmanyan, 1958) but *Coscinodiscus* ranked second and *Rhizosolenia* third in species numbers.

Auxosopores were noted in *Rhizosolenia alata*, *Chaetoceros didymum*, and *C. lorenzianus* and microspores in *Odontella mobiliensis*. No relation of any sort was established between salinity and auxospore formation. *Ditylum brightwelli*, *Biddulphia pulchella*, *Odontella aurita*, *O. sinensis*, *O. mobiliensis* and *Coscinodiscus granii* were found in a state of active cell division at the time of sampling.

TABLE 2. Similarity index of Barkman $a/\sqrt{(a+b)(a+c)}$ applied to species composition between any two stations. Values converted into percentage.

Date:		Stations			Date:		Stations		
		I II	II III	I III			I II	II III	I III
Apr.	1970	53	61	57	June.	1971	56	79	62
May.	1970	47	31	13	Aug.	1971	51	—	—
Aug.	1970	60	52	58	Sept.	1971	51	—	—
Sept.	1970	67	67	61	Nov.	1971	47	65	39
Oct.	1970	61	64	62	Oct.	1971	—	58	—
Nov.	1970	64	65	55	Nov.	1972	—	49	—
Dec.	1970	64	64	69	Dec.	1972	—	55	—
Jan.	1970	50	45	61	Jan.	1973	—	47	—
Feb.	1971	16	37	31	Feb.	1973	—	65	—
Mar.	1971	75	58	62	Mar.	1973	—	33	—
Apr.	1971	52	35	47	Apr.	1973	—	52	—
May.	1971	55	53	57					

The spatial distribution of diatoms in Lower Harbour was even more irregular than temporal distribution. The three stations were hardly 1 kilometer apart from each other, but the variation in species composition among the three was large. When the similarity index of Barkman (Goodall, 1973) was applied to test the similarity of species composition between any two stations (Table 2), it was found that the stations were dissimilar from one another. The similarity in species composition between any two stations was found to be generally lower than 60 percent.

Besides a number of environmental perturbations prevalent in the Harbour, the semidurnal tides and dredging operations are also responsible for the observed irregularity in the temporal and spatial distribution of diatoms. Subba Rao (1973) noted a similar situation in Lawson's Bay, India.

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