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Relationship of epilithic diatom communities to environmental variables in Homa lagoon (Izmir, Turkey)

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ABSTRACT: Spatio-temporal changes in taxonomic composition and structure of a diatom community were assessed between June 2006 and June 2007 at the intertidal zone of Homa lagoon, Izmir, Turkey. The communities were composed of a mixture of epilithic, epiphytic, epipsammic, and occasionally some pelagic diatoms. In total, 87 taxa belonging to 39 genera were identified, of which 39 were used as active taxa in the numerical analysis. The Shannon-Wiener diversity index (H') values were quite variable, varying between 1.00 and 3.39 and correlated with both species richness (r = 0.93) and evenness (J'; r = 0.38). *Cylindrotheca closterium*, *Halamphora veneta, Licmophora gracilis*, *L. lyngbyei*, *Navicula cryptocephala*, *N. cincta*, and *N. ramosissima* var. *mollis* were the overall most abundant taxa throughout the sampling. The relationship between epilithic algal communities and 10 environmental variables was explored using canonical correspondence analysis. According to a Monte Carlo unrestricted permutation test, the silicate and ammonium concentrations were the most important variables in accounting for species distribution.

KEY WORDS: Benthic diatom · Epilithic · Species diversity · Canonical correspondence analysis · Wetland area · Homa lagoon · Turkey

INTRODUCTION

Coastal lagoons are areas of close contact between a river and the open sea, mixing freshwater from continental drainages and seawater with high levels of salinity. These systems are often characterized by extended intertidal mud- and sand-flats (Lankford 1977). Despite the fact that intertidal benthic biota have to survive in a harsh and variable environment, intertidal flats are sites of intense biological activity, often with high productivity (Herman et al. 1999), supporting large populations of birds and forming feeding areas for coastal fisheries.

Epilithic diatoms are recognized worldwide as one of the most appropriate biological components for water quality assessment, due to their continuous presence along the aquatic system and their quick response to the environmental changes (Salomoni 2004).

Benthic diatoms are present on almost all stable substrata. The benthic assemblage most commonly sampled is epilithon (Wunsam et al. 2002). The advantages and disadvantages of using natural or artificial substrates for sampling have been discussed at length (Watanabe 1990). Artificial substrates are generally selective and inert and do not show the whole natural community. On the other hand, natural substrates present advantages because the stones supply nutrients that support community development. In addition to the advantages and disadvantages of using natural or artificial substrates in lagoonal system, there is also no consensus on the main factors that determine diatom species composition and distribution; therefore, the results from different studies may prove contradictory (Sullivan & Currin 2000).

Studies conducted in Homa lagoon, Izmir, Turkey, have been focussed on fisheries (Hossucu & Ak

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2000), bivalve culture (Serdar & Lok 2007), and the physical and chemical properties of the lagoon (Unsal et al. 2000), but there is a gap in knowledge concerning epilithic diatoms. Few algological surveys have been conducted in the study area (Çolak Sabanci & Koray 2010, Çolak Sabanci et al. 2011). Epilithic diatom samples obtained in the present study have a wide spectrum of ecologically different types, including marine, brackish, and even freshwater affinities. In addition to this, samples also contained a mixture of forms growing on the stones themselves, on silt accumulated on the stones, and epiphytic forms on other algae, but here I will refer to this collective community as the epilithon. The aims of the present study were to describe the species composition of diatom assemblages, to determine which environmental factors explain the composition of epilithic diatoms and to assess the response of common diatom taxa to these environmental variables.

MATERIALS AND METHODS

Study area

Homa Lagoon (38° 33′ 10″ N, 26°49′50″E) is located 25 km to the northwest of the Gulf of Izmir and within the borders of the town of Menemen (Fig. 1). The lagoon is 7.4 km long and 3 km wide. The Gediz Delta region (20 400 ha), which includes the study area, consists of freshwater and salt water marshes (5000 ha), bays and saltpans (3300 ha), and lagoonal areas (Homa, 1800 ha; Cilazmak, 725 ha; Tas, 500 ha; Kirdeniz, 450 ha) which makes it a typical Mediterranean delta ecosystem. The average rainfall and temperature of the area are 544.2 mm and 16.8°C (Ministry of Environment & Forestry 2007). Homa lagoon is one of the most important lagoons on the Aegean coast of Turkey, being a biodiversity hotspot. Because of its enormous species diversity and natural habitats, the lagoon was included in the important wetlands list in the Ramsar Convention. It is also the last active lagoon in Izmir Bay. Between June and December, the fish traps are closed and the seawater input is reduced

From June 2006 until June 2007, epilithon samples were collected from 4 stations in Homa lagoon on a monthly basis. Stn 1 was in the sea region and open to the waves. It was deeper than the other stations, and throughout the sampling period the water depth was approximately 1 m. The bottom was extensively covered with broken sea shells. Stns 2 and 3 were located in regions where seawater and lagoon water mix and both had a bottom covered with muddy sediment. Stn 3 was less affected by seawater than Stn 2. The water depth of these stations varied between 0.6 and 1 m. Stn 4, the shallowest station, was located in a completely sheltered area. It had a muddier bottom structure than the other stations, and the water depth was <0.5 m. Stn 4 is strongly influenced by meteorological conditions, and, especially in the summer period, drying and fracturing are evident as an effect of evaporation.

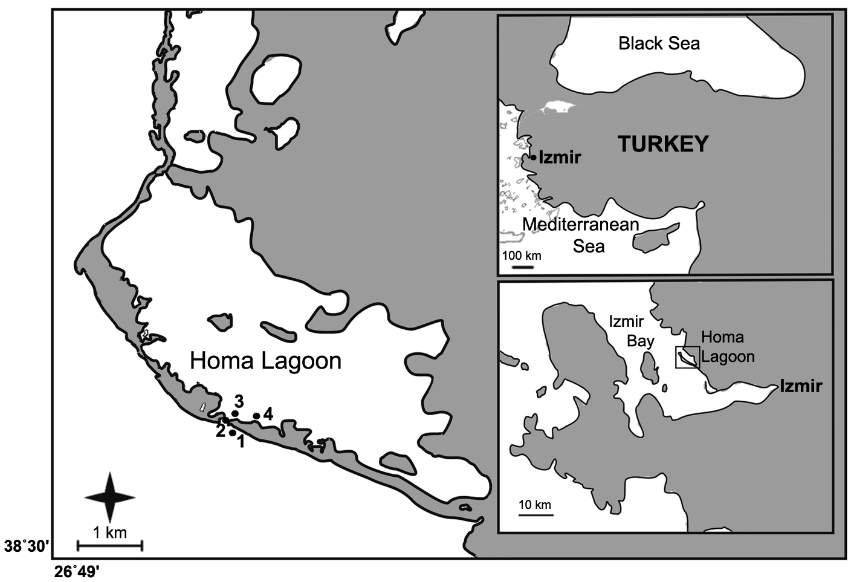

Fig. 1. Location of stations in the Homa Lagoon

Water sampling

Water samples were taken monthly from the same stations in order to determine the physico-chemical structure of Homa lagoon. Water temperature (°C) and pH were measured *in situ* with a mercury thermometer and a HANNA HI 8314 model pH meter. Water samples for analyzing salinity (‰), nitrite (NO_2-N), nitrate (NO_3-N), ammonium (NH_4-N), phosphate (PO_4-P), and silicate (Si) were collected in 1 l plastic bottles and immediately transferred to the laboratory. Salinity and dissolved oxygen concentration were analyzed according to the methods of Martin (1972) and Winkler (1888), respectively. Chlorophyll *a* (chl *a*) and nutrient concentrations were determined colorimetrically with an HACH DR/4000 U model spectrophotometer. The method of Strickland & Parsons (1972) was followed for the colorimetric analysis.

Diatom analysis

Sampling of epilithic diatoms were performed monthly at the 4 stations. To define the species composition of epilithic diatoms, stones 15 to 20 cm in diameter were collected (one stone per station per month, for 13 mo, yielding 52 samples). Each stone was chosen as randomly as possible amongst those that were not covered with filamentous algae and with an evident film of diatoms. The entire surface area of each stone was scraped clean with a toothbrush in 150 ml of distilled water and preserved with formaldehyde (4%). Before counting, the preserved sample was brought to a final volume of 200 ml with distilled water and homogenized at low speed until the sediment was throughly mixed (Winter & Duthie 2000). The results were expressed as the number of diatom cells cm^{-2}. Three water-mounted slides for each sample were counted at 400× magnification (Utermöhl 1958). Permanent slides for the identification of diatoms from the same sample were prepared chemically with 10% HCl, 30% H_2SO_4, $KMnO_4$, and oxalic acid (Lauriol et al. 2006). Diatoms were identified to the species level at 1000× magnification by phase-contrast optics with an OLYMPUS ×100 PlanApo oil-immersion objective following standard diatom preperation methods (Battarbee 1986). Identifications were made following Peragallo & Peragallo (1897–1908), Hendey (1964), Hartley (1996), and Witkowski et al. (2000).

Data analyses

The Shannon-Wiener index (H'; log base = e) and Pielou's evenness index (J') were calculated from relative abundance values (RA, %). Differences in H' values were tested using a non-parametric Kruskal-Wallis ANOVA median test. Diatom counts of all 52 samples were first converted into RA. The RA values were used in the multivariate analysis and were the means of 3 replicate samples. Only the taxa which had an RA of at least 1% in any single sample were taken into consideration. In total, 87 taxonomic entities were distinguished, of which 39 were used as active taxa in the numerical analysis.

All environmental variables were tested for skewness. The environmental variables, with the exception of nitrate, phosphate, salinity, Si/N ratio, and Si/P ratio, had a skewed distribution and were log $(x + 1)$ transformed.

Canonical correspondence analysis (CCA) was used to identify statistically significant directions of variations within the 52 samples. CCA is a powerful, statistically robust procedure for analyzing complex biological data (e.g. diatom percantages) and their relation to environmental variables (e.g. salinity, temperature). It provides a simultaneous low-dimensional representation of diatom taxa, samples, and environmental variables (Birks et al. 1990). A code was assigned to the species used in the CCA analyses (see Table 2). Species abundance data were log $(x + 1)$ transformed prior to the analysis. Pearson's correlation analysis was used to assess the relationships between environmental variables and community parameters. All statistical analyses were conducted using the PRIMER package (Clarke & Warwick 2001), Statistica 7.0, Statgraphics Plus 5.1, and the CANOCO 4.5 package (ter Braak & Šmilauer 2002). Significance was accepted at $p \leq 0.05$ for all statistical tests used in this study.

RESULTS

Physical and chemical characteristics

During the sampling period, surface water temperature of the lagoon varied between 4 and 29°C, with the maximum temperature recorded in August 2006 at Stn 4, and the minimum in December 2006 at Stns 1 and 2. The salinity ranged between 29.12 in October 2006 at Stn 1 and 54.12 in December 2006 at Stn 4. Dissolved oxygen concentrations were measured with a minimum of 4.80 mg l^{-1} in January 2007 at Stn 2 and a maximum of 28.00 mg l^{-1} in December 2006 at Stn 4. Significant freshwater input into the study area was provided by rainfall. During autumn, the observed rainfall was less than expected, and the fish traps were closed between June and December; therefore, the seawater input was weak in this period. For these reasons, high salinity values were observed in the sheltered region (Stn 4). Also in December 2006, a high oxygen value was determined at the same station. This may have been due to water mixing caused by wind. The pH was mostly stable throughout the sampling period, and the highest value (8.48) was detected in April 2007 at Stn 2.

Table 1. Correlation matrix for the 13 environmental variables measured in the study. DO: dissolved oxygen, NO_3-N: nitrate, NO_2-N: nitrite, NH_4-N: ammonium, PO_4-P: phosphate, Si: silicate, N/P: N/P ratio, Si/N: Si/N ratio, Si/P: Si/P ratio, Chl *a*: chlorophyll *a*. *p ≤ 0.05

	Temperature	Salinity	pH	DO	NO_3-N	NO_2-N	NH_4-N	PO_4-P	Si	N/P	Si/N	Si/P	Chl *a*
Temperature	1.00												
Salinity	– 0.33*	1.00											
pH	0.14	0.13	1.00										
DO	–0.22	0.17	0.15	1.00									
NO_3-N	–0.15	0.10	–0.10	0.20	1.00								
NO_2-N	–0.38*	0.06	–0.14	–0.14	0.14	1.00							
NH_4-N	0.57*	–0.33*	0.11	–0.43*	–0.28*	–0.35*	1.00						
PO_4-P	–0.15	0.06	–0.18	0.06	–0.05	0.65*	–0.42*	1.00					
Si	–0.04	–0.17	–0.30*	0.21	0.03	0.19	–0.20	0.41*	1.00				
N/P	–0.01	–0.22	0.07	0.00	0.63*	–0.17	0.26	–0.61*	–0.19	1.00			
Si/N	–0.14	–0.12	–0.25	0.18	–0.41*	0.21	–0.27*	0.51*	0.77*	–0.54*	1.00		
Si/P	0.01	–0.31*	0.11	0.12	0.01	–0.36*	0.21	–0.55*	0.27	0.54*	0.01	1.00	
Chl *a*	0.17	–0.04	0.05	–0.08	–0.03	–0.29*	0.30*	–0.19	–0.25	0.06	–0.26	–0.06	1.00

During the sampling period, the maximum amounts of nitrite, nitrate, and ammonium were 1.13 µM (March 2007, Stn 1), 34.57 µM (November 2006, Stn 4), and 7.20 µM (June 2006, Stn 1, respectively. Phosphate amounts ranged between 0.15 µM in October 2006 at Stn 4 and 2.60 µM in March 2007 at Stn 1. Silicate amounts ranged between 1.64 µM in November 2006 at Stn 1 and 12.90 µM in March 2007 at Stn 4. The lowest N/P ratio occurred in March 2007 at Stn 1 (2.51), while the highest value was recorded in November 2006 at Stn 4 (76.17). The maximum Si/P ratio was determined in October 2006 at Stn 4 (37.67) and the minimum in April 2007 at Stn 2 (2.10), whereas the maximum Si/N ratio was observed in March 2007 at Stn 4 (2.53) and the minimum in November 2006 at Stns 3 and 4 (0.15). Minimum and maximum lagoon water chl *a* values were 0.10 µg l^{-1} (December 2006, Stn 4; March 2007, Stns 3 and 4; April 2007, Stn 4) and 17.62 µg l^{-1} (June 2006, Stn 3). Table 1 shows the results of the correlation analysis (r = Pearson product-moment correlation) among environmental parameters.

Biological characteristics

In total, 87 taxa belonging to 39 genera were determined from 4 stations in the Homa lagoon. The maximum num-

Table 2. Species found in Homa lagoon and the abbreviation codes used in the canonical correspondence analyses

Species	Code
Achnanthes brevipes C. Agardh	ACH BREV
Cocconeis placentula Ehrenberg	COC PLAC
Cocconeis scutellum Ehrenberg	COC SCUT
Craticula cuspidata (Kutzing) D.G. Mann in Round, Crawford & Mann	CRA CUSP
Ctenophora pulchella (Ralfs ex Kützing) D.M. Williams & Round	CTE PULC
Cylindrotheca closterium (Ehrenberg) Reimann & J.C. Lewin	CYL CLOS
Eunotogramma marinum (W.Smith) H. Peragallo	EUN MARI
Grammatophora oceanica Ehrenberg	GRA OCEA
Gyrosigma spencerii (J.W. Bailey ex Quekett) Griffith & Henfrey	GYR SPEN
Halamphora turgida (Gregory) Levkov	HAL TURG
Halamphora veneta (Kützing) Levkov	HAL VENE
Licmophora gracilis (Ehrenberg) Grunow	LIC GRAC
Licmophora lyngbyei (Kützing) Grunow ex Van Heurck	LIC LYNG
Mastogloia braunii Grunow	MAS BRAU
Mastogloia pumila Cleve	MAS PUMI
Navicula cincta (Ehrenberg) Ralfs in Pritichard	NAV CINC
Navicula cryptocephala	NAV CRYP
Navicula distans	NAV DIST
Navicula forcipata var. *densestriata* A.W.F.Schmidt	NAV FODE
Navicula menaiana Hendey	NAV MENA
Navicula menisculus Schumann	NAV MENI
Navicula radiosa Kützing	NAV RADI
Navicula ramosissima var. *mollis* (W. Smith) Hendey	NAV RAMO
Navicula trivialis Lange-Bertalot	NAV TRIV
Nitzschia debilis (Arnott) Grunow in Cleve & Grunow	NIT DEBI
Nitzschia dissipata (Kützing) Grunow	NIT DISS
Nitzschia frustulum (Kützing) Grunow in Cleve & Grunow	NIT FRUS
Nitzschia longissima (Brébisson) Ralfs in Pritchard	NIT LONG
Nitzschia sigma (Kützing) W. Smith	NIT SIGM
Pinnularia viridis (Nitzsch) Ehrenberg	PIN VIRI
Pleurosigma salinarum (Grunow) Grunow in Cleve & Grunow	PLE SALI
Psammodictyon panduriforme (W. Gregory) D.G. Mann in Round, Crawford & Mann	PSA PAND
Rhabdonema adriaticum Kützing	RHA ADRI
Seminavis robusta D.B. Danielidis & D.G.Mann	SEM ROBU
Striatella unipunctata (Lyngbye) C. Agardh	STR UNIP
Synedra gaillonii (Bory de Saint-Vincent) Ehrenberg	SYN GAIL
Tabularia fasciculata (C. Agardh) D.M. Williams & Round	TAB FASC
Toxonidea insignis Donkin	TOX INSI
Tryblionella acuminata W. Smith	TRY ACUM

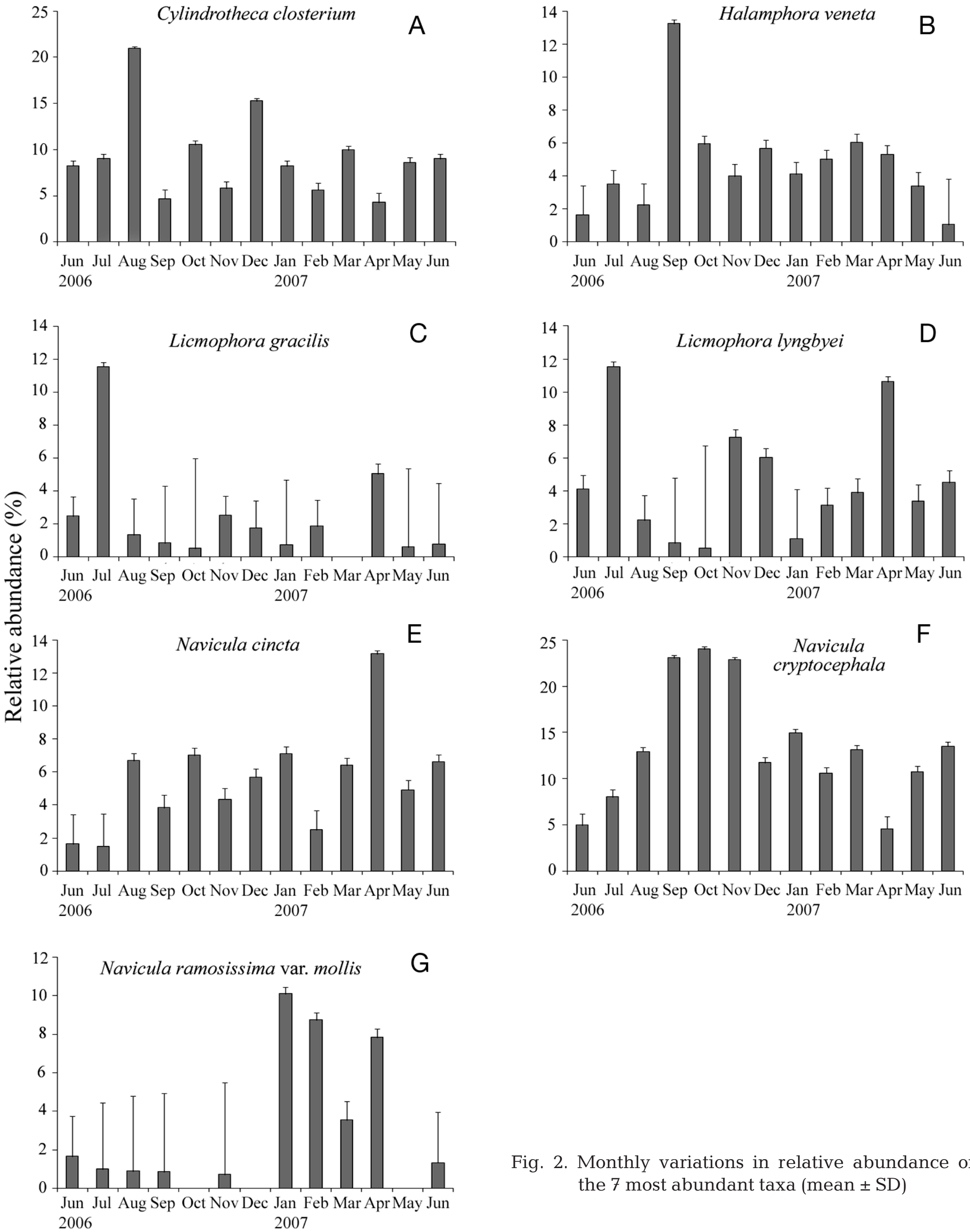

Fig. 2. Monthly variations in relative abundance of the 7 most abundant taxa (mean ± SD)

ber of species with 67 taxa was found at Stn 2, of which 41 taxa were also observed at Stn 4, which had a slightly lower number of species (50). In terms of total epilithic diatom density, considerable differences were recorded among the stations. The highest total numbers were recorded in April 2007 (75 693 cells cm^{-2}) at Stn 3 and in September 2006 (120 086 cells cm^{-2}) at Stn 3 due to a sharp increase in cell numbers of *Navicula cryptocephala*.

The most abundant diatom taxa encountered are listed in Table 2. The percentage of species with a maximum RA (the highest RA value observed during the study period) of 54 % in a sample was less than 5 %, with approximately 28 % of species having an

RA of less than 10%. Only 7 taxa occurred at a maximum RA of over 10% (Fig. 2), and some of these were either planktonic or belonged to the genus *Navicula*. These 7 were also generally frequent within the data. *Cylindrotheca closterium* (maximum RA 20%) and *N. cryptocephala* (maximum RA 24%) were the overall most abundant taxa throughout the sampling. There were some other species such as *Halamphora veneta*, *Licmophora gracilis*, *L. lyngbyei*, *N. cincta*, and *N. ramosissima* var. *mollis* which occurred in all samples, showing maximum RA values of more than 10% during some periods. Although the abundant taxa were registered in all samples, they exhibited some differences in their spatial distribution in relation to sampling period. The RA of *H. veneta* was substantially higher (>10%) in September 2006 (Stns 2 and 3), *L. gracilis* in July 2006 (Stn 3), *L. lyngbyei* in July 2006 and in April 2007 (Stn 3), and *N. cincta* in April 2007 (Stns 1 and 3).

The Shannon-Wiener *H'* values were quite variable, varying between 1.00 and 3.39, and correlated with species richness (r = 0.93), which varied from 3 to 34, and evenness (*J'*; r = 0.38), which ranged from 0.66 to 0.98. Median diversity was lower for Stn 4 (2.12) than for Stn 2 (3.06), Stn 3 (2.76), and Stn 1 (2.26; Fig. 3). Differences in *H'* values among sampling sites were statistically significant.

Ordination and classification

The relationships between the diatom assemblages and the environmental variables were explored in more detail using CCA and the results are plotted in Fig. 4. The result of the CCA ordination for 39 diatom species, 10 environmental variables, and 52 samples showed that 24% of the variance in species abundance was accounted for by the first 4 ordination axes. The eigenvalues for CCA axes 1 and 2 are 0.48 and 0.33, and the species–environment correlations for CCA axes 1 (0.87) and 2 (0.85) are high. After evaluating the importance of all 10 environmental variables by forward selection of the environmental variables, Monte Carlo unrestricted permutation tests of the statistical significance, canonical coefficient and intra-set correlations between environmental variables and the axes, the Si and NH_4-N concentrations were the most important environmental variables accounting for species distribution. The distribution of species along the first axis reflects their requirements with regard to Si and NH_4-N in which the 2 environmental variables capture about 41% of the total variance and Si concentration alone accounts for about 24%. The distributions of *Halamphora veneta*, *H. turgida*, *Mastogloia pumila*, *Navicula cryptocephala*, *N. menisculus*, *N. trivialis*, *Nitzschia frustulum*, *Nitzschia sigma*, *Pinnularia viridis*, and *Tabularia fasciculata* are positively correlated to NO_3-N and NH_4-N and negatively correlated to salinity. *Gyrosigma spencerii*, *M. braunii*, *Navicula radiosa*, and *Synedra gaillonii* are positively correlated to NO_2-N and PO_4-P; *Cylindrotheca closterium, Navicula dissipata*, and *Seminavis robusta* are positively correlated to Si concentrations and negatively correlated to pH and temperature; and *Cocconeis*

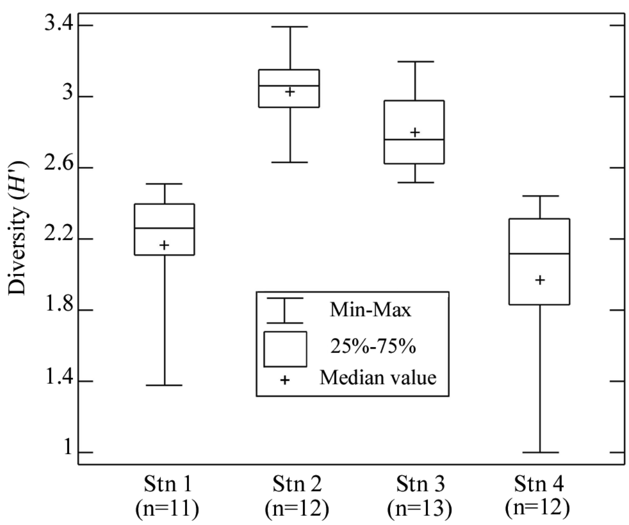

Fig. 3. Differences in the values of the Shannon-Wiener diversity index (*H'*) at the 4 sampling sites

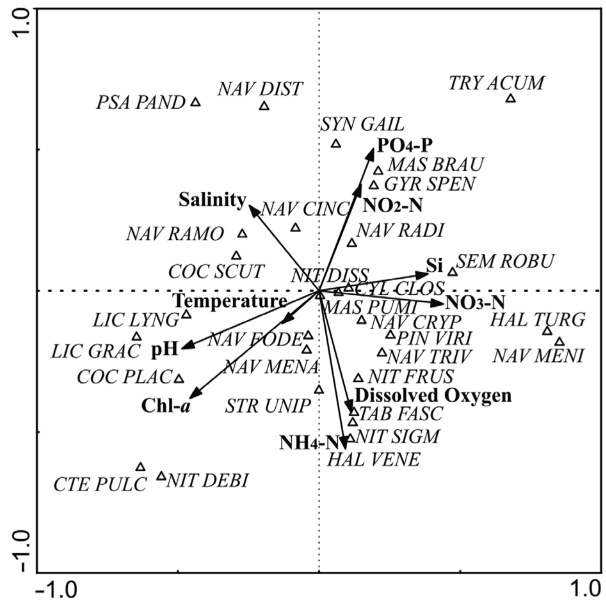

Fig. 4. Canonical correspondence analysis of 52 samples from 4 sites. For abbrevations see Tables 1 & 2

scutellum, *Navicula cincta*, and *N. ramosissima* var. *mollis* are positively correlated to salinity and negatively correlated to nutrient concentrations. Also, *C. placentula*, *N. forcipata* var. *densestriata*, *N. menaiana*, *Licmophora gracilis*, and *L. lyngbyei* are strongly positively correlated to pH and temperature (Fig. 4).

DISCUSSION AND CONCLUSIONS

The present investigation showed that the epilithic assemblage of the Homa lagoon appeared to be relatively homogeneous, and few species made a significant contribution to the assemblage structure. *Cylindrotheca closterium*, *C. placentula*, *Halamphora veneta*, *Licmophora gracilis*, *L. lyngbyei*, *Navicula cincta*, *N. cryptocephala*, *N. distans*, *N. ramosissima* var. *mollis*, *N. trivialis*, and *Pinnularia viridis* were the dominant species, and the monthly succession of these species constituted the most important portion of assemblage structure. In this study, some diatom species sometimes strongly predominated over the others in the composition of the epilithic community (RA of *C. closterium* at Stn 1 was 41 % in August 2006 and 52 % in December 2006; RA of *N. cryptocephala* at Stn 4 was 49 % in September 2006, 30 % in October 2006, and 53 % in November 2006).

Several studies have investigated the spatial distribution of epilithic diatoms and revealed correlations between the species distribution and salinity, temperature, amount of sand grains, and macroalgae on the stones (Ulanova & Snoeijs 2006). These studies have compared several sites from different mudflats (Underwood 1994), or sampled along salinity (Ulanova & Snoeijs 2006) or pollution gradients (Admiraal & Peletier 1980), or with water movement (Delgado et al. 1991) or the microalgal biomass (Kendrick et al. 1996). The area in the present study is characterized by a highly dynamic environment, basically because of the frequent changes of physical characteristics due to shallowness. Depending on the depths of the stations, they are exposed to varying degrees of wind and wave action, which has an important effect in the regional composition of diatom species. Water turbulance can lead to biomass losses of up to 80 % (Hoagland 1983), and, at wave-exposed sites, the high water column primary productivity can be largely (90 %) caused by resuspension of the benthic diatom flora (Shaffer & Sullivan 1988). In very shallow waters, benthic and planktonic communities are not clearly differentiated, mainly due to the continuous mixture of the shallow water column. Therefore, it is not unusual to find a typical planktonic species such as *Cylindrotheca closterium* as the dominant species in a sessile community.

Ordination techniques have been used successfully to interpret epilithic diatom community structure. In this study, it was possible to describe the relationships of species–environmental factors. As a result of CCA analyses, the distribution of community composition was clearly correlated, particularly with variations in Si and NH_4-N. Non-restrictive silicate conditions are favorable for diatoms, which are excellent competitors at high Si/N ratios (N-limitation) and high Si/P ratios (P-limitation; Sommer 1996). High concentrations of silica can promote diatom growth and strong silicification of diatom frustules (Busse & Snoeijs 2003). The mean ratios of Si/N (range: 0.15–2.53) and Si/P (range: 2.10–37.67) in the study area were 0.66 and 10.4, respectively. The values Si/N (except March 2007) and Si/P were below the Redfield ratio during the sampling, which indicates that silicate was likely the limiting factor for the growth of diatoms in the Homa lagoon. Under N limitation, diatoms are capable of relatively high Si uptake, which ultimately results in smaller and tougher frustules (Lynn et al. 2000). Variations in salinity, usually a significant structuring factor (Weckström & Juggins 2005), had no effect on the composition of the diatom communities of the Homa lagoon. This is an expected situation, given a lack of marked changes in the salinty values. Adaptation to changes in salinity is a prerequisite for diatoms living in these environments.

Diatoms in the center of the CCA ordination diagram are rather complex, including both marine planktonic and benthic species, and even a few brackish water species. The analyses indicated that some species in the Homa lagoon respond positively to increased nutrient concentrations: *Halamphora veneta*, *Nitzschia frustulum*, and *Tabularia fasciculata* to NH_4-N; and *Gyrosigma spencerii*, *Mastogloia braunii*, *Navicula radiosa*, and *Synedra gaillonii* to NO_2-N and PO_4-P. In a marine study by Busse & Snoeijs (2003), *T. fasciculata* were favored by Si and Si/N, and *N. frustulum* responded negatively to P and positively to Si/P and N/P. *N. frustulum* can be found at extremely high abundances in strongly eutrophied waters with heavy sewage impact (Wendker 1990). *Cocconeis placentula*, *C. scutellum*, and *Ctenophora pulchella* grouped in the direction of higher salinity and were defined as typical epiphytes (Ulanova & Snoeijs 2006). There is some controversy about the ecology of *C. placentula*. Pipp & Rott (1993) considered that the occurrence and abundance of *C. placentula* can be favored by NO_3 increases. However, the findings of the present study were similar to those of Eulin (1997), and the same species were found not to be affected by the water nutrient content. *Craticula cuspidata*, *G. spencerii*, and *Navicula trivialis* have been reported to have no habitat specificity (Townsend & Gell 2005). Similarly, in the present study, these species did not appear to be specific to the stubtrata in Homa Lagoon. This is not surprising because in a study carried out on artificial substratum, epilithic species were observed first (Munda 2005). The same study also reported that sand particles accumulated on the study plaques over time, depending on water movements, and, consequently, epipelic and epipsammic species were seen in addition to the epilithic species. Therefore, the species composition of the epilithic community was made up of planktonic, epipelic, and epipsammic algae.

The species defined in lagoonal systems are usually quite mixed and often difficult to interpret, because the distribution of epilithic diatoms is not only controlled by the substratum but also by biotic and abiotic factors. In transitional systems, the continual changes of these factors, and interactions between them, make it difficult to understand which factor(s) is (are) affecting the community structure. Microphytobenthic studies are important for understanding the general ecology of benthic communities. In this context, studies similar to the present study (i.e. analysing benthic diatom community composition in the Homa lagoon) could be helpful in future quantitative evaluations of species composition and their responses to environmental gradients.

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