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Contributions to the knowledge of algal flora of Homa Lagoon (Aegean Sea, Turkey)

Homa Lagünü (Ege Denizi, Türkiye) alg florası için yeni kayıtlar

Fatma Çolak Sabancı

Faculty of Fisheries, Department of Hydrobiology, Ege University, 35100 Bornova, Izmir, Turkey.

Abstract

In this study, the benthic diatoms of Homa lagoon were determined between June 2006 and September 2007. Samples were collected from four selected sampling sites. The major confusion in genus *Nitzschia* identification is largely caused by the lack of comprehensive descriptions of nomenclatural types and undescribed variability of diagnostic features. Therefore it's important to describe the species in sufficient detail to permit correct species recognition. For this purpose, structural details of observed in nine species of genus *Nitzschia* were examined. *Nitzschia compressa* var. *balatonis* (Grunow) Lange-Bertalot, *Nitzschia rectirobusta* Lange-Bertalot, *Nitzschia vidovichii* Grunow were reported for the first time from the Turkish coastal waters. Original photographs, morphological features and some information on their distribution patterns and the substratum they inhabit were also provided.

Key words: *Nitzschia*, benthic diatom, morphometric data, Aegean Sea.

Introduction

Lagoons are nutrient rich environments because of the sediment mixing as a result of shallowness. Benthic algae make a significant contribution

***Corresponding author:** sabanci.fatma@gmail.com

to primary production especially in estuarine ecosystems and play an important role in food webs in waters (Pinckney and Zingmark 1993). Investigations on the population dynamics, biomass, and production of benthic algae suggest that they might sometimes exceed total phytoplankton production and, therefore, cannot be neglected when the total primary production of aquatic ecosystems is assessed (Moss 1969, Khonder and Dokulil 1988).

Lagoons are important wetlands in respect of ecological significance. These wetlands located between land and sea, are the transition zones between freswater and salty water. There are 72 lagoons in Turkey and these occupy on area of 36000 hectares. Few algological studies have been performed in these lagoon systems. The seasonal variations of phytoplankton were investigated by Cevik et al. (2008) in lagoon Akyatan and Tuzla which are located in the southern Anatolia. On the other hand, algal flora of important dam lakes and running waters of the lower euphrates basin were examined by Baykal et al. (2009) in the southeast Anatolian region. The Kizilirmak and Yesilirmak lagoon series are located around the mouths of the Kizilirmak and Yesilirmak rivers in the Northern Anatolia. Among these series, the phytoplankton of Balik lagoon and Uzun lagoon (Gonulol and Comak 1992, 1993), Gici lagoon (Soylu and Gonulol 2006), Cernek lagoon (Tas and Gonulol 2007), Karabogaz lagoon (Baytut et al. 2006) were investigated in the Kizilirmak lagoon series. In the delta of Yesilirmak river, Simenit lagoon (Ersanli and Gonulol 2006), Akgol lagoon (Ersanli et al. 2006) were investigated in respect of algal flora. In addition to these studies, the seasonal variations of benthic algae in Karagol Lake were examined by Kolayli and Şahin (2009) in the northeast Anatolia.

The objective of this work was to contribute to the knowledge on the structural details observed in nine *Nitzschia* species using phase contrast apochromat objective. In this study, three species of the genus *Nitzschia* are reported for the first time in Turkish coastal waters.

Materials and Methods

Homa Lagoon (38° 33' 10" N, 26° 49' 50" E) is located 25 kilometeres to the northwest of the Gulf of Izmir and within the borders of the town of Menemen (Figure 1). The depth of the fish trap is maximum 1.5 meters and its depth mostly varies between 0.5 and 1 meter. During the study period, temperature, salinity and dissolved oxygen ranged between 4-27° C, 35-50 psu and 6-24.4 mg L^{-1} respectively. Costal region of Homa lagoon was investigated at 4 different stations between June 2006-September 2007 in order to determine the epipelic, epiphytic and epilithic diatom communities.

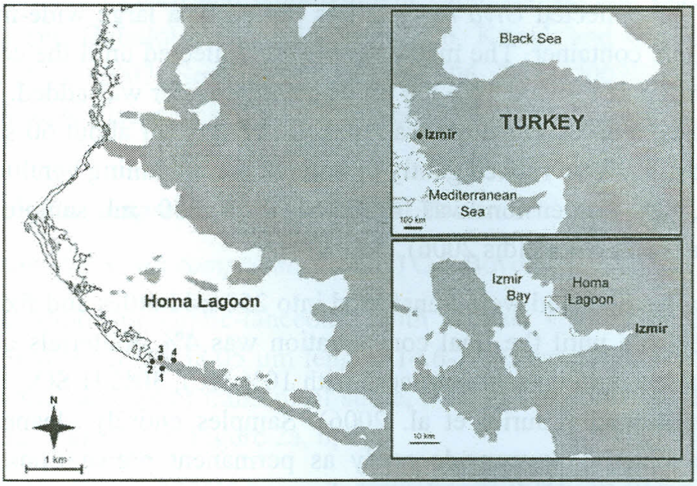

Figure 1. The study area and the location of sampling points.

Sediment samples were taken using cylindrical plexiglas corers (13 cm long × 6.1 cm i.d.) in order to determine the epipelic diatom flora living on coastal sediments. The sediment corers left undisturbed for 24 h. During the exposure period, the corers were artificially illuminated for 2 h. After the waiting period, the sample from the upper part of 0-2 cm was taken and transferred to 250 ml polythene bottles containing distilled water (Ribeiro et al. 2003).

For defining the species composition of epilithic diatoms in the benthic regions the stones of 15-20 cm in diameter in the lagoon were used. Stones chosen as randomly as possible from amongst those that are not smothered with filamentous algae and which have an obvious diatom film were taken into consideration. Selected stones were taken into a plastic bath of 1lt. in which 200 ml of distilled water was added. The upper parts of the stones were rubbed with a hard toothbrush and finally the mixture was decanted into the 250 ml polythene bottles (Winter and Duthie 2000).

In order to define the species composition of epiphytic diatoms *Ulva lactuca* Linnaeus was chosen in the research region. The main purpose for choosing this macroalgae is to have a large area of the structure tallus. The collected *Ulva lactuca* was placed in a large wide-mouthed 1lt. sample container. The macroalgae were collected until the container was about half full and 100-200 ml of distilled water was added. The lid was closed and the container was shaked strongly for about 60 seconds. The substrata were rubbed gently to remove the remaining benthic algae. Finally, the suspension was decanted in a 250 ml sample bottle (Aligizaki and Nikolaidis 2006).

All samples obtained were transferred into 250 ml bottles and fixed with formaldehyde until the final consantration was 4%. Materials obtained were subjected to chemical process with 10% HCl, 30% H_2SO_4, $KMnO_4$ and oxalic acid (Lauriol et al. 2006). Samples entirely cleaned from organic material were made ready as permanent preparations. Clean diatom valves were identified via phase-contrast apochromate objectives on a OLYMPUS BX-50 research microscope. Foged (1985), Krammer and Lange-Bertalot (1999), Peragallo and Peragallo (1897-1908) and Witkowski et al. (2000) were followed for identification of detected diatoms.

At each sampling points measurements of salinity (p.s.u.), temperature (°C) and dissolved oxygen (mg L^{-1}) were performed. Salinity and dissolved oxygen (DO) measurements were made by Martin (1972) and the Winkler method (Winkler 1888) respectively.

Results and Discussion

Nitzschia compressa var. *balatonis* (Grunow) Lange-Bertalot, *Nitzschia rectirobusta* Lange-Bertalot, *Nitzschia vidovichii* Grunow from Bacillariophyceae were reported for the first time from the Turkish coastal waters. The other species of the genus *Nitzchia* determined in this study as *Tryblionella compressa* (J.W.Bailey) M.Poulin, *Nitzschia linearis* var. subtilis (Grunow) Hustedt, *Nitzschia microcephala* Grunow, *Nitzschia scalpelliformis* Grunow, *Nitzschia supralitorea* Lange-Bertalot and *Nitzschia vermicularis* (Kützing) Hantzsch have been also reported in many previous studies by various authors in Turkish Coastal Waters (Acıkgoz and Baykal 2005, Akanıl Bingöl et al. 2007, Aysel 2005, Celekli 2006, Celekli and Kulkoyluoglu 2006, Elmacı and Obalı 1998, Ersanlı and Gonulol 2006, Kalyoncu 2006, Kıvrak and Gurbuz 2010, Sıvacı et. al. 2007, Soylu and Gonulol 2006, Zaim 2007). All of the species were also checked in the algaebase web site (Guiry and Guiry 2009).

***Tryblionella compressa* (J.W.Bailey) M.Poulin**

Synonym: *Nitzschia compressa* (Bailey) C.S.Boyer

Valves elliptic or eliptic-lanceolata with cuneate slightly produced to sub-apiculate, 28.25-38.05 µm length, 14.6-14.85 µm width. Number of fibulae the same as of transapical striae, 9-10 in 10 µm, striae distinctly punctate, 9 in 10 µm (Figure 2a, b, c)

Distribution: June 2006 (station 3, Epipelic, 26.2 °C; 38.40 p.s.u.; 11.6 mg L^{-1}), September 2006 (station 1, Epipelic, 21 °C; 35.00 p.s.u; 14 mg L^{-1}), March 2007 (station 2, Epiphytic, 14.5 °C; 39.85 p.s.u; 18.4 mg L^{-1}).

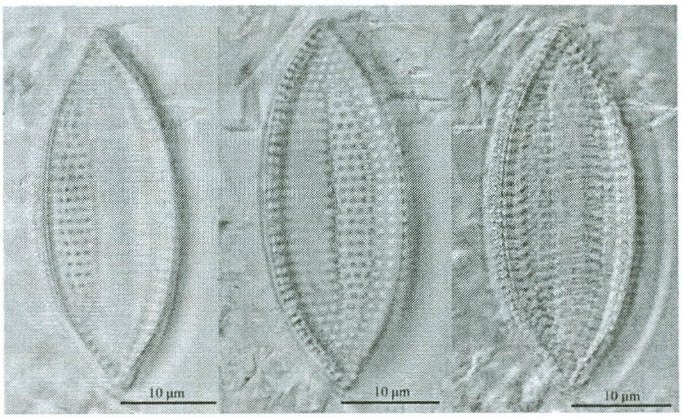

Figure 2. Phase contrast photographs of *Tryblionella compressa*.

***Nitzschia compressa* var. *balatonis* (Grunow) Lange-Bertalot**

Valves elliptic or eliptic-lanceolata, 14.55 μm length, 5.9 μm width. Striae, 18 in 10 μm, striae distinctly punctate (Figure 3a, b, c)

Distribution: September 2006 (station 3, Epiphytic, 22 °C; 36.46 p.s.u; 14 mg L^{-1})

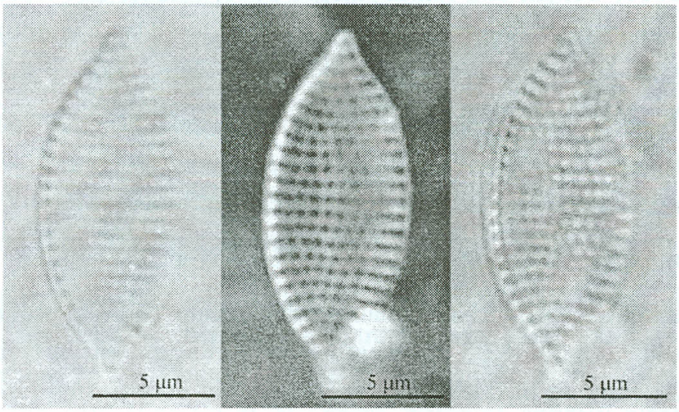

Figure 3. Phase contrast photographs of *Nitzschia compressa* var. *balatonis*.

***Nitzschia linearis* var. *subtilis* (Grunow) Hustedt**

Synonym: *Synedra subtilis* Kützing

Nitzschia subtilis (Kützing) Grunow

Synedra tenuis var. *subtilis* (Kützing) Brun

Bacillaria subtilis (Kützing) Elmore

Valves narrow- lanceolata or linear- lanceolata, sometimes slightly curved. 64.45 μm length, 6.8 μm width. Fibulae 11-12 in 10 μm, striae 35-36 in 10 μm (Figure 4a, b).

Distribution: September 2006 (station 2, Epilithic, 22 °C; 35.97 p.s.u; 13.2 mg L^{-1}), September 2006 (station 1, Epilithic, 21 °C; 35.00 p.s.u; 14 mg L^{-1})

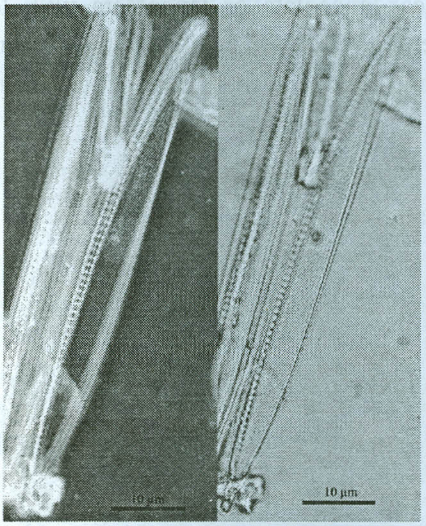

Figure 4. Phase contrast photographs of *Nitzschia linearis* var. *subtilis*.

Nitzschia microcephala **Grunow**

Valves, lanceolata, elliptic or linear- elliptic, with conspicuously capitate or short rostrate ends. 7.0 µm length, 2.15 µm width. Fibulae 8 in 5 µm, striae 17 in 5 µm, often quite difficult to be seen in LM (Figure 5 a,b)

Distribution: September 2006 (station 1, Epilithic, 21 °C; 35.00 p.s.u; 14 mg L^{-1})

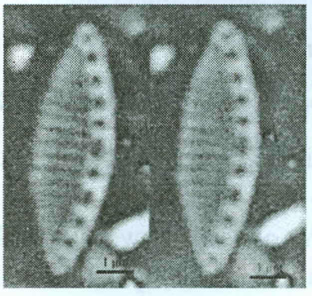

Figure 5. Phase contrast photographs of *Nitzschia microcephala*.

Nitzschia rectirobusta Lange-Bertalot

Synonym: *Nitzschia recta* var. *robusta* Hustedt

Valves linear, linear-lanceolata or lanceolata with long wedge shape. Valve 57.6 µm length, 6.25 µm width, at the upper limit of the total variability spectrum. Fibulae, 9 in 10 µm. Striae, 27 in 10 µm (Figure 6 a,b).

Distribution: June 2007 (station 1, Epiphytic, 26 °C; 38.88 p.s.u; 19.6 mg L^{-1}), June 2007 (station 4, 27 °C; 39.85 p.s.u; 21.6 mg L^{-1}).

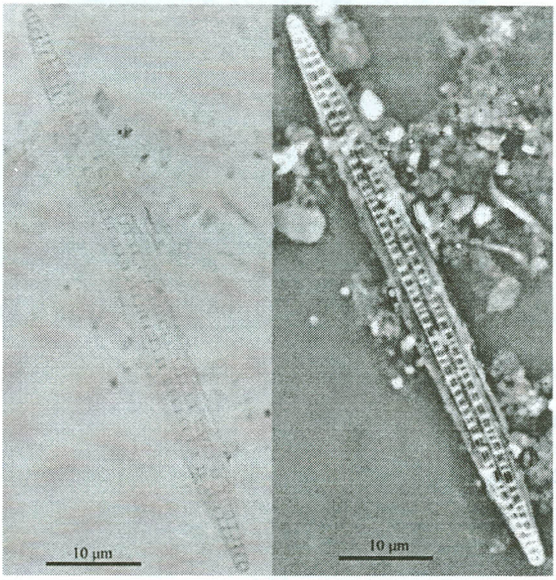

Figure 6. Phase contrast photographs of *Nitzschia rectirobusta*.

Nitzschia scalpelliformis **Grunow**

Synonym: *Nitzschia obtusa* var. *scalpelliformis* Grunow

Valve linear, in the middle sometimes slightly concave, in the end the scalpel-shaped. 70.55-100 µm length, 5.48-5.70 µm width. Raphe basically same with *N. obtusta*, however, slightly less eccentric and central node slightly farther to centripetal. Fibulae, 8-9 in 10 µm. Striae 26-30 in10 µm (Figure 7a, b)

Distribution: June 2006 (station 3, Epiphytic, 22 °C; 36.46 p.s.u; 14 mg L^{-1}), September 2006 (station 3, Epilithic, 26.2°C; 38.40 p.s.u; 11.6 mg L^{-1}), September 2006 (station 4, Epiphytic, 24 °C; 44.71 p.s.u; 18 mg L^{-1}), September 2007 (station 4, Epilithic 21 °C; 39.66 p.s.u; 9.8 mg L^{-1}).

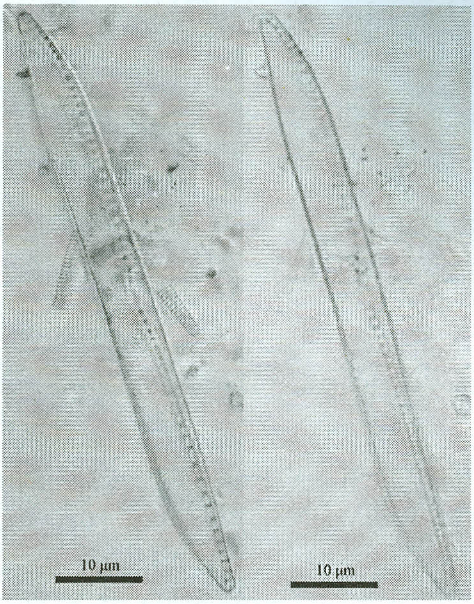

Figure 7. Phase contrast photographs of *Nitzschia scalpelliformis*.

Nitzschia supralitorea Lange-Bertalot

Valve lanceolata or linear- lanceolata. Sometimes apex has a slightly rounded end. 26.75 µm length, 2.85 µm width. Fibulae 13-14 in 10 µm, fibulae also closely spaced in the centre of the valve, striae 31 in 10 µm (Figure 8 a, b, c)

Distribution: September 2007 (station 1, Epilithic, 22 °C; 34.42 p.s.u; 6.8 mg L^{-1}).

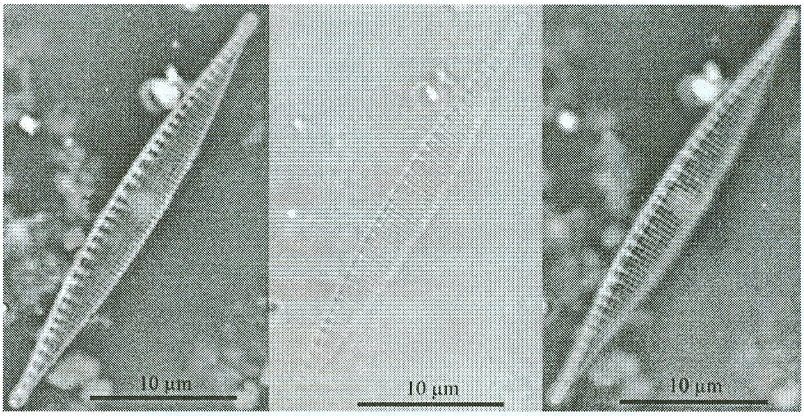

Figure 8. Phase contrast photographs of *Nitzschia supralitorea*.

Nitzschia vermicularis (Kützing) Hantzsch

Valve sigmoid, linear, slightly attenuated towards the end, keel punctate, 73.0 µm length, 4.95 µm width. Fibulae 11 in 10 µm, transapical striae 35 in 10 µm (Figure 9a,b)

Distribution: September 2006 (station 2, Epilithic, 22 °C; 35.97 p.s.u; 13.2 mg L^{-1}).

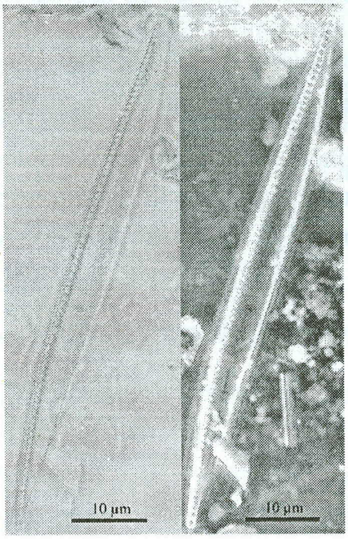

Figure 9. Phase contrast photographs of *Nitzschia vermicularis*.

***Nitzschia vidovichii* Grunow**

Valves in the girdle view very slightly sigmoid, very slightly narrowed towards the obtuse ends. 120 µm length, 6.85 µm width. Fibulae 8 in 10 µm, transapical striae finely punctate, 28-29 in 10 µm (Figure 10 a, b)

Distribution: September 2006 (station 4, Epiphytic, 24 °C; 44.71 p.s.u; 18 mg L^{-1}).

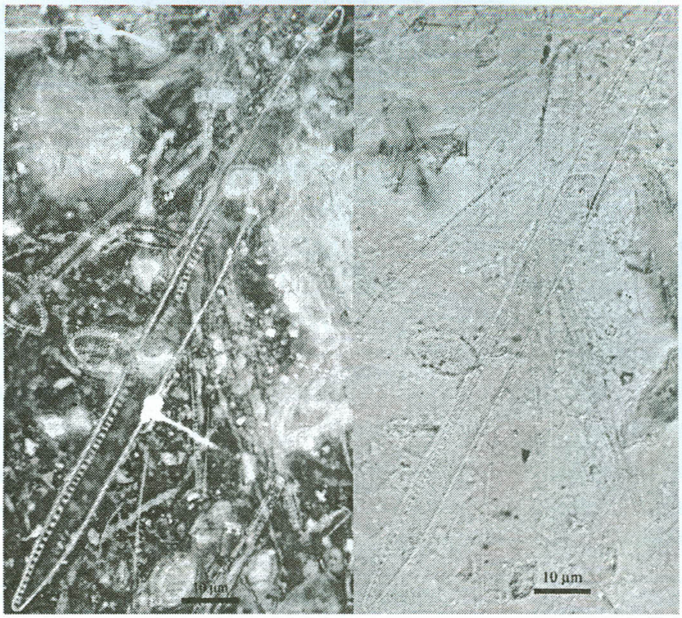

Figure 10. Phase contrast photographs of *Nitzschia vidovichii*.

Parameters in this study have shown some similarities and differences with the parameters given by other researchers (Table). The values of *Nitzschia compressa* var. *compressa*, *Nitzschia compressa* var. *balatonis*, *Nitzschia linearis* var. *subtilis*, *Nitzschia rectirobusta* and *Nitzschia scalpelliformis* were within the limits given by other researchers.

The width of our samples for *Nitzschia microcephala* was found 2.15 µm, whereas the values reported by Krammer and Lange-Bertalot (1999) was given as 2.3-4 µm. The lenght and the number of fibulae for *Nitzschia supralitorea* in this study was found 26 µm and 13-14 fibulae in 10 μm respectively, whereas the same parameters reported by Krammer and Lange-Bertalot (1999) was given as 10-25 μm and 14-18(20) fibulae in 10 μm. While the lenght of *Nitzschia vermicularis* was found 73 μm, it was reported as 75-250 μm by Krammer and Lange-Bertalot (1999). In the studies by Çelekli (2006) and Çelekli and Kulkoyluoglu (2006), the lenght, the width and the number of striae for *Nitzschia vermicularis* were reported as 87-156 μm, 4-6.5 μm and 29-32 striae in 10 μm respectively. In addition to this, in the research by Syed et al. (2006), this species was reported 90-170 μm in lenght and 6-9 μm in width. The width and the number of striae of our samples for *Nitzschia vidovichii* was found 6.85 μm and 28-29 striae in 10 μm respectively, on the other hand the values reported by Witkowski et al. (2000) was given as 7-9 μm and 24-25 striae in 10 μm. Also, for the same species, the number of fibulae and striae in 10 μm were given as 8 and 24-25 respectively by Peragallo and Peragallo (1897-1908), at the same time in the study by Foged (1985), it was reported 68 μm in the lenght, 7 μm in width.

Table 1. Comparative morphology of *T. compressa*, *N. compressa* var. *balatonis*, *N. linearis* var. *subtilis*, *N. microcephala*, *N. rectirobusta*, *N. scalpelliformis*, *N. supralitorea*, *N. vermicularis*, *N. vidovichii*.

Taxa	Lenght (μm)	Width (μm)	Fibulae (in 10 μm)	Striae (in 10 μm)	Reference
Tryblionella compressa		>9			3
	25-70	10-16	5-21	7-25	4
Nitzschia compressa var. *balatonis*	12.5-30	3.5-8		16-21	3
Nitzschia linearis var. *subtilis*				33-37	3
Nitzschia microcephala	7-19	2.3-4	9-10	30-41	3
Nitzschia rectirobusta		6-7		26-32	3
Nitzschia scalpelliformis	20-110	4.5-7.4	7-10	(25)27-38	3
Nitzschia supralitorea	10-25	2.5-4	14-18(20)	25-34	3
Nitzschia vermicularis	75-250	3.5-7	5-12	30-40	3
Nitzschia vidovichii			8	24-25	1
	68	7			2
	88-120	7-9	5-8	28	4

[1]Peragallo and Peragallo (1897-1908). [2]Foged (1985). [3]Krammer & Lange-Bertalot (1999). [4]Witkowski et. al., (2000).

Species of the genus *Nitzchia* Hassall are found in a wide range of salinity from fresh to brackish waters (Denys and Lange-Bertalot 1998).

Members of this *Nitzchia* are known to be important indicators of organic pollution and high nutrient loads which makes them significant for water quality studies and biomonitoring (Lange-Bertalot 1979, Van Dam et al. 1994). On the other hand, in the genus *Nitzschia* determining the species delimitations causes a big problem (Trobajo et al. 2004, 2006). Although numerous studies are done for morphology and taxonomy of the genus (Lange-Bertalot 1980, Lange-Bertalot and Krammer 1987, Krammer and Lange-Bertalot 1988, Wendker and Geissler 1988, Tudesque et al. (2008) it's still difficult and unclear to determine and delimitate of many taxa with overlapping diagnostic criteria. The absence of detailed documentation on nomenclatural types and undefined ranges of morphological variability can lead to species misinterpretations which make confusion in taxonomy of the group (Jahn et al. 2004). For this purpose, structural details of nine species of *Nitzschia* were examined.

Microphytobenthic studies are important in order for the general ecology of communities to be understood. Nevertheless, the studies on microphytobenthos are very limited (Cahoon and Laws 1993, Schreiber and Pennock 1995). Particularly the taxonomic literature on brackish water diatoms is unclear and scattered. In this context, beside the reports on pelagic microalgae, studies on the taxonomy of benthic microalgae will contribute to the algae flora.

Özet

Bu çalışmada Homa lagünü bentik diyatom kommunitesi, Haziran 2006-Eylül 2007 tarihleri arasında seçilen dört istasyonda incelendi. Kapsamlı nomenklatür açıklamaları ve belirleyici özelliklerin tanımlanmasındaki eksikliklerden dolayı *Nitzchia* genusuna ait türlerin tayininde ciddi karışıklıklar bulunmaktadır. Bu nedenle, populasyonun doğru tanımlamasına imkan sağlayacak şekilde türlerin yapısal detaylarının belirlenmesi önemlidir. Bu amaçla, bölgedeki *Nitzschia* genusuna ait saptanan dokuz türün yapısal detayları incelenmiştir. *Nitzschia compressa* var. *balatonis* (Grunow) Lange-Bertalot, *Nitzschia rectirobusta* Lange-Bertalot, *Nitzschia vidovichii* Grunow Türkiye kıyısal suları için ilk kez rapor edilmiştir. Orijinal fotoğrafların yanında morfolojik özellikleri, dağılım alanları ve yaşadıkları substratum hakkında bilgiler verilmiştir.

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