Mediterranean Marine Science

Vol 14, No 1 (2013)

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doi: [10.12681/mms.331](https://doi.org/10.12681/mms.331)

To cite this article:

COLAK SABANCI, F. (2013). Species of Mastogloia (Bacillariophyceae) new for the Aegean coast of Turkey. *Mediterranean Marine Science*, *14*(1), 129–140. https://doi.org/10.12681/mms.331

Research Article

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net
http://dx.doi.org/10.12681/mms.331

Species of *Mastogloia* (Bacillariophyceae) - new for the Aegean coast of Turkey

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Received: 27 March 2012; Accepted: 24 January 2013; Published on line: 12 March 2013

Abstract

This paper describes the comprehensive morphological characteristics of ten *Mastogloia* Thwaites ex W. Smith (Bacillariophyceae) species, including *M. aquilegiae*, *M. baldjikiana*, *M. binotata*, *M. grunowii*, *M. ignorata*, *M. paradoxa*, *M. pumila*, *M.* cf. *regula*, *M. similis* and *M. vasta*. Specimens were examined under a light microscope; eight of them are reported for the first time from Turkish coastal waters. Apart from the photo documentation, some information on the geographical distribution patterns of the species and the type of substratum is also provided.

Keywords: Mastogloia, morphometric data, taxonomy, periphytic diatoms, Homa Lagoon (Turkey), Eastern Mediterranean.

Introduction

Mastogloia Thwaites ex W. Smith is mainly a marine genus which can also be found in hypersaline, brackish and fresh water environments (Round *et al*., 1990). The number of taxa (140 taxa, Hustedt, 1933) belonging to this genus in the Van Landingham's (1971) catalogue of diatoms had increased 1.5 times by 1988 (Novarino, 1989) and an estimated number of 410 taxa have been described. Although *Mastogloia* has a worldwide distribution, no significant fossil record of the genus is available (Paddock & Kemp, 1990); the sophisticated form of the frustule and, occasionally, the weird pattern of the valves indicates that the origin of the genus does not date back to earlier times and that they are undergoing rapid evolution (Paddock & Kemp, 1990).

Mann (Round *et al*., 1990) described a new order, the Mastogloiales, including *Mastogloia*, which was defined as having: two fore and aft chloroplasts that are H-shaped in girdle view, the plates under the valves being indented under the raphe and connected by a central pyrenoid; areolae that are occluded by cribra or volae, but not hymenes; girdle bands that are open porous bands and valvocopulae that are loculate. Species of *Mastogloia* are easily distinguished from those of other genera by the presence of various forms of marginal chamber ring (Hustedt, 1933) or partectal ring (Stephens & Gibson, 1979; Paddock & Kemp, 1988; Paddock & Kemp, 1990). The gross arrangement of this feature within the frustule of *Mastogloia* can be clearly observed in the LM and provides a practical way of describing the differences between most species.

The genus is usually the most prominent and abundant epipelic or epiphytic diatom representative in a biofilm community (Gaston, 2008; Pennesi *et al*., 2011) and is especially distributed in tropical and subtropical regions (Voigt, 1942, 1952; Paddock & Kemp, 1990; Hein *et al*., 2008), but also present in the temperate zone (Tomas, 1982; Pennesi *et al*., 2011), including scarce occurrences in polar seas (Cleve, 1883). In the temperate Turkish inland waters, genus *Mastogloia* has been reported from both pelagic and benthic diatom flora (Elmacı & Obalı, 1998; Akbulut & Yıldız, 2002; Çelekli & Külköylüoğlu, 2006; Sıvacı *et al*., 2007).

The purpose of this paper was to assess the *Mastogloia* genus diversity and to report new findings (*Mastogloia aquilegiae*, *M. baldjikiana*, *M. grunowii*, *M. ignorata*, *M. paradoxa*, *M.* cf. *regula*, *M. similis* and *M. vasta*) from Turkish coastal waters based on morphological characters using light microscopy. In addition, some information on two *Mastogloia* species (*M. binotata* and *M. pumila*) previously reported from Turkish waters is also given.

Materials and Methods

Study area

Homa Lagoon (38° 33', 10'' N, 26° 49', 50'', E) is located 25 km northwest of the Gulf of Izmir and bordered by the town of Menemen (Fig. 1). Located adjacent to Çamaltı Saltpan and Izmir Bird Paradise, the lagoon has a surface area of 1800 hectares (ha) and its depth ranges between 0.5 and 1.5 m. The surrounding

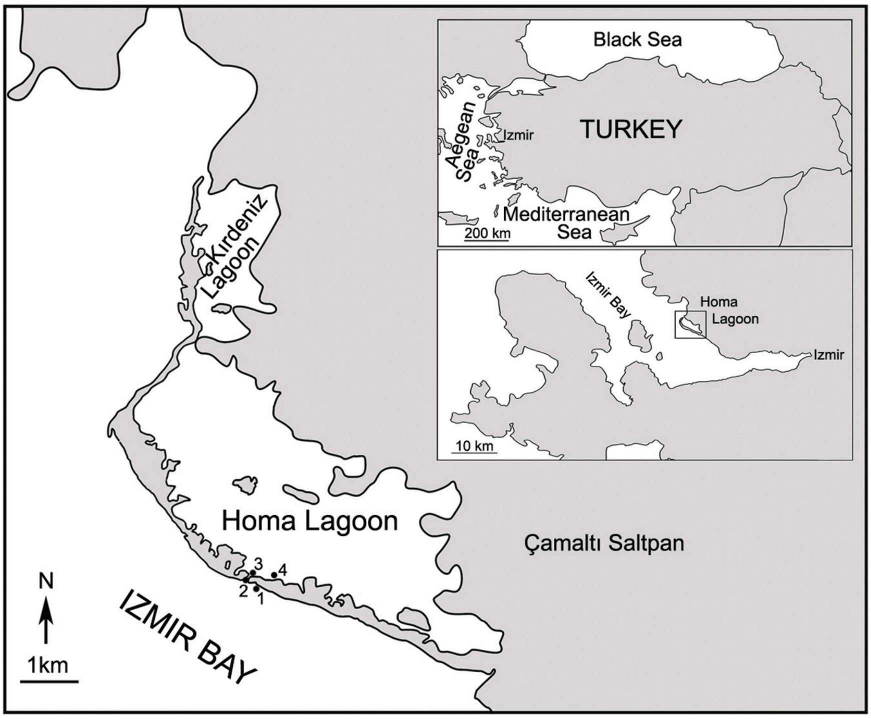

Fig. 1: Study area and the location of sampling points.

Gediz Delta region (20400 ha) is a typical Mediterranean delta ecosystem consisting of freshwater and salt water marshes (5000 ha), bays and saltpans (3300 ha), and lagoon areas (Homa, 1800 ha; Çilazmak, 725 ha; Taş, 500 ha; Kırdeniz, 450 ha). Homa lagoon is one of the most important lagoons on the Aegean coast of Turkey representing a biodiversity hotspot. Because of high species diversity and natural habitats, the lagoon was included in the List of Wetlands of International Importance, Ramsar Convention.

Periphytic samples were collected seasonally from four stations in Homa lagoon during June 2006 and September 2007 (2006: June, September, December; 2007: March, June and September). Station 1 is the deepest station and throughout the sampling period the water depth is approximately 1.5 m. The station is wave−exposed and its sea floor is covered with gravel and sand. Station 2 is located in the region where sea water and lagoon water are mixed. This station is a little more sheltered than station 1 and has soft sediment substrata. Station 3 has the same sea floor structure with station 2, but is less affected by seawater. The water depth of these stations varied between 0.6 and 1 m. Station 4 is located in a completely sheltered area and the water depth is less than 0.5 m. The bottom structure is covered with muddy sediment where, during low tide, drying and fracturing is seen.

Periphyton and Water Sampling

Periphyton sampling included epipelic algae, epiphytic algae, and epilithic algae. Epipelic diatom samples were taken using cylindrical Plexiglas corers (13 cm long × 6.1 cm i.d.). The sediment corers were 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 the collection of epiphytic diatom samples, the macroalgae *Ulva lactuca* Linnaeus was chosen in the research region. The collected specimens of *Ulva lactuca* were placed in a large wide-mouthed 1lt sample container until it was about half full and 100-200 ml of distilled water was added. Then, the sealed container was shaken strongly for ~ 60 seconds. The substrata were rubbed gently to remove the remaining attached algae and the suspension was decanted in a 250 ml sample bottle (Aligizaki & Nikolaidis, 2006). In order to define the epilithic diatom samples in the benthic regions, stones of 15−20 cm in diameter were used. The stones were chosen as randomly as possible. From them, only those that were not smothered with filamentous algae and had an obvious diatom film were taken into consideration. The selected stones were transfered to a plastic 1lt bath filled with 200 ml of distilled water. The upper parts of the stones were scrubbed using a hard toothbrush and finally the mixture was decanted into the 250 ml polythene bottles (Winter & Duthie, 2000). Finally, all sample bottles containing epipelic, epiphytic and epilithic diatom samples were fixed with a formaldehyde solution (4% final concentration). Permanent slides for the identification of diatoms were prepared from the same sample chemically with 10% HCl, 30% H_2SO_4, $KMnO_4$ and oxalic acid (Christiansen, 1988).

Cleaned diatom material was mounted permanently on slides with Naphrax and identified at 1000× magnification by phase–contrast optics using an OLYMPUS ×100 PlanApo oil immersion objective lens. Morphological characters of the species [valve size (VS) or valve length × valve width, valve length ⁄ valve width (L ⁄ W), the number of transapical striae in 10 µm (STR ⁄ 10 µm), partecta length at central area (PLC), partecta width at central area (PWC), partecta number in 10 µm at central area (PNC⁄ 10 µm), partecta length at apices (PLA), partecta width at apices (PWA), partecta number in 10 µm at apices (PNA⁄ 10 µm), large partecta number (LPN) and small partecta number (SPN)] were measured using a calibrated ocular micrometer (µm) in the eyepiece. Identification at species level was performed according to the descriptions of Peragallo & Peragallo (1897–1908), Hendey (1964), Foged (1985a & b), Hartley (1996) and Witkowski *et al*. (2000).

Water samples were taken at the same time as periphyton sampling for the measurement of temperature (°C) and salinity (p.s.u.). Water temperature (°C) was measured in situ using a mercury thermometer and salinity was measured according to the methodology described in Martin (1972).

Results

Physical Parameters

Physical features of stations in seasons are shown in Table 1. During the sampling period, water temperature varied between 4–28.8°C, and maximum temperature was recorded in June 2006 at station 4, but minimum in December 2006 at station 2 and 3. Salinity ranges between 34.4 psu in September 2007 at station 1 and 54.1 psu in December 2006 at station 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.

Morphometric characteristic in Mastogloia species

In this study eight *Mastogloia* species were found. These included *M. aquilegiae*, *M. baldjikiana*, *M. grunowii*, *M. ignorata*, *M. paradoxa*, *M.* cf. *regula*, *M. similis* and *M. vasta*. All these species are relatively uncommon and were reported for the first time from Turkish coastal waters. Additionally, two other species, *M. binotata* and *M. pumila*, that have been previously reported in Turkish coastal waters (Üstsoy *et al*., 2004; Sıvacı *et al*., 2008) were morphologically described. Classification of the genus follows that of Graham & Wilcox (2000) as:

Phylum: Ochrophyta
Class: Bacillariophyceae
Subclass: Bacillariophycidae
Order: Mastogloiales

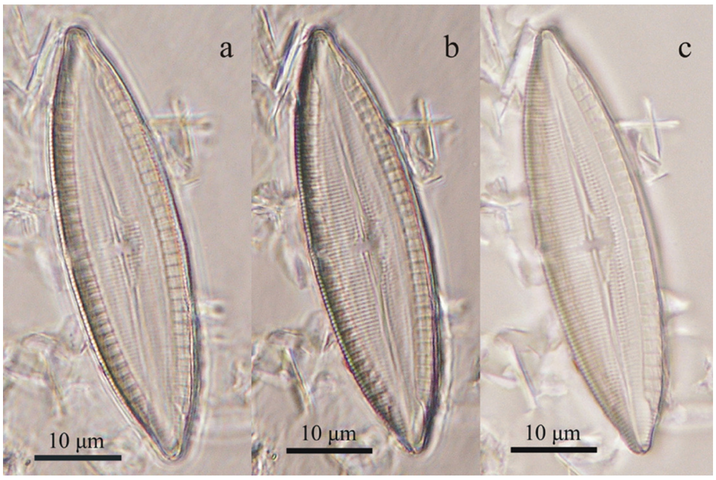

Fig. 2: a, b & c. Photographs of *Mastogloia aquilegiae* showing transapical striae and partectal ring.

Table 1. Seasonal variations of temperature (°C) and salinity (‰ p.s.u.) at the different sampling stations.

Stations	June 2006	September 2006	December 2006	March 2007	June 2007	September 2007
Station 1		21.0 °C ⁄ 35 p.s.u.	10.0 °C ⁄ 48.1 p.s.u.			22.0 °C ⁄ 34.4 p.s.u.
Station 2		22.0 °C ⁄ 35.9 p.s.u.	4.0 °C ⁄ 50.1 p.s.u.	14.5 °C ⁄ 39.8 p.s.u.	28.0 °C ⁄ 43.7 p.s.u.	21.0 °C ⁄ 51.4 p.s.u.
Station 3	26.2 °C ⁄ 38.4 p.s.u.	22.0 °C ⁄ 36.4 p.s.u.	4.0 °C ⁄ 52.1 p.s.u.	14.0 °C ⁄ 38.8 p.s.u.	27.0 °C ⁄ 41.3 p.s.u.	23.0 °C ⁄ 50.5 p.s.u.
Station 4	28.8 °C ⁄ 39.3 p.s.u.	24.0 °C ⁄ 44.7 p.s.u.	9.0 °C ⁄ 54.1 p.s.u.	16.0 °C ⁄ 37.9 p.s.u.	27.0 °C ⁄ 39.8 p.s.u.	

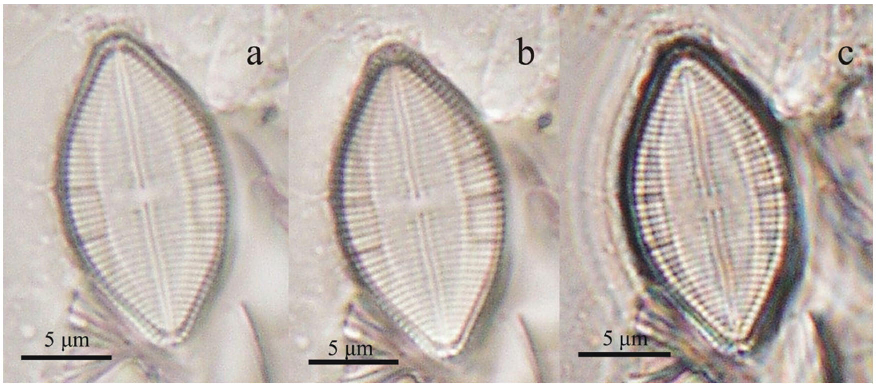

Fig. 3: a, b & c. Photographs of *Mastogloia baldjikiana* showing transapical striae and partectal ring.

Family: Mastogloiaceae

Mastogloia aquilegiae Grunow in A. Schmidt 1893

Figs. 2a–c

Valves are lanceolate with slightly protracted, broadly rounded apices (Figs. 2a, b & c), 50.0 µm long and 13.3 µm wide. Raphe is straight. The transapical striae are radiate (23 in 10 µm). Partectal ring extends to the apices. Rectangular partecta are uniform in size and shape, reaching 1.9–2.1 µm in width, 8–9 in 10 µm, and convex in the inner margin (Table 2).

Distribution & Ecology: June 2006 (epiphytic, station 4).

Mastogloia baldjikiana Grunow in A. Schmidt 1893

Figs. 3a–c

Valves are elliptical–lanceolate with short protracted apices (Figs. 3a, b & c), 16.7 to 17.7 µm long and 8.7 to 9.2 µm wide. Raphe is wavy to straight. The transapical striae are radiate (26–27 in 10 µm). Partectal ring extends to the apices. Partecta are variable in size and shape, reaching 1.4–1.8 µm in width, 3 in 5 µm, and convex in the inner margin (Table 2).

Distribution & Ecology: December 2006 (epiphytic and epilithic, station 4).

Mastogloia binotata (Grunow) Cleve 1895

Basionym: *Cocconeis binotata* Grunow 1863

Figs. 4a–c

Valves are elliptical (Figs. 4a, b & c), 22.1 µm long and 14.0 µm wide. Raphe is straight. The transapical striae are radiate (15–16 in 10 µm), crossed by a more or less quincunx pattern. A single central partectum is apically elongated, 2.0–2.3 µm in width, and straight in the inner margin (Table 2).

Distribution & Ecology: December 2006 (epilithic, station 2).

Mastogloia grunowii A. Schmidt 1893

Figs. 5a–c

Valves are elliptical–lanceolate with sub-rostrate apices (Figs. 5a, b & c), 28.9 to 29.2 µm long and 10.5 to 11.1 µm wide. Raphe is slightly wavy or straight. The transapical striae are radiate (26–27 in 10 µm). Partectal ring extends to the apices. Partecta are variable in size and shape, reaching 1.6–2.2 µm in width, 4–5 in 10 µm, and convex in the inner margin (Table 2).

Distribution & Ecology: September 2006 (epiphytic, station 1); December 2006 (epipelic, station 2).

Mastogloia ignorata Hustedt 1933

Figs. 6a–b

Valves are elliptical–lanceolate with protracted to rostrate apices (Figs. 6a & b), 33.2 µm long and 12.1 µm wide. Raphe is straight. The transapical striae are radiate (24 in 10 µm). Partectal ring extends to the apices. Rectangular partecta are uniform in size and shape, reaching 1.3–1.7 µm in width, 8 in 10 µm, and flat in the inner margin (Table 2).

Distribution & Ecology: December 2006 (epiphytic, station 3).

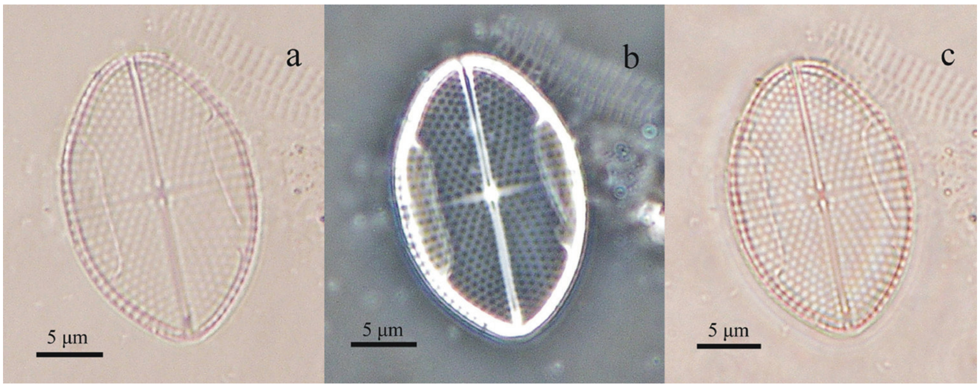

Fig. 4: a, b & c. Photographs of *Mastogloia binotata* showing transapical striae and two central partecta.

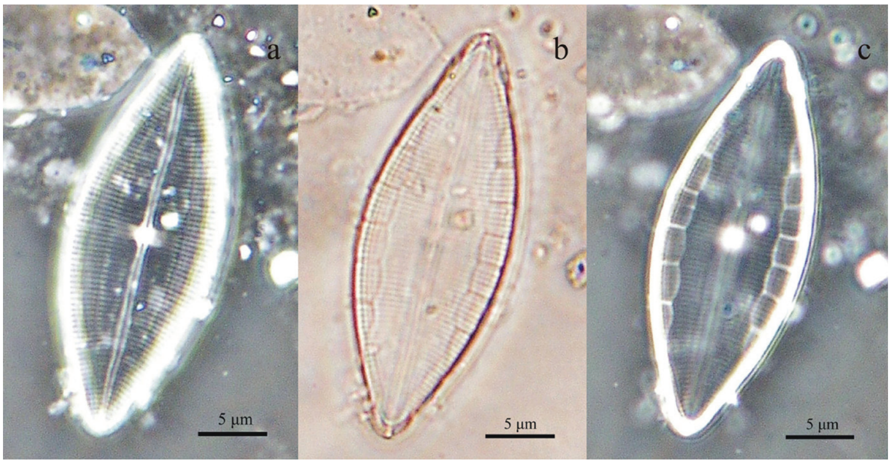

Fig. 5: a, b & c. Photographs of *Mastogloia grunowii* showing transapical striae and partectal ring.

Mastogloia paradoxa Grunow 1878

Fig. 7a–c

Valves are lanceolate with rostrate apices (Figs. 7a, b & c), 33.9 to 38.7 µm long and 10.4 to 11.7 µm wide. Raphe is sinuous with flaps (Fig. 7a). The transapical striae are parallel (27–28 in 10 µm). Partectal ring more displaced interiorly toward the middle line of the valve by a siliceous flange attached to the margin which show some partectal duct. Partecta differing in size, the larger ones located at the central area, reaching 1.2–1.8 µm in width, 5–6 in 10 µm, and almost flat in the inner margin (Table 2).

Distribution & Ecology: September 2006 (epilithic, stations 2 and 3); December 2006 (epipelic, station 4).

Mastogloia pumila (Cleve & Möller; Grunow) Cleve 1895

Basionym: *Mastogloia braunii* var. *pumila* Grunow in van Heurck 1880

Figs. 8a–e

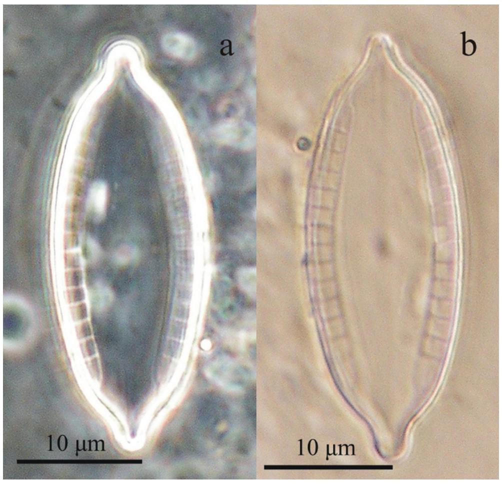

Fig. 6: a & b. Photographs of *Mastogloia ignorata* showing partectal ring.

Valves are elliptical–lanceolate with slightly protracted to broadly rounded apices (Figs. 8a, b, c, d & e), 17.0 to 31.8 µm long, 5.7 to 9.0 µm wide. Raphe is almost straight. The transapical striae (25–28 in 10 µm) vary

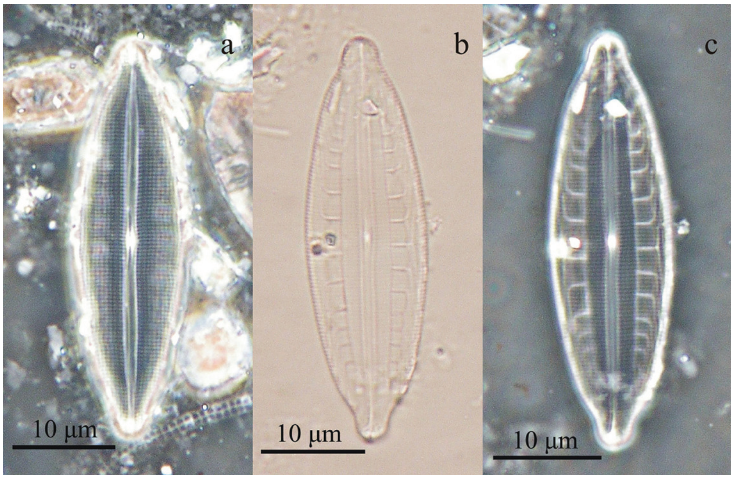

Fig. 7: a, b & c. Photographs of *Mastogloia paradoxa* showing transapical striae and partectal ring.

from parallel at central area to slightly radiate at apices (Fig. 8a). A partectal ring runs at the valve's valvocopula. Partecta differing in size, the largest one located at the central area, reaching 0.9−2.0 µm in width, and convex in the inner margin (Table 2).

Distribution & Ecology: June 2006 (epipelic, station 3); September 2006 (epiphytic and epilithic, stations 2−4); December 2006 (epipelic, epiphytic and epilithic, stations 1−4); March 2007 (epilithic, stations 2−4); June 2007 (epipelic, epiphytic and epilithic, stations 2−4); September 2007 (epiphytic, epilithic, stations 1−3).

Mastogloia* cf. *regula Hustedt 1933

Figs. 9a−c

Valves are ellipical-lanceolate with rounded apices (Figs. 9a, b & c), 18.8 to 19.2 µm long and 5.3 to 5.4 µm wide. Raphe is almost straight. The transapical striae (24−25 in 10 µm) vary from parallel at central area to slightly radiate at apices. A partectal ring runs at the valve's valvocopula. Rectangular partecta are uniform in size and shape, reaching 0.7−0.9 µm in width, 8−9 in 10 µm, and convex in the inner margin (Table 2).

Distribution & Ecology: June 2006 (epipelic and epiphytic, station 4).

Mastogloia similis Hustedt 1933

Figs. 10a−c

Valves are linear−lanceolate with rostrate apices (Figs. 10a, b & c), 38.9 µm long and 10.9 µm wide. Raphe is straight. The transapical striae are parallel (27 in 10 µm). A partectal ring runs at the valve's valvocopula and displaced interiorly toward the middle line of the valve by a siliceous flange attached to the margin which show some partectal duct. Partecta differing in size, the larger ones located at the central area, reaching 2.1−2.5 µm in width, 3 in 5 µm and convex in the inner margin (Table 2).

Distribution & Ecology: December 2006 (epilithic, station 4).

Mastogloia vasta Hustedt 1933

Figs. 11a−c

Valves are elliptical−lanceolate with rounded apices (Figs. 11a, b & c), 32.1 to 41.7 µm long and 13.2 to 17.0 µm wide. Raphe is straight. The central area is transapically dilated and is connected to two narrow longitudinal depressions (i.e. H-shaped area) (Fig. 11a). The transapical striae are radiate (21−23 in 10 µm). Partectal ring runs at the valve's valvocopula. Quadrangular partecta are not uniform in size and shape, reaching 2.2−3.2 µm in width, 6−7 in 10 µm, and convex in the inner margin (Table 2).

Distribution & Ecology: June 2006 (epilithic and epipelic, stations 3 and 4); September 2006 (Epiphytic, sta-

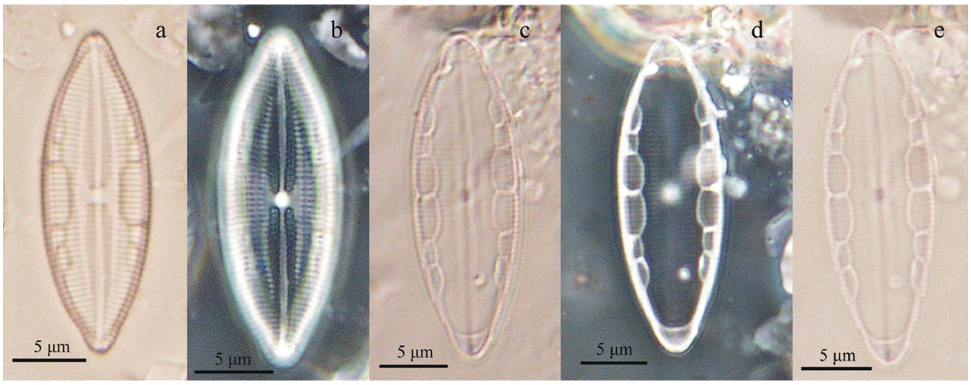

Fig. 8: a, b, c, d & e. Photographs of *Mastogloia pumila* showing transapical striae and partectal ring.

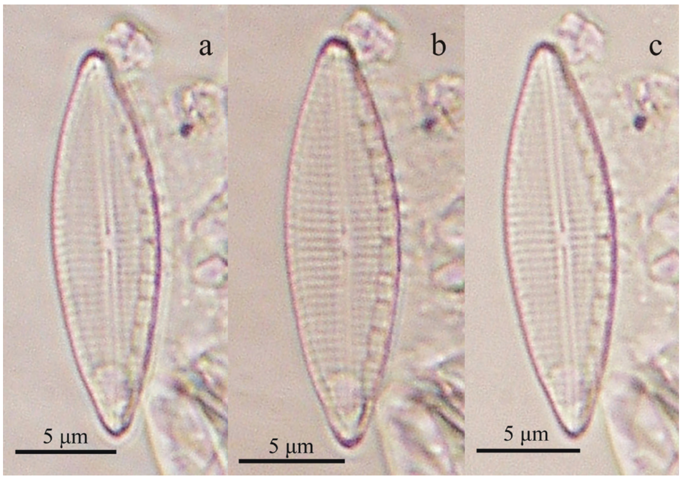

Fig. 9: a, b & c. Photographs of *Mastogloia* cf. *regula* showing transapical striae and partectal ring.

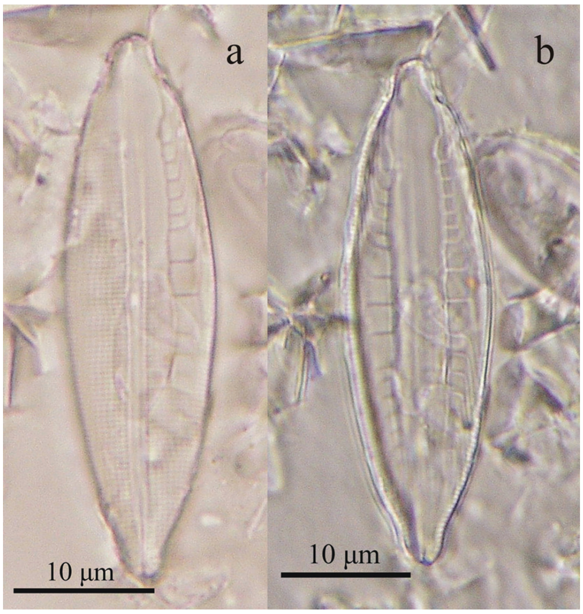

Fig. 10: a & b. Photographs of *Mastogloia similis* showing transapical striae and partectal ring.

tions 2 and 3); December 2006 (epipelic and epilithic, station 3); March 2007 (epipelic, station 3); September 2007 (epipelic, station 1).

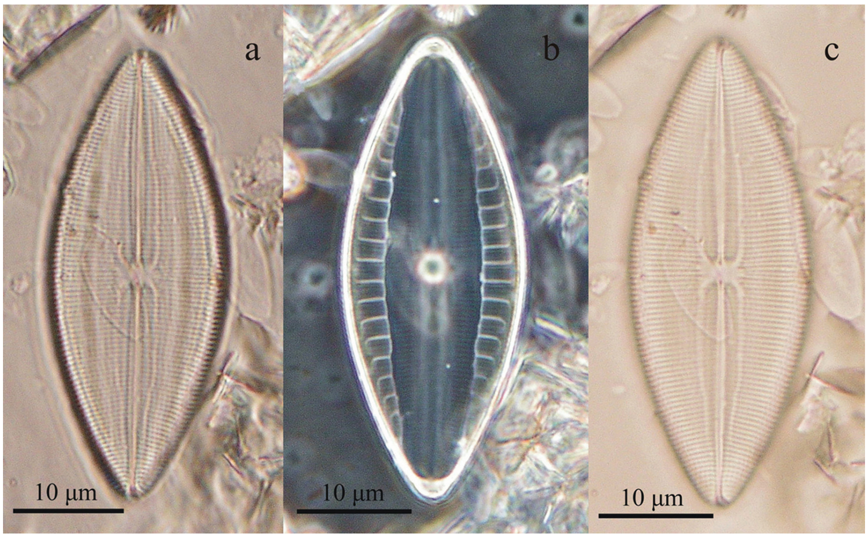

Fig. 11: a, b & c. Photographs of *Mastogloia vasta* showing transapical striae and partectal ring.

Discussion

Infraspecific taxa of the genus *Mastogloia* have been described by Smith (1856), Cleve (1894−1896), Boyer (1927), Hustedt (1933), Voigt (1942, 1952, 1963), Stoermer *et al*. (1964), Ricard (1975), Foged (1985a & b) and others by means of transmitted light microscopy (TLM), transmission electron microscopy (TEM) and scanning electron microscopy (SEM). Although studies related to genus *Mastogloia* started in 1856, the study of this genus is ongoing as region-specific new records are added (Gaiser *et al*., 2010; Martinez−Goss & Evangelista, 2010) or ultrastructural studies (Pennesi *et al*., 2011).

Focusing on the biogeographical distribution of the species examined in this paper, we found that: (i) *M. aquilegiae* Grunow has been reported from the Greek Islands of Samos and Kos (Foged 1985a & b), from the Greek Bay of Pagasitikos (Foged, 1986); (ii) *M. baldjikiana* Grunow was reported from Borneo, New Caledonia and Vairao in Tahiti (Hustedt, 1933; Ricard, 1975; Witkowski *et al*., 2000). It has also been recorded from the Greek Island of Kos (Foged, 1985b), and other areas of Greece (Messologhi lagoon, Danielidis, 1991; Evoikos Gulf, Belegratis, 2002) and from the Xisha Islands of the South China Sea (Shicheng, 1993), Siladen Island in Indonesia (Pennesi *et al*., 2011); (iii) *M. grunowii* A. Schmidt has been reported from the Xisha Islands of the South China Sea (Shicheng, 1993) and the Greek coast of Athos (Politis, 1925); (iv) *M. ignorata* Hustedt has been reported from the Greek Islands of Samos, Kos and Kalymnos (Foged, 1985a & b), other areas of Greece (Pagasitikos Bay, Foged, 1986; Messologhi lagoon, Danielidis, 1991; Evoikos Gulf, Belegratis, 2002), and also from areas of the Mediterranean (Tomas, 1982), Australia and New Zealand (Day *et al*., 1995); (v) *M. paradoxa* Grunow has been reported from the Greek Islands of Samos and Kos (Foged, 1985a & b), other areas of Greece (Pagasitikos Bay, Foged, 1986; Messologhi lagoon, Danielidis, 1991; Evoikos Gulf, Belegratis, 2002), and also from areas of the Mediterranean (Adriatic Sea, Viličić *et al*., 2002), the Black Sea (Caraus, 2002) and the Adriatic Sea (Viličić *et al*., 2002); (vi) *M. regula* Hustedt has been reported from the South Pacific (Funafuti, Vanuatu) and the Mediterranean (Crete) (Witkowski *et al*., 2000); (vii) *M. similis*

Table 2. Comparison of morphological features among ten Mastogloia species studied in this paper and in the literature.

Taxa	VS (µm)	L/W	STR/10 µm	PLC (µm)	PWC (µm)	PNC/10 µm	PLA (µm)	PWA (µm)	PNA/10 µm	LPN	SPN	Reference
M. aquilegiae	50.0×13.3	3.7	23	1.0–1.3	1.9–2.1	8–9	1.2–1.5	1.6–1.9	8			5
	64×17											***3***
M. baldjikiana	16.7×8.7	1.9	27									5
	17.7×9.2	1.9	26	2.2–2.4	1.4–1.8	3 (in 5 µm)	1.9–2.0	1.0–1.2				5
	28×12											***3***
	18–45×10–20		***20–24***		***1.5–2.5***	***5–6***						***4***
M. binotata	22.1×14.0	1.5	15–16	10.2–10.7	2.0–2.3							5
	20–40×16–25											***2***
	19–34×14–20											***3***
	18–40×13–25		***13–15***									***4***
M. grunowii	28.9×11.1	2.6	26	2.4–2.6	2.0–2.2	4–5	2.6–2.9	1.1–1.4				5
	29.2×10.5	2.7	26–27	1.8–2.0	1.6–1.8	5	2.1–2.5	0.9–1.2				5
			22–24									***1***
	25–55×12–22		***24–30***		***2***	***3–5***						***4***
M. ignorata	33.2×12.1	2.7	24	1.0–1.2	1.3–1.7	8	2.0–2.4	1.2–1.4	7–8			5
	32×12											***3***
	23–35×7–12		***24***		***2***	***7–8***						***4***
M. paradoxa	33.9×10.4	3.2	27	1.5–1.9	1.2–1.5	6	0.9–1.2	0.7–0.9	5 (in 5 µm)	6	10	5
	38.3×11.3	3.3	27	2.1–2.4	1.6–1.8	3 (in 5 µm)	1.2–1.4	0.7–1.1	4–5 (in 5 µm)	5	12	5
	38.7×11.7	3.2	27–28	1.8–2.3	1.4–1.7	5	1.3–1.5	1.0–1.2	4 (in 5 µm)	6	8	5
			28									***1***
	30–50×9–12		***25–28***		***1.5–2***	***4–5***		***1***	***6–8***			***4***
M. pumila	17.0×6.4	2.6		2.3–2.6	1.5–1.8		0.9–1.8	0.7–1.0		1	4	5
	17.4×6.9	2.5	27–28	2.8–3.1	1.5–1.9		1.4–1.6	0.7–0.8		1	4	5
	18.0×7.4	2.4	26–27	3.6–3.8	1.7–2.0		1.9–2.2	0.9–1.1		1	4	5
	18.1×7.1	2.5	28	3.1–3.4	1.3–1.7		1.5–1.7	0.6–0.8		1	4	5
	18.9×5.7	3.2		3.0–3.2	0.9–1.2		1.5–1.6	0.5–0.8		1	4	5
	20.0×7.5	2.6	28	3.6–3.7	1.5–1.8		1.6–1.9	0.6–0.8		1	4	5
	20.8×7.2	2.8	27	1.9–2.2	1.0–1.3		1.2–1.5	0.7–0.8		2	4	5
	21.8×7.4	2.9	27	4.2–4.3	1.6–2.0		1.4–1.7	0.6–0.9		1	4	5
	22.3×7.3	3.0	25–26	4.1–4.2	1.7–1.9		2.4–2.7	0.9–1.1		1	4	5
	22.5×7.7	2.9	26–27	3.4–3.9	0.9–1.3		1.8–2.0	0.7–0.9		1	4	5
	22.7×7.4	3.0	27	3.4–3.7	1.6–1.8		2.2–2.4	0.7–1.1		1	4	5
	24.0×8.0	2.9	27	2.8–3.2	1.3–1.6		1.7–2.1	0.7–0.9		2	4	5
	24.3×8.0	3.0	26	3.6–3.8	1.5–1.8		1.7–2.0	0.8–1.0		1	6	5
	26.0×8.3	3.1	26	2.1–2.5	1.2–1.5		1.7–1.8	0.8–1.1		2	6	5
	26.8×6.4	4.1	26–27	2.5–2.7	1.5–1.6		1.9–2.2	0.7–1.0		2	6	5
	31.8×9.0	3.5	25	4.2–4.6	1.5–1.8		2.4–2.5	1.0–1.2		1	6	5
	20–30×5–9		***25–30***									***2***
	20–30×5–9		***25–30***		***1.5–2***	***4***			***6–18***	***1–3***		***4***
M. cf. *regula*	18.8×5.4	3.4	24–25	0.9–1.1	0.7–0.8	9	1.1–1.2	0.7–0.8				5
	19.2×5.3	3.6	24	1.2–1.5	0.8–0.9	8–9	1.2–1.5	0.8–0.9				5
	18–23×4–7		***20–22***		***0.5–1***	***8***						***4***
M. similis	38.9×10.9	3.5	27	2.0–2.2	2.1–2.5	3 (in 5 µm)	1.1–1.4	0.9–1.0	4–5 (in 5 µm)	4	12	5
	35–43×9–11		***28***		***2***	***5***		***1***	***6–7***			***4***
M. vasta	32.1×13.2	2.4	23	1.4–1.5	2.4–2.5	7	1.7–1.9	1.6–1.8				5
	33.4×13.5	2.4	23	1.5–1.7	2.2–2.5	6	1.6–1.7	0.9–1.2				5
	35.9×14.3	2.5	22–23	1.5–1.7	2.6–2.9	7	1.6–1.7	1.5–1.7				5
	36.9×15.5	2.3	22–23	1.6–1.9	2.2–2.6	6–7	1.6–1.8	1.5–1.7				5
	38.9×17.0	2.2	21–22	1.8–2.0	2.6–2.8	6	1.6–1.8	1.2–1.3				5
	41.2×14.2	2.8	23	1.6–1.8	2.8–3.2	6–7	1.6–1.9	1.1–1.3				5
	41.6×16.0	2.5	22–23	1.7–1.9	2.4–2.6	6	1.3–1.6	1.0–1.3				5
	41.7×16.8	2.4	22–23	1.5–1.7	2.4–2.7	6–7	1.2–1.6	1.3–1.5				5
	20–40×9–16		***20–24***		***1–4***	***3–8***						***4***

VS: Valve size (valve length×valve width); L/W: valve length/ valve width; STR/10 µm: the number of transapical striae in 10 µm; PLC: Partecta length at central area; PWC: Partecta width at central area; PNC/10 µm: Partecta number in 10 µm at central area; PLA: Partecta length at apices; PWA: Partecta width at apices; PNA/10 µm: Partecta number in 10 µm at apices; LPN: Large partecta number; SPN: Small partecta number.
Reference: [1]Peragallo and Peragallo (1897-1908), [2]Hendey (1964), [3]Foged (1985a, b), [4]Witkowski *et. al.*, (2000), [5]This study. The literature data is given as bold and italic.

Hustedt has been reported from the Greek Bay of Pagasitikos (Foged, 1986), Crete (Witkowski *et al*., 2000) and from Indonesia; and (viii) *M. vasta* Hustedt has been reported from the Greek Bay of Evoikos (Belegratis, 2002), Australia and New Zealand (Day *et al*., 1995).

A comparison of the morphological features for the ten studied *Mastogloia* species is presented in Table 2. Our specimens are usually smaller in size than those previously reported. The valve length and width for *M. aquilegiae* were smaller in our samples (50×13.3 µm) than that reported by Foged (1985a) (64×17 µm). Morphometric data determined for *M. baldjikiana*, especially valve size (valve length×valve width), striae density (number of transapical striae in 10 µm) and partecta width at central area showed some differences with other studies. The valve size of *M. baldjikiana* in our samples was determined as 16.7−17.7×8.7−9.2 µm. However, the valve size of the same species was reported by Foged (1985b), Witkowski *et al*. (2000) and Pennesi *et al*. (2011) as 28×12 µm, 18−45×10−20 µm and 23.6−27.9×10.6−12.1 µm respectively. The striae density for *M. baldjikiana* was higher in our samples (26−27 striae in 10 µm) than that reported by Witkowski *et al*. (2000) (20−24 striae in 10 µm), but the striae density for the same species in Pennesi *et al*. (2011) was found to be 24−28 striae in 10 µm. However, partecta width at central area for *M. baldjikiana* was slightly narrower in our samples (1.4−1.8 µm) than that reported by Witkowski *et al*. (2000) and Pennesi *et al*. (2011) (1.5−2.5 µm; 1.9−2.1 µm, respectively).

Both the valve width and partecta width at central area for *M. grunowii* in our samples were different from the study conducted by Witkowski *et al*. (2000). In our samples, the valve width was between 10.5 and 11.1 µm, the partecta width at central area varied between 1.6 and 2.2 µm. On the other hand, Witkowski *et al*. (2000) reported the valve width and the partecta width at central area as 12−22 µm and 2 µm respectively. Furthermore, Van Landingham (1971) suggested that *M. grunowii* should merge into *M. quinguescostata*. However, Shicheng (1993) stated that although *M. grunowii* and *M. quinquecostata* were very similar to each other, they represent different species. It is reported that in *M. grunowii*, central partecta are slightly larger, about 2 µm in width, decreasing in size at the ends but not reaching the ends, whereas in *M. quinquecostata*, partecta are very narrow, equal in size and 1.0−1.5 µm in width, reaching the ends, 4−5 in 10 µm. In this study, the partecta of *M. grunowii* were 1.8−2.6 µm long and 1.6−2.2 µm wide at the center, gradually becoming narrower towards the apices, 2.1−2.9 µm in length and 0.9−1.4 µm in width, in compliance with the measurements of Shicheng (1993).

The morphometric measurements for *M. ignorata* and *M. paradoxa*, especially the partecta width at central area were different from the data reported by Witkowski *et al*. (2000). For *M. ignorata*, the partecta width showed little variation at central area (1.3−1.7 µm in width), and in the apices (1.2−1.4 µm in width), and they were uniform in width, and 8 in 10 µm. However, the partecta width at central area of the same species was reported slightly wider by Witkowski *et al*. (2000) (2 µm). For *M. paradoxa*, the partecta width at central area, the partecta width at apices and partecta number in 10 µm at central area were determined as 1.2−1.8 µm, 0.7−1.2 µm and 5−6, respectively. Whereas, these morphometric data were reported as 1.5−2 µm, 1 µm and 4−5 respectively (Witkowski *et al*., 2000).

The valve size of *M. pumila* in our samples was determined as 17.0−31.8×5.7−9.0 µm. However, the valve size of the same species was reported by both Hendey (1964) and Witkowski *et al*. (2000) as 20−30×5−9 µm. Also, the partecta width at central area of the same species is slightly narrower in our samples (0.9−2.0 µm) than that reported by Witkowski *et al*. (2000) (1.5−2.0 µm).

The striae density for *M.* cf. *regula* (24−25 striae in 10 µm) in our samples was greater in comparison to that given by Witkowski *et al*. (2000) (20−22 in 10 µm). The partecta size of *M.* cf. *regula* varied at the central area (0.9−1.5 µm in length, 0.7−0.9 µm in width), and in the apices (1.1−1.5 µm in length, 0.7−0.9 µm in width), and they were uniform in size and 8−9 in 10 µm. Witkowski *et al*. (2000) found that the valve outline of *M. regula* and *M. linearis* was similar, differing however in the form of apices (more capitae in *M. regula*) and in the shape and size of partecta: in *M. regula* (the partecta width at central area; 0.5−1 µm) they are apically rectangular, ca. 8 in 10 µm, whereas in *M. linearis* (the partecta width at central area; 0.7−1 µm) they are distinctly apically rectangular, 4−5 in 10 µm. For *M. similis*, some differences with Witkowski *et al*. (2000) in the striae density and the partecta width of both central area and apices were determined. The striae density, the partecta width at central area and apices in our samples were 27 in 10 µm, 2.1−2.5 µm and 0.9−1.0 µm, respectively. It is noted that these data were reported by Witkowski *et al*. (2000) as 28 in 10 µm, 2 µm and 1 µm, respectively.

The valve size for *M. vasta* was slightly larger in our samples (32.1−41.7×13.2−17.0 µm) than that reported by Witkowski *et al*. (2000) (20−40×9−16 µm). The partecta width and partecta number in 10 µm at central area was determined as 2.2−3.2 µm and 6−7 in 10 µm, whereas in Witkowski *et al*. (2000), it is reported as 1−4 µm and 3−8 in 10 µm, respectively. The majority of these differences between my specimens and others reported in the literature can be associated with a case of natural morphometric differentiation between different populations of the same species. This is more or less expected, as literature data for the studied species are very scarce.

There are many cultural studies investigating the relationship between morphological characteristics and environmental parameters, which reported that the morphological differences may be dependent on the environmental parameters e.g. salinity (Johansen & Theriot, 1987;

Wendker & Geissler, 1988; Trobajo *et al*., 2004a; Trobajo *et al*., 2004b, Trobajo *et al*., 2011). In these studies, it is mentioned that valve length increases with higher salinity, while contrastingly, valve width decreases with high salinity (Trobajo *et al*., 2004a) in spite of this; valve width was also reported increase with increasing salinity (Cox, 1995). However, striae densities were reported to be increased or fluctuated around a mean value with a decrease in valve length or diameter (Theriot & Stoermer, 1981; Cox, 1983) but known to be invariable under different environmental conditions (Mizuno, 1987). In estuarine systems, environmental factors such as water movement, nutrient availability and concentration are known to co−vary with salinity frequently (Underwood & Provot, 2000; Thornton *et al*., 2002). Therefore, it is very difficult to determine the factors affecting variations in morphometric characteristics in the natural environment.

In the study area, there was a wide spectrum of ecologically different biotopes and this allows the formation of marine, brackish water and fresh water forms in the region. The *Mastogloia* species examined in this study preferred different biotopes and stations. They were more frequently observed primarily in epiphytic diatom samples and then in epilithic and epipelic diatom samples. Martinez−Goss & Evangelista (2011) reported generally high abundances of the *Mastogloia* species in epipelic and epiphytic flora. In Homa lagoon, although *M. pumila* and *M. vasta* have been determined in all periphyton samples, *M. aquilegiae* and *M. ignorata* have been observed only in epiphytic diatom samples and *M. binotata* has been found in epilithic diatom samples only. When the distribution of these species per station was examined, *M. vasta* and *M. ignorata* were present only at station 1 and station 3, respectively, and *M. aquilegiae*, *M. baldjikiana*, *M.* cf. *regula* and also *M. similis* were present at station 4 in particular. The reason for prefering station 4 might be due to the shallowness (<0.5 m) and brackish water characteristics. Stoermer (1967) examined the effect of total dissolved solids on the valve structure and found the presence of coarsely structured forms of diatoms in habitats having relatively low levels of total dissolved solids, while the more finely structured forms are consistently present in brackish or other highly mineralized waters. The variability of the valve morphology examined in Homa lagoon might be affected by the rapid environmental changes; therefore, both coarsely and finely structured forms of the genus *Mastogloia* were identified.

The *Mastogloia* genus, one of the largest diatom genera, has a tropical to temperate worldwide distribution. Although most of the *Mastogloia* species are marine species, some freshwater and brackish water forms have been reported (Round *et al*., 1990; Patrick & Reimer, 1966). However, the taxonomic literature on brackish water diatoms is quite scattered. In this sense, the detailed description about the taxonomy, ecology and distribution of species obtained in this study will help correct species recognition and contribute to the knowledge of the periphytic algal flora apart from the better known pelagic one.

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