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An illustrated survey on the morphological characters in three species of the diatom genus *Mastogloia* (Bacillariophyceae)

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Abstract: The valve morphology of *Mastogloia braunii* Grunow, *Mastogloia pumila* Cleve, and *Mastogloia vasta* Hustedt were investigated using field material. Specimens for study were collected from Homa Lagoon, İzmir Bay, Turkey (4-29 °C; salinity 35‰-54‰) as epipelic and epiphytic (*Ulva lactuca* L.). The valve morphological characteristics of the 3 species were measured by calibrated ocular micrometer using 20 specimens from each species per station. The valve of *M. braunii* was 35.15-80.20 µm in length and 12.35-19.85 µm in width, the valve of *M. pumila* was 13.70-31.85 µm in length and 5.75-9.00 µm in width, and the valve of *M. vasta* was 31.20-43.35 µm in length and 11.90-18.10 µm in width. The results of Pearson's correlation analysis revealed significant correlations among morphological features and environmental factors. All of the species display a positive correlation between valve length and valve width, and the number of transapical striae in 10 µm are invariable with changes in environmental factors. Seasonal differences in the morphological features of *Mastogloia* species were determined by one-way ANOVA analyses. Valve length, valve width, and total number of partecta were the common characteristics showing seasonal variation.

Key words: *Mastogloia*, Bacillariophyceae, field material, Homa Lagoon, eastern Mediterranean

Introduction

The large diatom genus *Mastogloia* Thw. ex Wm. Smith is predominantly a benthic marine genus in the division Bacillariophyta (Round et al., 1990). The genus is usually the most prominent and abundant epipelic or epiphytic diatom in a biofilm community (Martinez-Goss & Evangelista, 2011; Pennesi et al., 2011). Although the genus has a worldwide distribution, there is no considerable fossil record of the genus; 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).

Species belonging to this genus are most easily distinguished from those of other genera by the presence of various forms of marginal chambers or partecta, which are modified in the first girdle band or valvocopula that developed into a series of more or less spherical hollow or bulbous chambers or partecta (Stephens & Gibson, 1979; Paddock & Kemp, 1988; Round et al., 1990). Despite these distinctive characteristics, it is also known that the genus *Mastogloia* is similar to the genus *Aneumastus* Mann DG & Stickle AJ in frustule structure (Hajos, 1973; Round et al., 1990); in particular, when the valvocopulae are broken or missing, there may be some resemblance. In addition, taxonomically important diatom frustules characters, such as shape and transapical striae density in 10 µm, are known to vary with changes in valve size or environmental conditions (Mizuno, 1982). Therefore, the

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comprehensive descriptions of nomenclatural types and variability of diagnostic features available for correct species identification are substantial.

Moreover, a general, predictable pattern of shape change associated with size diminution was formulated by Geitler (1932). This has been substantiated in numerous studies (Wallace & Patrick, 1950; Mizuno, 1987; Kociolek & Stoermer, 1988; Subba Rao & Wohlageschaffen, 1990; Williams et al., 1999).

This paper provides the detailed morphological characters of the valve of the 3 most abundant Mastogloia species (Mastogloia braunii Grunow, Mastogloia pumila Cleve, and Mastogloia vasta Hustedt) using field material. Details of the morphological characters of the valve (light microscopy images), new information regarding relationships between the characteristics [valve length, valve width, number of transapical striae in 10 µm, large partecta length and width (in the middle), small partecta length and width (in the apices), total number of partecta, number of large partecta, number of small partecta, and number of partecta in 10 µm] and interactions with environmental conditions are examined. Moreover, the seasonal changes in morphological features are also presented.

Materials and methods

Study area

Homa Lagoon (38°33′10″N, 26°49′50″E) is located 25 km north-west of the Gulf of İzmir within the borders of the town of Menemen (Figure 1). The lagoon has a length of 7.4 km and a width of 3 km. The maximum depth of the lagoon is 1.5 m, and the depth varies between 0.5 and 1 m. 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 lagoon areas (Homa, 1800 ha; Çilazmak, 725 ha; Taş, 500 ha; Kirdeniz, 450 ha), which make it a typical Mediterranean delta ecosystem. Homa Lagoon is one of the most important lagoons on the Aegean coast of Turkey. Because it is a biodiversity hotspot, the lagoon was included in the important wetlands list of the Ramsar Convention. It is also the last active lagoon in İzmir Bay.

The pelagic and benthic diatom flora of Turkish inland waters have been described many times by various authors, and some of the recent studies cover the benthic diatom communities and their relationship to environmental variables (Kıvrak & Gürbüz, 2010; Solak et al., 2012). Reports from the study area focus on the physical and chemical properties and fisheries of the lagoon (Ünsal et
Diatom and water sampling

Microphytobenthos sampling was carried out on sediment for epipelagic algae and on macroalgae (*Ulva lactuca* L.) for epiphytic algae. Morphological characters of *M. braunii*, *M. pumila*, and *M. vasta*; their seasonal changes; and interactions with environmental conditions were studied at 4 stations between June 2006 and June 2007. Epipelic samples were taken using cylindrical Plexiglas corers (13 cm in length, 6.1 cm in diameter). 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, samples from the upper 0-2 cm were taken and transferred to 250 mL polythene bottles containing distilled water (Ribeiro et al., 2003). In order to define the epiphytic samples, *U. lactuca* was chosen in the research region. Collected *U. lactuca* was placed in a large, wide-mouthed 1 L 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 shaken strongly for about 60 s. The substrata were rubbed gently to remove the remaining benthic algae, and the suspension was decanted into a 250 mL sample bottle (Aligizaki & Nikolaidis, 2006). Finally, sample bottles were fixed with formaldehyde until the concentration reached 4%. Materials obtained were subjected to a chemical process with 10% HCl, 30% H2SO4, KMnO4, and oxalic acid (Lauriol et al., 2006). The cleaned samples were prepared for permanent mounting following the methods of Batterbee (1986). Diatom specimens were examined at 1000× magnification by phase-contrast optics with OLYMPUS × 100 PlanApo oil immersion. The valve length (L), valve width (W), number of transapical striae in 10 µm (Str), large partecta length (LPL) and width (LPW) (in the middle), small partecta length (SPL) and width (SPW) (in the apices), total number of partecta (NP), number of large partecta (NLP), number of small partecta (NSP), and number of partecta in 10 µm (Prt) were measured in 20 specimens per station for each *Mastogloia* species using a calibrated ocular eyepiece. Specimens were measured in micrometers (µm). Identifications were made using Peragallo and Peragallo (1897-1908), Hendey (1964), Hustedt (1933), Foged (1985a, 1985b), Hartley (1996), and Witkowski et al. (2000).

Water samples were taken seasonally from the same stations in order to determine the physicochemical structure of Homa Lagoon. Water temperature (°C) and pH were measured in situ with a mercury thermometer and HANNA HI 8314 model pH meter. Water samples used to analyze salinity (%o), total nitrogen (TNO3-N) (µM), phosphate (PO4-P) (µM), and silicate [Si(OH)4-Si] (µM) were taken in 1 L plastic bottles and transferred to the laboratory immediately. Salinity was analyzed according to Martin (1972), and Strickland and Parsons (1972) was followed for colorimetric analysis.

Pearson’s correlation analysis (Zar, 1999) was used to assess the relationships of morphological characteristics within the species and also the interaction with environmental conditions (temperature, salinity, total nitrogen, phosphate, and silicate). Additionally, in order to evaluate seasonal differences in morphological features, one-way ANOVA analyses were used. All statistical analyses were conducted using Statistica 7.0 and Statgraphics Plus 5.1. Significance was accepted at P ≤ 0.05 for all statistical tests used in this study.

Results

Physical and chemical characteristics

The study area is a coastal lagoon, and, due to its shallowness, rapid changes in environmental parameters can be observed. Water temperature is influenced by meteorological conditions and both temperature (4-29 °C) and total nitrogen (4.52-11.06 µM) were high in June 2006. The phosphate concentration (0.33-4.22 µM) was usually high in March 2007, while silicate (2.59-25.00 µM) was usually high in June 2007. On the other hand, salinity values ranged between 35‰ and 54‰, and the maximum value was observed in December 2006 (Table 1). The study area is an active lagoon, and during the June and December periods fish traps are closed, and seawater input is reduced. In addition, significant freshwater input into the area was provided.
by rainfall. During the autumn, observed rainfall was lower than expected. For these reasons, high salinity values were observed during this period.

**Morphological characteristics of *Mastogloia* species**

The species identified in this study are generally common and usually abundant in the microphytobenthic community. In the study area, there is a wide spectrum of ecologically different types, and this allows for the formation of marine, brackish water, and freshwater forms in the region. *Mastogloia braunii* Grunow is frequently a marine species and very common in brackish waters. *Mastogloia pumila* Cleve is a common marine species that can sometimes also be found in brackish water. *Mastogloia vasta* Hustedt is a common marine species (Hustedt, 1933; Witkowski et al., 2000; Hein et al., 2008). The majority of *Mastogloia* species found in the study area were small and had tougher frustules. The general morphological characters of the whole valve are shown in Figure 2. Classification of the genus follows Graham and Wilcox (2000):

- **Phylum:** Ochrophyta
- **Class:** Bacillariophyceae
- **Subclass:** Bacillariophycidae
- **Order:** Mastogloiales
- **Family:** Mastogloiaceae

*Mastogloia braunii* Grunow:
- Figures 3a, b, c

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Jun. 06</th>
<th>Sep. 06</th>
<th>Dec. 06</th>
<th>Mar. 07</th>
<th>Jun. 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. (°C)</td>
<td>26.00 ± 1.02</td>
<td>22.25 ± 0.63</td>
<td>6.75 ± 1.60</td>
<td>14.63 ± 0.47</td>
<td>21.75 ± 0.48</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>38.52 ± 0.31</td>
<td>38.03 ± 2.24</td>
<td>51.12 ± 1.29</td>
<td>38.28 ± 0.72</td>
<td>44.00 ± 4.16</td>
</tr>
<tr>
<td>TNO$_3$ - N</td>
<td>9.03 ± 1.13</td>
<td>10.24 ± 0.39</td>
<td>6.05 ± 0.62</td>
<td>5.62 ± 0.33</td>
<td>6.89 ± 0.12</td>
</tr>
<tr>
<td>PO$_4$ - P</td>
<td>0.48 ± 0.03</td>
<td>0.44 ± 0.10</td>
<td>0.67 ± 0.16</td>
<td>2.47 ± 0.64</td>
<td>1.14 ± 0.24</td>
</tr>
<tr>
<td>[Si(OH)$_4$] - Si</td>
<td>4.07 ± 0.88</td>
<td>6.28 ± 0.74</td>
<td>3.97 ± 0.17</td>
<td>10.50 ± 0.88</td>
<td>13.88 ± 5.45</td>
</tr>
</tbody>
</table>

Abbreviations: Temp.: temperature (°C); TNO$_3$ - N: total nitrogen (µM); PO$_4$ - P: phosphate (µM); [Si(OH)$_4$] - Si: silicate (µM). Jun. 06: June 2006; Sep. 06: September 2006; Dec. 06: December 2006; Mar. 07: March 2007; Jun. 07: June 2007.
Figure 3. **a, b, c:** Phase contrast photographs of the valve view of *Mastogloia braunii* Grunow showing partecta and the transapical striae; **d, e, f:** Phase contrast photographs of the inner valve of *Mastogloia pumila* Cleve showing the transapical striae and partecta; **g, h:** Phase contrast photographs of the inner valve of *Mastogloia vasta* Hustedt showing the partecta and the transapical striae.
An illustrated survey on the morphological characters in three species of the diatom genus *Mastogloia* (Bacillariophyceae)

### Table 2. Morphological characters of valves of *Mastogloia braunii* Grunow, *Mastogloia pumila* Cleve, and *Mastogloia vasta* Hustedt collected from the field.

<table>
<thead>
<tr>
<th>Morphological characters</th>
<th><em>Mastogloia braunii</em></th>
<th><em>Mastogloia pumila</em></th>
<th><em>Mastogloia vasta</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>L (μm)</td>
<td>35.15-80.20</td>
<td>13.70-31.85</td>
<td>31.20-43.35</td>
</tr>
<tr>
<td>W (μm)</td>
<td>12.35-19.85</td>
<td>5.75-9.00</td>
<td>11.90-18.10</td>
</tr>
<tr>
<td>Str/10 μm</td>
<td>18-22</td>
<td>25-29</td>
<td>20-23</td>
</tr>
<tr>
<td>LPL (μm)</td>
<td>1.29-2.10</td>
<td>0.90-4.10</td>
<td>1.08-1.82</td>
</tr>
<tr>
<td>LPW (μm)</td>
<td>2.12-3.20</td>
<td>1.01-4.25</td>
<td>2.10-3.00</td>
</tr>
<tr>
<td>SPL (μm)</td>
<td>1.00-1.55</td>
<td>0.50-1.90</td>
<td>1.08-2.05</td>
</tr>
<tr>
<td>SPW (μm)</td>
<td>1.05-1.56</td>
<td>0.60-2.40</td>
<td>0.95-1.60</td>
</tr>
<tr>
<td>NP (μm)</td>
<td>15-45</td>
<td>4-8</td>
<td>13-17</td>
</tr>
<tr>
<td>NLP (μm)</td>
<td>5-10</td>
<td>1-2</td>
<td></td>
</tr>
<tr>
<td>NSP (μm)</td>
<td>10-38</td>
<td>2-6</td>
<td></td>
</tr>
<tr>
<td>Prt/10 μm</td>
<td>6-7</td>
<td></td>
<td>6-7</td>
</tr>
</tbody>
</table>

Abbreviations: L: valve length; W: valve width; Str: number of transapical striae in 10 μm; LPL: large partecta length; LPW: large partecta width; SPL: small partecta length; SPW: small partecta width; NP: total number of partecta; NLP: number of large partecta; NSP: number of small partecta; Prt: number of partecta in 10 μm.

### Mastogloia pumila Cleve:
Figures 3d, e, f

Valves 13.70-31.85 μm in length and 5.75-9.00 μm in width, 25-28 transapical striae in 10 μm. Large partecta 0.90-4.10 μm in length, 1.01-4.25 μm in width; small partecta 0.50-1.90 μm in length, 0.60-2.40 μm in width (Table 2).

### Mastogloia vasta Hustedt:
Figures 3g, h

Valves 31.20-43.35 μm in length and 11.90-18.10 μm in width, 20-23 transapical striae in 10 μm. Partecta in the middle of the valve 1.08-1.82 μm in length, 2.10-3.00 μm in width; partecta in the apices of the valve 1.08-2.05 μm in length, 0.95-1.60 μm in width (Table 2).

### Statistical examination of relationships in valve morphology

The results of Pearson’s correlation analysis showed that the valve length of *M. braunii* was significantly and positively correlated with the valve width, total number of partecta, and number of large and small partecta. The valve width was positively correlated with the total number of partecta and number of large partecta and small partecta. Additionally, the number of transapical striae in 10 μm was positively correlated with small partecta length. The valve length associated with *M. pumila* was particularly positively correlated with the valve width, total number of partecta, and number of small partecta; it also had a weak positive correlation with the number of transapical striae in 10 μm and small partecta width. The valve width was positively correlated with the total number of partecta and number of small partecta; additionally, the number of transapical striae in 10 μm was positively correlated with total number of partecta. In *M. vasta*, there was a significantly positive correlation between the valve length and the valve width; also, the valve width was negatively correlated with the number of transapical striae in 10 μm and large partecta width. The number of striae in 10 μm had both a positive and negative correlation with the number of partecta in 10 μm and large partecta length, respectively. The significant Pearson’s correlation coefficients are given in Table 3.
According to the results of one-way ANOVA, the morphological characterisation of *Mastogloia* species revealed some seasonal variability (Figures 4-12). Valve length, large partecta length, and total number of partecta in *M. braunii* show significant seasonal differences (Figures 4-6). The results of Pearson's correlation analysis showed that the valve length of *M. braunii* was positively correlated with phosphate (r = 0.85) and negatively correlated with total nitrogen concentration (r = -0.56). Valve length and the total number of partecta were significantly affected by the N/P ratio. Both reached the highest (greatest length and total number of partecta) at the lowest N/P ratio (2.00) in March 2007. Moreover, the length of the large partecta had a positive correlation with increasing silicate concentration (r = 0.53). Seasonal differences in the valve morphology of *M. pumila* were valve length and width and total number of partecta (Figures 7-9). Valve length increased with increasing silicate concentrations (r = 0.48), especially in June 2007 (25 μM), and, consequently valve width increased with both increasing silicate concentrations.

Table 3. Results of Pearson's correlation analysis of morphological characters for the 3 Mastogloia species studied (P ≤ 0.05 given).

<table>
<thead>
<tr>
<th>Variable</th>
<th><em>Mastogloia braunii</em></th>
<th><em>Mastogloia pumila</em></th>
<th><em>Mastogloia vasta</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>W (0.68)</td>
<td>W (0.81)</td>
<td>W (0.85)</td>
</tr>
<tr>
<td></td>
<td>NP (0.90)</td>
<td>Str/10 µm (0.46)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NLP (0.67)</td>
<td>SPW (0.48)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NSP (0.90)</td>
<td>NP (0.86)</td>
<td>NSP (0.86)</td>
</tr>
<tr>
<td>W</td>
<td>NP (0.57)</td>
<td>NP (0.65)</td>
<td>Str/10 µm (−0.53)</td>
</tr>
<tr>
<td></td>
<td>NLP (0.53)</td>
<td>NSP (0.67)</td>
<td>LPW (−0.51)</td>
</tr>
<tr>
<td></td>
<td>NSP (0.55)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Str/10 µm</td>
<td>SPL (0.45)</td>
<td>NP (0.50)</td>
<td>LPL (−0.45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prt/10 µm (0.62)</td>
</tr>
<tr>
<td>LPL</td>
<td></td>
<td>LPW (−0.57)</td>
<td>NP (−0.54)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPW (−0.51)</td>
<td>Prt/10 µm (−0.51)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPL (0.59)</td>
<td></td>
</tr>
<tr>
<td>LPW</td>
<td></td>
<td>SPL (−0.76)</td>
<td>Prt/10 µm (0.54)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NLP (−0.74)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPW (0.91)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>NSP (0.46)</td>
<td></td>
</tr>
<tr>
<td>SPL</td>
<td>NP (−0.55)</td>
<td>SPW (−0.65)</td>
<td>SPW (−0.67)</td>
</tr>
<tr>
<td></td>
<td>NSP (−0.55)</td>
<td>NLP (0.57)</td>
<td></td>
</tr>
<tr>
<td>SPW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NLP (−0.48)</td>
<td>NSP (0.56)</td>
<td></td>
</tr>
<tr>
<td>NP</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>NLP (0.78)</td>
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<tr>
<td></td>
<td>NSP (0.99)</td>
<td>NSP (0.94)</td>
<td></td>
</tr>
<tr>
<td>NLP</td>
<td></td>
<td>NSP (0.71)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: L: valve length; W: valve width; Str: number of transapical striae in 10 µm; LPL: large partecta length; LPW: large partecta width; SPL: small partecta length; SPW: small partecta width; NP: total number of partecta; NLP: number of large partecta; NSP: number of small partecta; Prt: number of partecta in 10 μm.
An illustrated survey on the morphological characters in three species of the diatom genus *Mastogloia* (Bacillariophyceae)

and salinity ($r = 0.59$). With the exceptions of salinity and silicate concentration, no significant correlation was found between environmental parameters and morphological features. These 2 parameters caused seasonal variation in the valve morphology of *M. pumila*. Seasonal differences in valve length and width and large partecta length of *M. vasta* were observed during the sampling (Figures 10-12). Valve length and width were significantly affected by the N/P ratio. The valve width of *M. vasta* was positively correlated with phosphate concentrations ($r = 0.86$) and negatively correlated with total nitrogen concentrations ($r = -0.71$). In addition, valve length had a positive correlation with increasing phosphate concentrations ($r = 0.59$). Both length and width were highest (the greatest length and width) at the
lowest N/P ratio in March 2007 (2.00). The increase in the value of morphological characteristics during this period can be easily observed in Figures 10 and 11. The results of Pearson's correlation analysis showed that size variation increased with increasing silicate concentrations ($r = 0.48$). Furthermore, large partecta length had a negative correlation with increasing silicate concentrations ($r = -0.75$).

**Discussion**

There have been many morphometric studies of diatoms, in which the interaction of independent factors such as morphological characteristics and environmental parameters were examined. The majority of these encompass diatoms that were isolated from both freshwater and brackish/marine habitats (Johansen & Theriot, 1987; Wendker & Geissler, 1988; Trobajo et al., 2004a; Trobajo et al., 2004b). The present work focused on the relationship among morphological characteristics of 3 *Mastogloia* species in field material. The observations on the variability of morphological features showed that all of the species had a positive correlation between valve length and valve width. In *M. braunii* and *M. pumila*, the valve length and width were positively correlated with the total number of partecta, and the total number of partecta was positively correlated with the number of small partecta. In contrast, in *M. vasta* there is no significant correlation. Different species of the genus *Mastogloia* were investigated by Novarino and Muftah (1992). In this same study, a positive correlation was identified between the number of partecta and frustule length in *Mastogloia smithii*, *M. lanceolata*, *M. robusta*, and *M. erythraea*; in *M. decussata*, no significant correlation was presented. In addition, no correlation was found between the number of partecta and the frustule width in 5 species of *Mastogloia*. Similar to these results, a positive correlation was found between the valve length and total number of partecta in this study.

The presence of coarsely structured forms is identified in habitats with relatively low levels of total dissolved solids, while the presence of more finely structured forms is consistently reported from brackish or other highly mineralised waters (Stoermer, 1967). The variability in valve morphology at Homa Lagoon may be affected by the rapid environmental changes; both coarsely and finely structured forms of the genus *Mastogloia* were identified. The maximum valve length in *M. braunii* and *M. vasta* was found in the March 2007 sample, and the minimum length was found in June 2006. The greatest valve lengths in the species were determined at high phosphate concentrations and low N/P ratios. In addition, the maximum valve length in *M. pumila* was found in June 2007, and its greatest valve lengths were determined at high silicate concentrations. High concentrations of silica can promote diatom growth and strong silicification of diatom frustules (Busse & Snoeijis, 2003). In the present study, frustule length had a positive correlation with silicate and negative correlation with total nitrogen concentration. These correlations can be explained by the studies by Lynn et al. (2000) and Martin-Jézéquel et al. (2000), which noted that under limitations (e.g., nitrogen, light, temperature) the increased period available for silicate uptake enables a heavier silicification of the frustules, which ultimately leads to smaller size.

The influence of environmental parameters, especially the relationship between salinity and species morphological features of the valve in culture materials, has been presented in many studies (Stoermer, 1967; Schultz, 1971; Wendker & Geissler, 1988; Cox, 1995). Salinity has often been considered an important factor for determining diatom distribution in estuaries and wetlands. Trobajo et al. (2004a) found that valve length increased with higher salinity, while valve width decreased with rising salinity. Cox (1995) showed that valve width increases with increasing salinity. The relationship between valve width and salinity in *M. braunii* and *M. pumila* from Homa Lagoon was similar to the findings reported by Cox (1995). No significant correlation was found between valve length and salinity. The density of striae in 10 µm depends on both morphological features and environmental factors. Some reports have shown that the density of striae or areolae increases with decrements in valve length or diameter (Mizuno, 1982). In the present study, striae density (the number of transapical striae in 10 µm) of *M. pumila* increased with increasing frustule length; striae density of *M. vasta* increased with decreasing frustule width. Despite these changes that were determined in short-term studies, longer
An illustrated survey on the morphological characters in three species of the diatom genus *Mastogloia* (Bacillariophyceae)

term monitoring studies found that striae densities fluctuated around a mean as valves decreased in length (Cox, 1983). In addition, raphid and centric diatoms showed different variability in terms of striae density; while it is more or less constant in the raphid diatoms (Schmid, 1976; Cox, 1995; Trobajo et al., 2004a), it has a greater variability in centric diatoms under different salinity regimes (Schultz, 1971). Mizuno (1987) found that the density of striae in both valves, with the exception of the small araphid valve, is invariable with changes in environmental conditions. In this study, no significant correlation was found between environmental factors and striae density.

Different study findings can be caused by the dynamic structure (water movement) in the natural environment. It is known that environmental factors such as water movement, nutrient availability, and concentration frequently co-vary with salinity, especially in estuarine systems (Nedwell & Trimmer, 1996; Ogilvie et al., 1997; Underwood & Provot, 2000; Thornton et al., 2002). Nevertheless, further experiments conducted over a longer period, in addition to field material-based studies and culture-based research, are desirable; however, changes observed in valve morphology might then be determined more by intrinsic life cycle changes than environmental conditions.

References


Kvrač E & Gürbüz H (2010). Epipelic diatoms of Tortum Streams (Erzurum) and their relationship to some physicochemical features *Ekoloji* 19(74): 102-109.


