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The distribution of centric diatoms in different river catchments in the Anatolian Peninsula, Turkey

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Abstract: The diatoms are one of the most important groups of organisms for biomonitoring studies. In Turkey, most previous applications of diatoms to water quality monitoring have focused on the pennate diatoms, with almost no attention given to the centric forms. The paper presents the centric diatoms in some river catchments in Central Anatolia (Konya closed catchment and Kızılırmak) and Western Anatolia (Marmara, Sakarya, Susurluk, Akarçay, Küçük Menderes, and Meriç-Ergene in the Marmara and Aegean regions). The survey of these catchments is based on samples collected between 2009 and 2013 from 33 different locations, including some springs from Türkmen Mountain and Domaniç forest, as well as small streams and big rivers of the Anatolian Peninsula. Altogether 30 taxa were found, of which 14 are new records for the freshwater diatom flora of Turkey.

Key words: Biomonitoring, centric diatoms, freshwater, Marmara, Aegean, Inner Anatolia, new records, Turkey

1. Introduction

Turkey has embarked on a program to monitor the quality of its freshwaters, following the European Water Framework Directive. Included in the survey area are 25 different river basins. For freshwater biomonitoring in general, diatoms have been commonly used for rivers; this practice extends back more than a century (Kolkwitz and Marsson, 1909) and has been commonly applied since the 1960s (Ács et al., 2004; Stevenson et al., 2010; Rimet, 2012). However, the freshwater algal flora of Turkey, and in particular the freshwater diatom flora, is not well known; thus, it is imperative to document the algal flora for both scientific and biomonitoring purposes (Soylu and Gönülol 2003).

According to the last checklist of the freshwater algae of Turkey (Aysel, 2005), a total of 44 centric diatoms have been found in standing and running waters. That is, 5% of the identified species were centric diatoms. With regard to the distribution of commonly reported species of centric diatoms, *Stephanodiscus hantzschii* is common in standing waters while *Aulacoseira granulata*, *Cyclotella meneghiniana*, *Lindavia radiosa*, *Melosira varians*, and *Pantocsekiella ocellata* are common both in standing and running waters (Solak et al., 2012).

Freshwater centric diatom taxonomy and systematics have undergone significant discovery and revision over the past 30 years. New genera of recent centric diatoms (e.g., *Discostella* Houk & Klee; *Spicaticribra* J.Johansen, J.P.Kociolek & R.Lowe; *Ellerbeckia* R.M.Crawford; *Cyclotubicoalitus* E.F.Stoermer, J.P.Kociolek & W.Cody; *Stephanocostis* S.I.Genkal & A.E.Kuzmina) have been described (Karthick and Kociolek 2011), and there have been some large taxonomic revisions recently (e.g., Håkansson, 2002; Houk et al., 2010, 2014; Khursevich and Kociolek, 2012; Nakov et al., 2015; Ács et al., 2016).

The aim of the present report is to study the species composition and biodiversity of centric diatoms in the phytobenthos of some springs, small streams, and big rivers in the Meriç-Ergene (1), Marmara (2), Susurluk (3), Gediz (5), Küçük Menderes (6), Akarçay (11), Sakarya (12), Kızılırmak (15), and Konya closed (16) catchments of the Anatolian Peninsula (Figure 1). The study is based on samples collected since 2009 for the purpose of documenting the freshwater diatom flora of Turkey.

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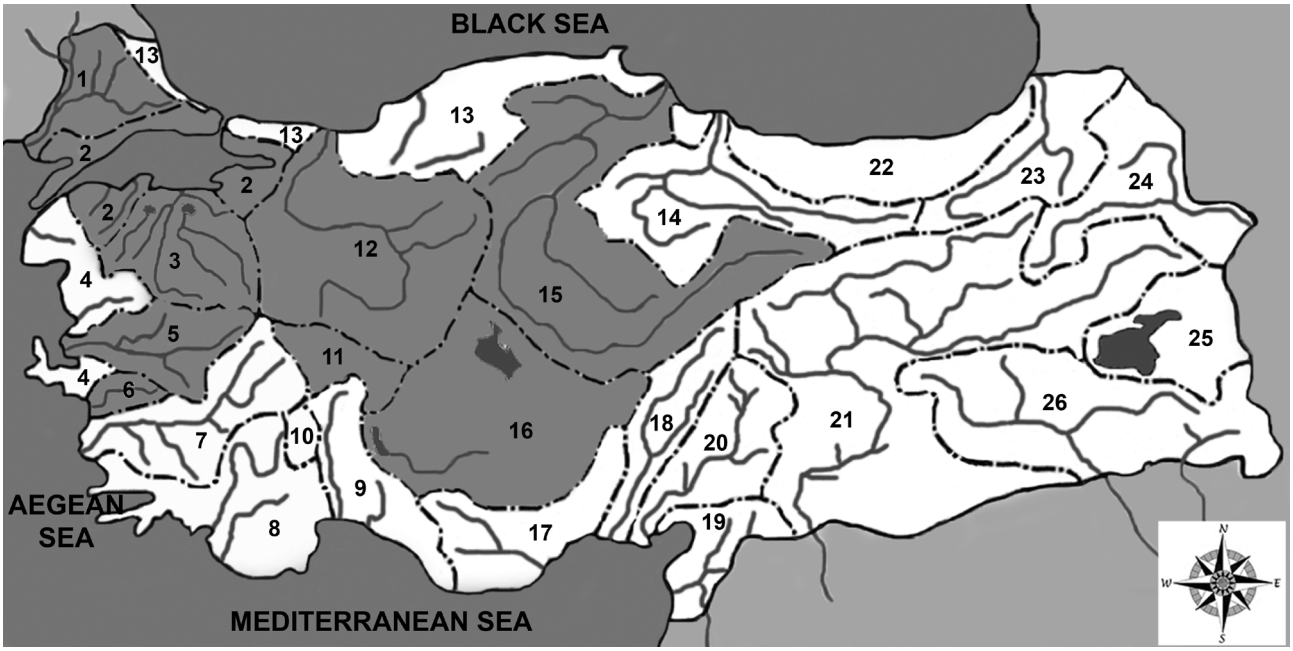

Figure 1. The distribution of river catchments in Turkey: 1 – Meriç-Ergene River Catchment, 2 – Marmara River Catchment 3 – Susurluk River Catchment, 4 – Northern Aegean River Catchment, 5 – Gediz River Catchment, 6 – Küçük Menderes River Catchment, 7 – Büyük Menderes River Catchment, 8 – Western Mediterranean River Catchment, 9 – Antalya River Catchment, 10 – Burdur River Catchment, 11 – Akarçay River Catchment, 12 – Sakarya River Catchment, 13 – Western Black Sea River Catchment, 14 – Yeşilırmak River Catchment, 15 – Kızılırmak River Catchment, 16 – Konya Closed Catchment, 17 – Eastern Mediterranean River Catchment, 18 – Seyhan River Catchment, 19 – Asi River Catchment, 20 – Ceyhan River Catchment, 21 – Fırat River Catchment, 22 – East Black Sea River Catchment, 23 – Çoruh River Catchment, 24 – Aras River Catchment, 25 – Van Closed Catchment, 26 – Dicle River Catchment (according to Akın and Akın, 2007).

2. Materials and methods

2.1. Sample collections

Nearly 200 collections were taken from different river catchments in Western (Akarçay, Gediz, Küçük Menderes, Marmara, Meriç-Ergene, Sakarya, and Susurluk river basins) and Central (Kızılırmak and Konya closed catchment) Anatolia in Turkey (Table 1; Figure 2). Epilithic samples were collected between 2009 and 2013 by brushing submerged stones.

2.2. Sample processing, observations, and identification

Samples were boiled with HCl and then H_2O_2 to remove organic matter. After washing three times with distilled water the material was air-dried on cover glasses and mounted in Naphrax. Observations of the diatoms were performed with a Nikon Eclipse 600 at the Earth Science Faculty of Szczecin University and a Nikon Ci light microscope (LM) at the Dumlupınar University Advanced Research Center (DPÜ-İLTEM). Light micrographs were taken with a Nikon DS-Fi1 camera. Scanning electron microscope observations of cleaned samples were made with a FEI Nova 650 at DPÜ-İLTEM, a JOEL 6510 LV at the Papanin Biology Institute, a Zeiss EVO MA 10 in the MTA Centre for Ecological Research of the Danube Research Institute, and a HITACHI S-4500 at Jagiellonian University and Warsaw University of Technology (Figures 3–13).

The diatoms were identified according to Krammer and Lange-Bertalot (1991), Håkansson (2002), Wojtal and Kwandrans (2006), Houk et al. (2010, 2014), Budzyńska and Wojtal (2011), Kiss et al. (2012), Bey and Ector (2013), Cavalcante et al. (2013), and Kheiri et al. (2013). Distribution of the species is given in Table 1. The reported dimensions (diameter, number of interstriae/10 µm) of each taxon are based on our own measurements from Turkish specimens.

2.3. Diatom distributions

Description of the distribution of the Turkish diatom flora was done according to Gönülol (2016). The taxa reported from Turkey in at least 10% of the literature by Gönülol (2016) are categorized here as "common" diatoms while those reported in less than 10% are noted as "rare" diatoms. For each station, about 400 valves were counted and then relative abundances were calculated.

2.4. Statistical analyses

The ordination of sampling sites was performed by using principal coordinates analyses (Podani and Miklós 2002) based on the Bray–Curtis similarity index. The SDR simplex approach (Podani and Schmara, 2011) based on

Table 1. The sampling sites of the study with river catchments.

River basin	Station name	Code
Marmara River Catchment	Ömerli reservoir	1
	Terkos reservoir	2
	Riva	3
	Biga	4
	Gönen	5
	Kurudere-1	6
	Kurudere-2	7
	Kurudere-3	8
	Kurudere-4	9
	Gökçedere	10
	Samanlıdere-1	11
	Samanlıdere-2	12
	Samanlıdere-3	13
	Havuzdere	14
Sakarya Basin	Felent stream	15
	Porsuk stream	16
	Murat stream	17
	Kokar stream	18
	İdris plateau	19
	Darıpınar plateau	20
Susurluk Basin	Topuk stream	21
	Safa stream	22
	Domaniç spring	23
Gediz Basin	Kocasu stream	24
	Simav stream	25
Kızılırmak Basin	Karasu	26
	Osmancık	27
Konya Basin	Beyşehir lake	28
	Çeltik canal	29
Akarçay Basin	Karadirek stream	30
	Sandıklı spring	31
Küçük Menderes Basin	Beydağı reservoir	32
Meriç-Ergene Basin	Şeytan stream	33

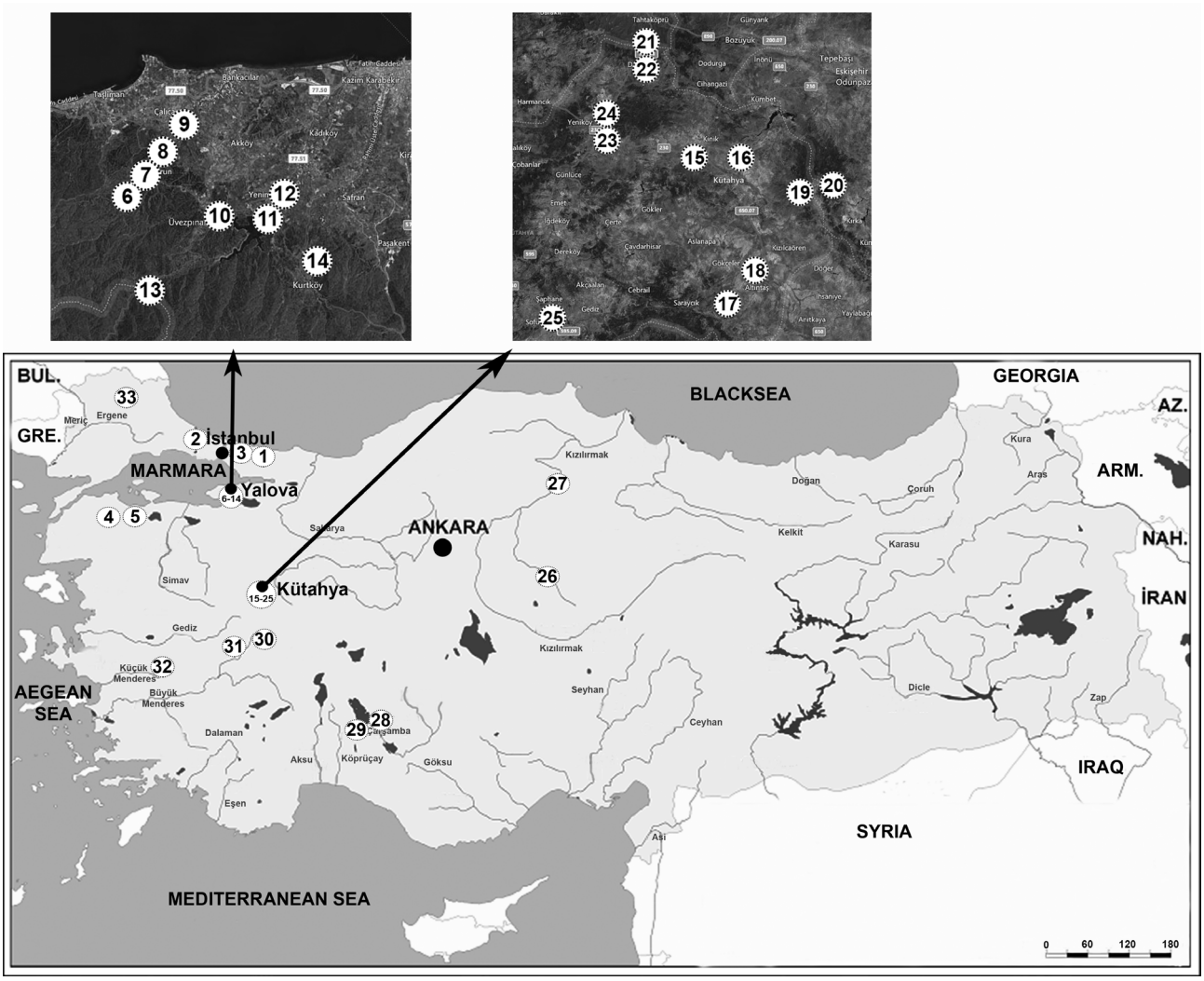

Figure 2. The sampling sites of the study with river catchments.

the Jaccard index was used to partition gamma diversity into relativized additive components (species replacement (R), richness difference (D), and similarity (S)) for all pairs of sites in the presence–absence data matrix. The pairwise values can then be presented on ternary plots.

3. Results

3.1. *Aulacoseira* Thwaites

3.1.1. *Aulacoseira ambigua* (Grunow) Simonsen (Figure 3)

Basionym. *Melosira crenulata* var. *ambigua* Grunow

Ref. Krammer and Lange-Bertalot, 1991 (p. 25, fig. 21: 1–16); Kiss et al., 2012 (p. 315, fig. 2: A–C); Bey and Ector, 2013 (Vol. 1, p. 8); Cavalcante et al., 2013 (p. 246, fig. 11: B–F).

Dimensions: Valve diameter 4.3–6.5 µm, valve mantle height 6.5–16.2 µm and 14–20 interstriae in 10 µm.

Distribution in river catchments: 1, 11, 12 (Marmara river catchment).

Distribution in Turkey: This is a rare species. It was found in the following regions: Western Black Sea (Kızılırmak and Yeşilırmak river catchments), Eastern Anatolia (Aras, Fırat, Dicle river catchments), and Western Anatolia (Susurluk and Sakarya river catchments).

3.1.2. *Aulacoseira granulata* (Ehrenberg) Simonsen (Figure 3)

Basionym. *Gaillonella granulata* Ehrenberg

Ref. Krammer and Lange-Bertalot, 1991 (p. 22, fig. 17: 1–10, 18: 1–14, 19: 1–9); Kiss et al., 2012 (p. 315, fig. 2: D–F); Bey and Ector, 2013 (Vol. 1, p. 10); Cavalcante et al., 2013 (p. 247, fig. 11: J–K).

Dimensions: Valve diameter 4.0–6.1 µm, valve mantle height 11.5–16.8 µm and 10–15 interstriae in 10 µm.

Distribution in river catchments: 1, 10, 11, 12, 13 (Marmara river catchment), 32 (Küçük Menderes river catchment).

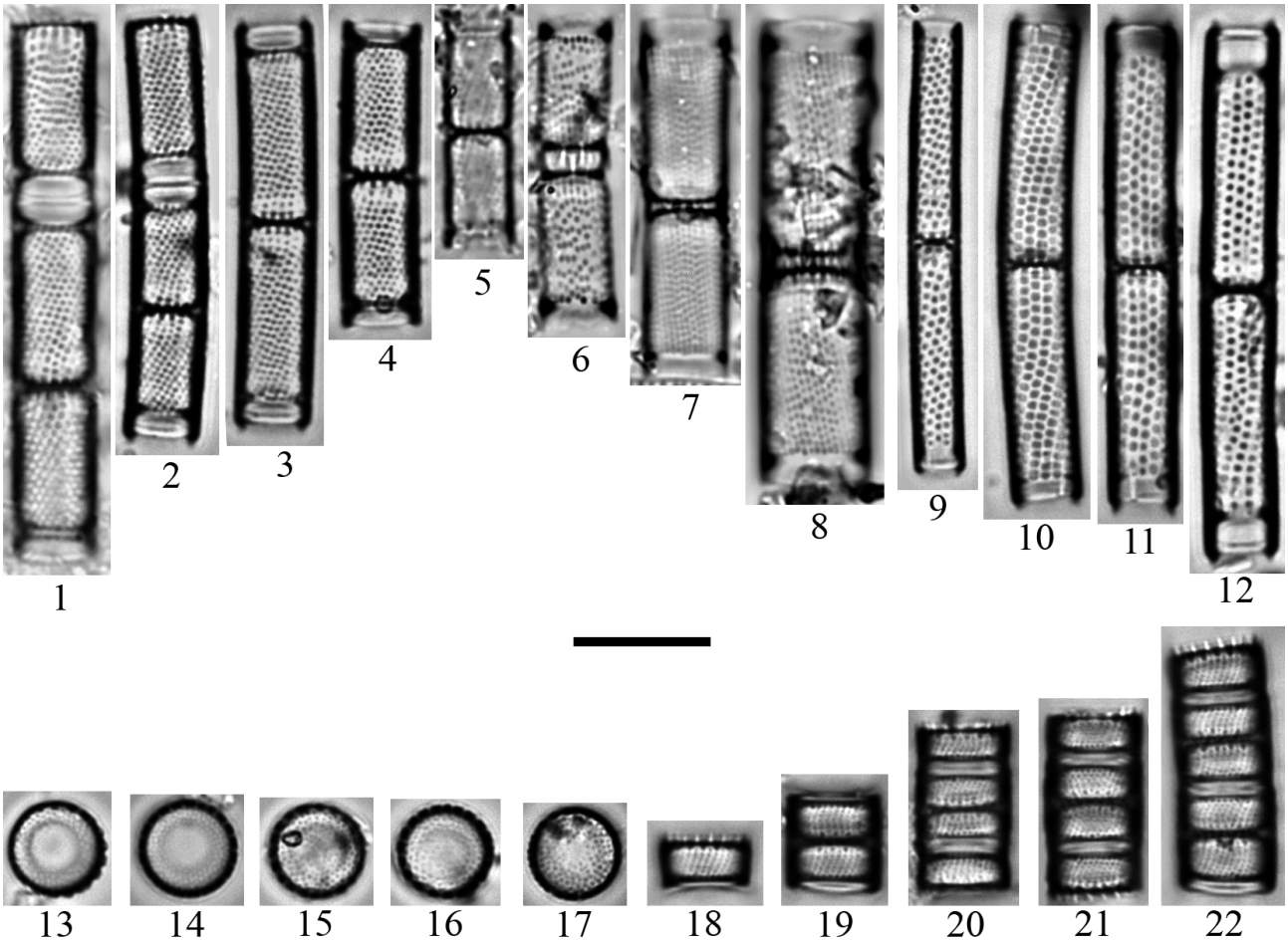

Figure 3. 1–4 – *Aulacoseira ambigua* (Grunow) Simonsen; 5–8 – *A. italica* (Ehrenberg) Simonsen; 9–12 – *A. granulata* (Ehrenberg) Simonsen; 13–22 – *A. pusilla* (Meister) Tuji & Houk; all LM. Scale bar: 10 µm.

Distribution in Turkey: This is a very common species.

3.1.3. *Aulacoseira italica* (Ehrenberg) Simonsen (Figure 3)

Basionym. *Gaillonella italica* Ehrenberg

Ref. Krammer and Lange-Bertalot, 1991 (p. 29, fig. 24: 1, 3–6; 25: 1–11); Crawford et al., 2003 (p. 6, fig. 2–8); Potapova et al., 2007 (p. 7, fig. 15–29).

Dimensions: Valve diameter 5.3–8.1 µm, valve mantle height 8.8–16.7 µm and 14–17 interstriae in 10 µm.

Distribution in river catchments: 26 (Kızılırmak river catchment).

Distribution in Turkey: This is a very common species.

3.1.4. *Aulacoseira pusilla* (Meister) Tuji & Houk (Figures 3 and 4)

Basionym. *Melosira pusilla* Meister

Ref. Bey and Ector, 2013 (Vol. 1, p. 14); Cavalcante et al., 2013 (p. 247, fig. 11: J–K); Tuji, 2015 (p. 55, figs. 2–16) .

Dimensions: Valve diameter 6.4–7.3 µm, valve mantle height 2.0–3.7 µm.

Distribution in river catchments: 7, 8, 10, 11, 12, 13, 14 (Marmara river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.2. *Conticribra* K.Stachura-Suchoples & D.M. Williams

3.2.1. *Conticribra weissflogii* (Grunow) K.Stachura-Suchoples & D.M.Williams (Figure 5)

Basionym*: Eupodiscus weissflogii* Grunow

Ref. Krammer and Lange-Bertalot, 1991 (p. 79, fig. 77: 3, 4); Kiss et al., 2012 (p. 320, fig. 5: D–F); Bey and Ector, 2013 (Vol. 1, p. 18); Cavalcante et al., 2013 (p. 238, fig. 2: A–M).

Dimensions: Valves diameter 12.5–21.4 µm and 9–13 marginal fultoportulae in 10 µm.

Distribution in river catchments: 17 and 18 (Sakarya river catchment), 26 (Kızılırmak river catchment), 32 (Konya closed catchment).

Distribution in Turkey: This is a very rare species. It was found in the Eastern Black Sea and Anatolia (Fırat and Dicle river catchments) regions.

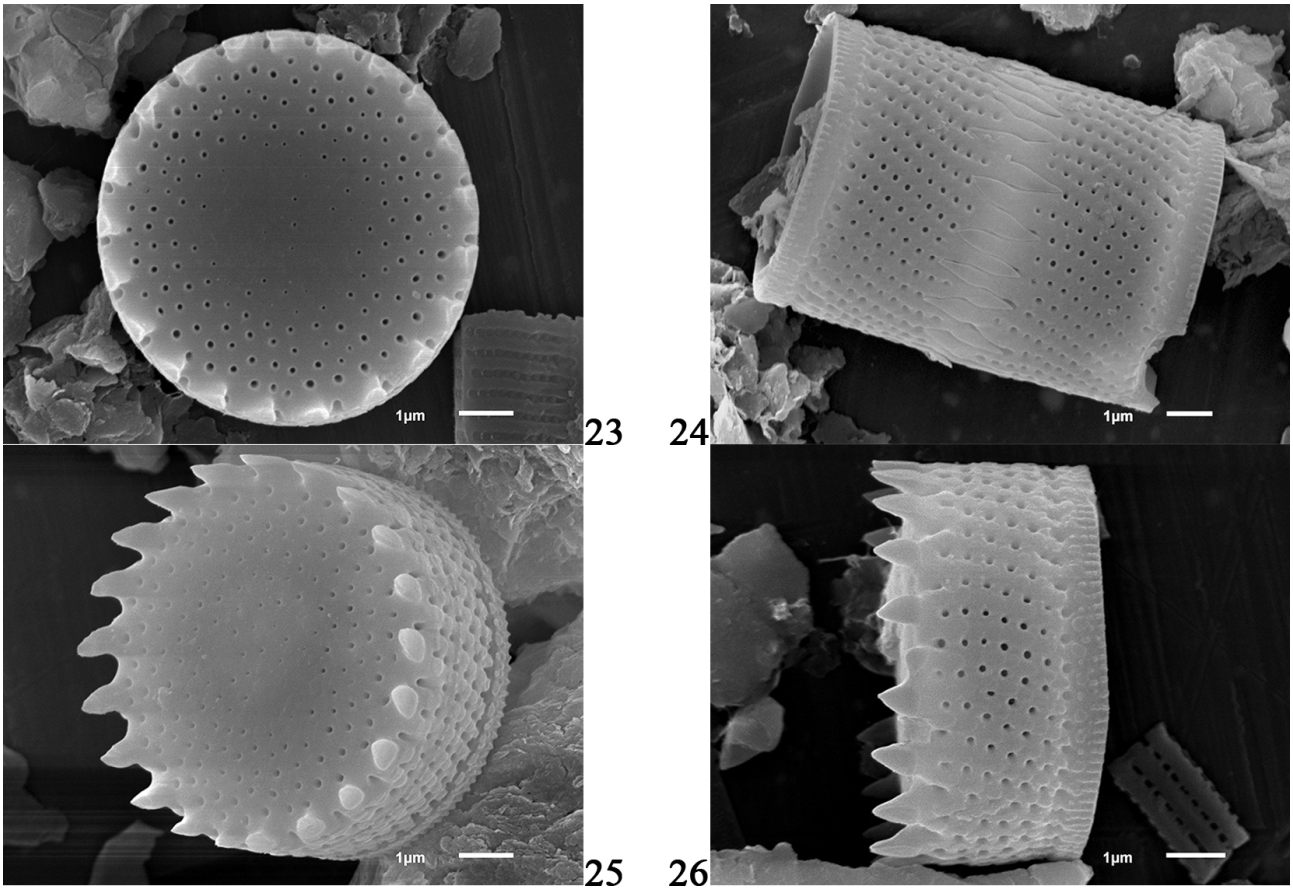

Figure 4. 23–26 – *Aulacoseira pusilla* (Meister) Tuji & Houk, all SEM. Scale bars: 1 µm.

3.3. *Cyclostephanos* Round

3.3.1. *Cyclostephanos dubius* (Hustedt) Round (Figures 5 and 6)

Basionym. *Stephanodiscus dubius* Hustedt

Ref. Krammer and Lange-Bertalot, 1991 (p. 64, fig. 67: 8a–9b); Håkansson, 2002 (p. 62, figs. 198–208); Wojtal and Kwandrans, 2006 (p. 196, fig. 15: 8, 16: 1–11); Kiss et al., 2012 (p. 329, fig. 10: A–C); Bey and Ector, 2013 (Vol. 1, p. 20).

Dimensions: Valve diameter 6.9–9.2 µm. The valve has 9–11 interstriae in 10 µm.

Distribution in river catchments: 30 and 31 (Akarçay river catchment), 19 (Sakarya river catchment).

Distribution in Turkey: Rare species. The taxon was found from Eastern Anatolia (Fırat, Dicle, and Asi river catchments) and the Western Black Sea.

3.3.2. *Cyclostephanos invisitatus* (Hohn & Hellerman) Theriot, Stoermer & Håkasson (Figure 5)

Basionym. *Stephanodiscus invisitatus* Hohn & Hellermann

Ref. Krammer and Lange-Bertalot, 1991 (p. 63, fig. 67: 3, 4); Håkansson, 2002 (p. 67, figs. 221–225); Wojtal and Kwandrans, 2006 (p. 198, fig. 15: 9, 16: 12–14, 17); Kiss et al., 2012 (p. 331, fig. 10: D–F); Bey and Ector, 2013 (Vol. 1, p. 22); Houk et al., 2014 (p. 49, fig. 160: 1–8).

Dimensions: Valve diameter 8.3–13.0 µm. The valve has 10–16 interstriae in 10 µm.

Distribution in river catchments: 24 (Gediz river catchment), 26 (Kızılırmak river catchment), 32 (Küçük Menderes river catchment), 28 (Konya closed catchment).

Distribution in Turkey: This is a new record for Turkey.

3.4. *Cyclotella* (Kützing) Brébisson

3.4.1. *Cyclotella atomus* var. *atomus* Hustedt (Figures 5 and 6)

Ref. Krammer and Lange-Bertalot, 1991 (p. 53, fig. 51: 19–21); Wojtal and Kwandrans, 2006 (p. 184, fig. 4: 13–15, 6: 1–6); Kiss et al., 2012 (p. 331, fig. 11: A–C); Bey and Ector, 2013 (Vol. 1, p. 24); Cavalcante et al., 2013 (p. 241, fig. 4: A–P); Houk et al., 2010 (p. 13, fig. 124: 1–19).

Dimensions: Valve diameter 6.7–14.5 µm. There are 14–20 interstriae in 10 µm.

Distribution in river catchments: 10 (Marmara river catchments).

Distribution in Turkey: This is a very rare species. It was reported from lakes in Inner Anatolia.

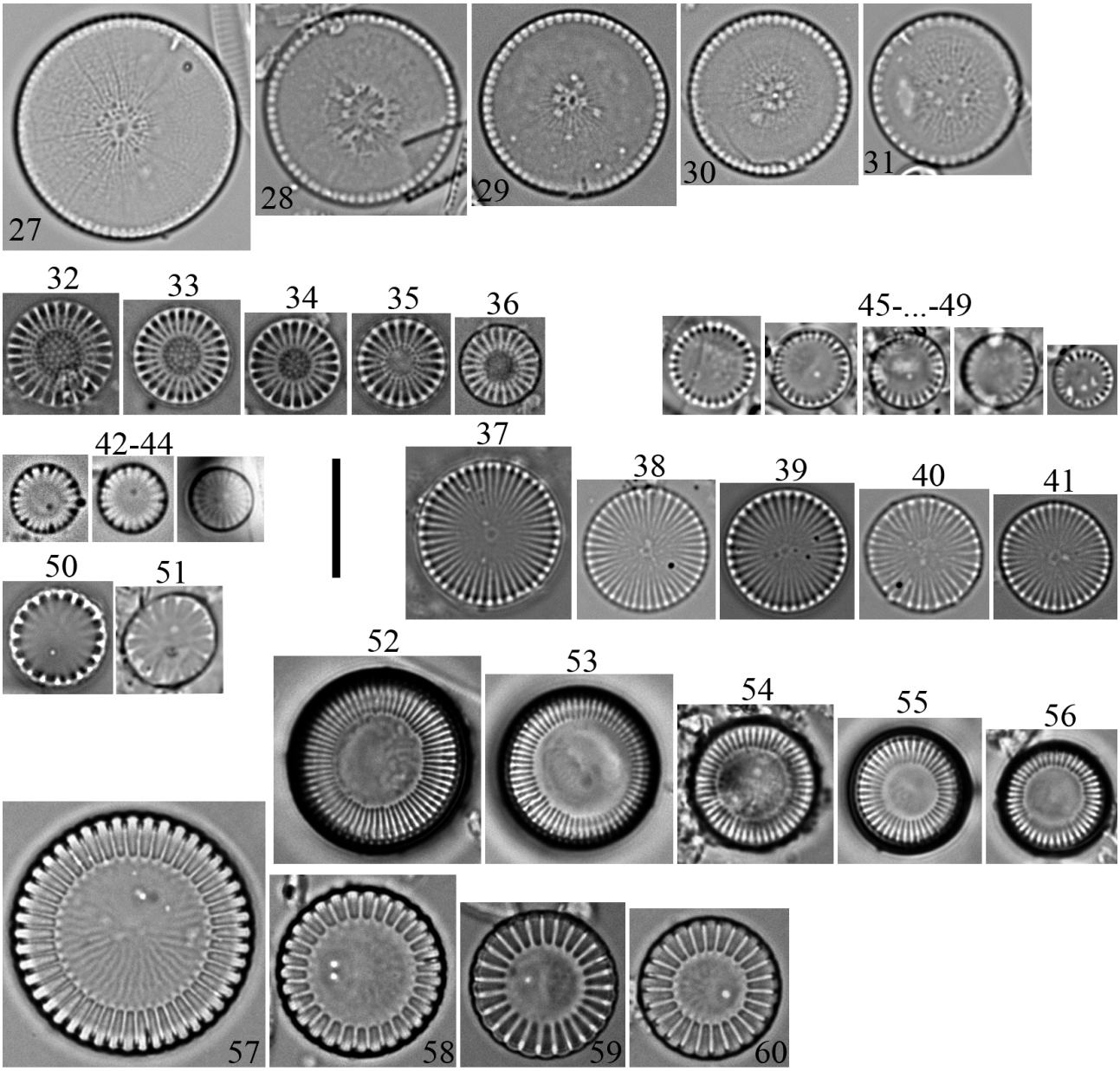

Figure 5. 27–31 – *Conticribra weissflogii* (Grunow) K.Stachura-Suchoples & D.M.Williams; 32–36 – *Cyclostephanos dubius* (Hustedt) Round; 37–41 – *C. invisitatus* (Hohn & Hellerman) Theriot, Stoermer & Håkasson; 42–44 - *Cyclotella atomus* var. *atomus* Hustedt; 45–49 – *C. atomus* var. *gracilis* Genkal & Kiss; 50, 51 – *C. cryptica* Reimann, Lewin & Guillard; 52–56 – *C. distinguenda* Hustedt; 57–60 – *C. meneghiniana* Kützing; all LM. Scale bar: 10 µm.

3.4.2. *Cyclotella atomus* var. *gracilis* Genkal & Kiss (Figure 5)

Ref. Kiss et al., 2012 (p. 332, fig. 11: D–F); Bey and Ector, 2013 (Vol. 1, p. 25); Houk et al., 2010 (p. 14, fig. 124: 20–27).

Dimensions: Valve diameter 9.6–12.7 µm. There are 11–13 interstriae in 10 µm.

Distribution in river catchments: 4 (Marmara river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.4.3. *Cyclotella cryptica* Reimann, Lewin & Guillard (Figure 5)

Ref. Cavalcante et al., 2013 (p. 242, fig. 6: A–K); Houk et al., 2010 (p. 17, fig. 148: 1–14).

Dimensions: Valve diameter 8.03–8.38 µm, with 6–8 interstriae in 10 µm.

Distribution in river catchments: 29 (Konya closed catchment).

Distribution in Turkey: This is a new record for Turkey.

3.4.4. *Cyclotella distinguenda* Hustedt (Figures 5 and 6)

Ref. Krammer and Lange-Bertalot, 1991 (p. 43, fig. 43: 1–11); Håkansson, 2002 (p. 72, figs. 228, 230–237); Wojtal and Kwandrans, 2006 (p. 186, fig. 4: 16, 17); Kiss et al., 2012 (p. 335, fig. 13: A–C); Bey and Ector, 2013 (Vol. 1, p. 28); Houk et al., 2010 (p. 20, fig. 164: 1–14).

Dimensions: Valve diameter 9.3–16.6 µm, having 12–15 interstriae in 10 µm.

Distribution in river catchments: 17 and 18 (Sakarya river catchment).

Distribution in Turkey: This is a rare species. It was found in the Eastern Black Sea and Anatolia (Fırat, Aras, and Çoruh river catchments) regions.

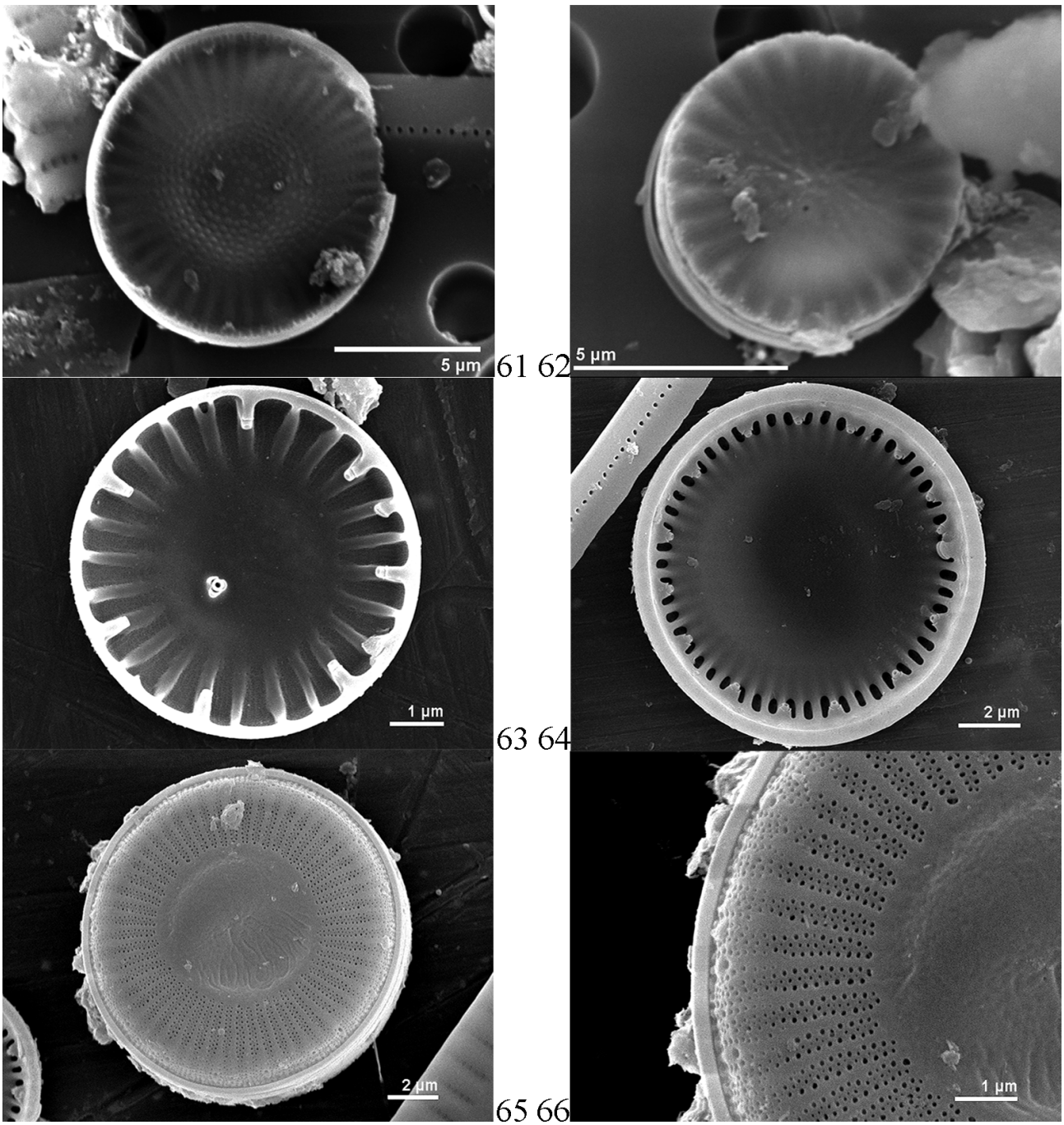

Figure 6. 61 – *Cyclostephanos dubius* (Hustedt) Round (internal view); 62, 63 – *C. atomus* Hustedt (62 – external view, 63 – internal view); 64–66 – *C. distinguenda* Hustedt (65, 66 – external view; 64 – internal view), all SEM. Scale bars: 61, 62 – 5 µm; 64, 65 – 2 µm; 63, 66 – 1 µm.

3.4.5. *Cyclotella meneghiniana* Kützing (Figures 5 and 7)
Ref. Krammer and Lange-Bertalot, 1991 (p. 44, fig. 44: 1–10); Håkansson, 2002 (p. 79, figs. 263–268); Wojtal and Kwandrans, 2006 (p. 186, fig. 4: 18–21, 7: 1–13, 9: 1–8, 10: 1–5); Kiss et al., 2012 (p. 337, fig. 14: A–C); Bey and Ector, 2013 (Vol. 1, p. 30); Cavalcante et al., 2013 (p. 243, fig. 8: A–O); Houk et al., 2010 (p. 16, fig. 143: 1–15).

Dimensions: Valve diameter 7.7–22.8 µm. There are 6–8 interstriae in 10 µm.

Distribution in river catchments: 17, 18, 20 (Sakarya river catchments), 25 (Gediz river catchment), 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a very common species.

3.5. *Discostella* Houk & Klee

3.5.1. *Discostella pseudostelligera* (Hustedt) Houk & Klee (Figures 7 and 8)
Basionym. *Cyclotella pseudostelligera* Hustedt

Ref. Krammer and Lange-Bertalot, 1991 (p. 51, fig. 49: 5–7); Wojtal and Kwandrans, 2006 (p. 188, fig. 12: 1–3, 13: 1–9); Kiss et al., 2012 (p. 343, fig. 17: A–C); Bey and Ector, 2013 (Vol. 1, p. 40); Cavalcante et al., 2013 (p. 245, fig. 9: A–G); Houk et al., 2010 (p. 50, fig. 317: 1–20).

Dimensions: Valve diameter 4.3–7.8 µm. Valves have 11–15 interstriae in 10 µm.

Distribution in river catchments: 1, 11, 14 (Marmara river catchment), 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.5.2. *Discostella stelligera* var. *stelligera* (Cleve & Grunow) Houk & Klee (Figure 8)
Basionym. *Cyclotella meneghiniana* var. *stelligera* Cleve & Grunow

Ref. Krammer and Lange-Bertalot, 1991 (p. 50, fig. 49: 1a–4); Wojtal and Kwandrans, 2006 (p. 190, fig. 12: 10, 11); Kiss et al., 2012 (p. 343, fig. 17: D–F); Bey and Ector, 2013 (Vol. 1, p. 41); Houk et al., 2010 (p. 47, fig. 303: 1–9).

Dimensions: Valve diameter 6.3–11.8 µm. There are 10–14 interstriae in 10 µm.

Distribution in river catchments: 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a rare species. The taxon was found in the Inner Anatolia (Konya closed catchment), Eastern Black Sea, and Anatolia (Fırat, Çoruh, and Aras river catchments) regions.

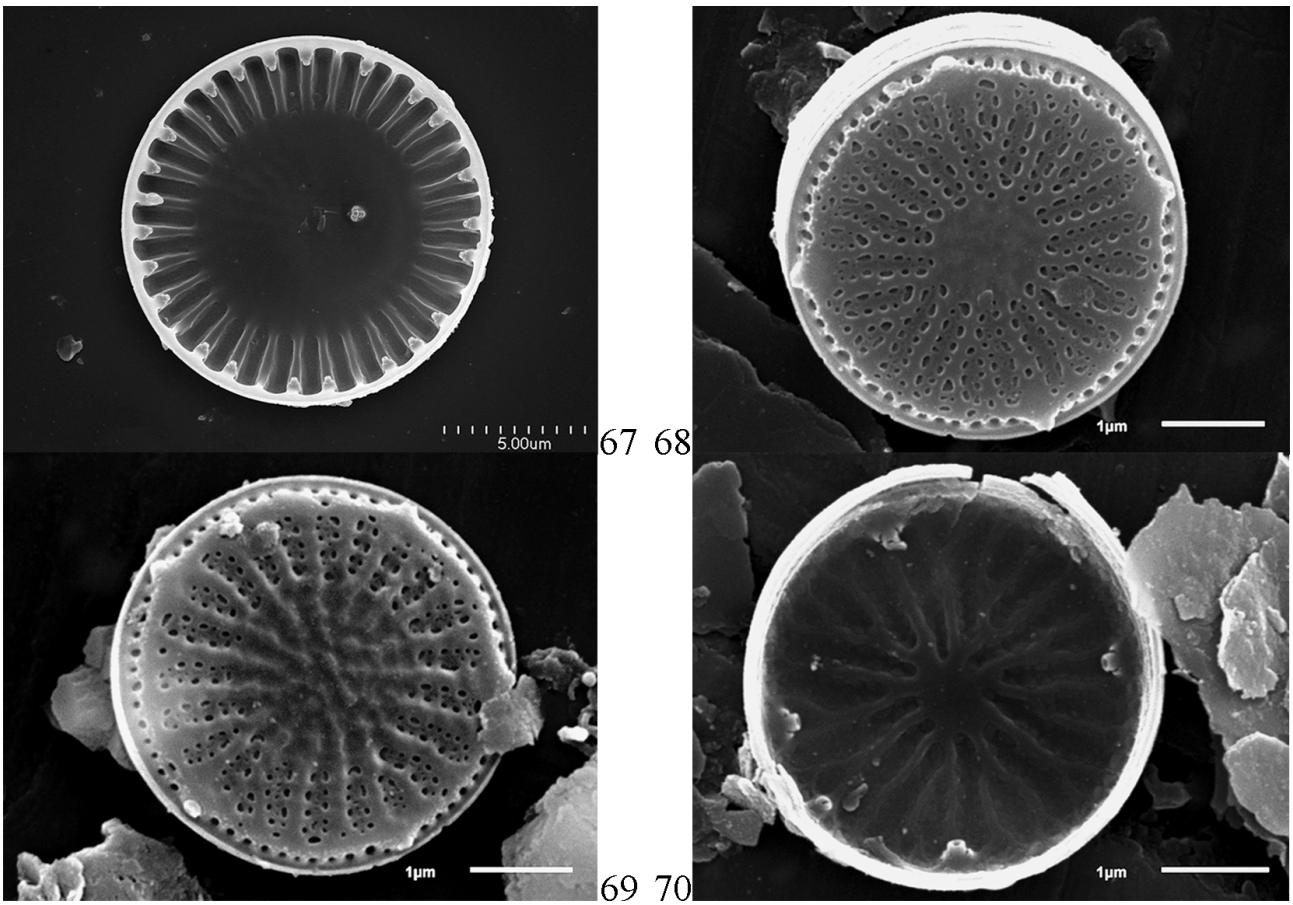

Figure 7. 67 – *Cyclotella meneghiniana* Kützing (internal view); 68–70 – *D. pseudostelligera* (Hustedt) Houk & Klee (68, 69 – external view; 70 – internal view); all SEM. Scale bar: 67 – 5 µm; 68–70 – 1 µm.

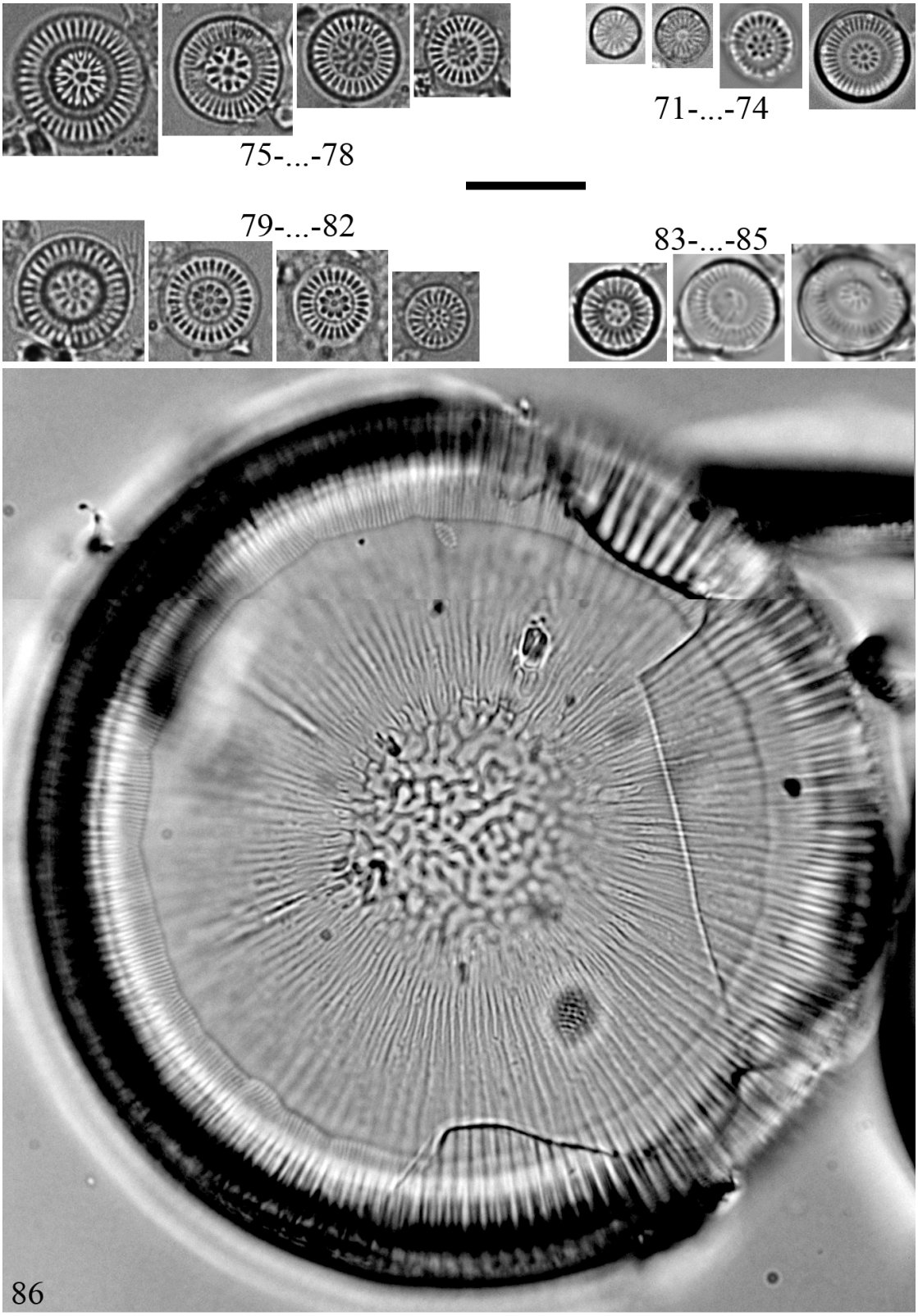

Figure 8. 71–74 – *Discostella pseudostelligera* (Hustedt) Houk & Klee; 75–78 – *Discostella stelligera* (Cleve & Grunow) Houk & Klee; 79–82 – *D. stelligera* var. *tenuis* (Hustedt) Houk & Klee; 83–85 – *D. stelligeroides* (Hustedt) Houk & Klee; 86 – *Ellerbeckia arenaria* (Moore ex Ralfs) Crawford; all LM. Scale bar: 10 µm.

3.5.3. *Discostella stelligera* var. *tenuis* (Hustedt) Houk & Klee (Figure 8)

Basionym. *Cyclotella stelligera var. tenuis* Hustedt

Ref. Houk et al., 2010 (p. 47, fig. 307: 1–8).

Dimensions: Valve diameter 5.5–10.2 µm, and valves have 10–13 interstriae in 10 µm.

Distribution in river catchments: 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.5.4. *Discostella stelligeroides* (Hustedt) Houk & Klee (Figure 8)

Basionym. *Cyclotella stelligeroides* Hustedt

Ref. Houk et al., 2010 (p. 51, fig. 321: 1–15).

Dimensions: Valve diameter 6.7–9.2 µm. There are 11–13 interstriae in 10 µm.

Distribution in river catchments: 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.6. *Ellerbeckia* Crawford

3.6.1. *Ellerbeckia arenaria* (Moore ex Ralfs) Crawford (Figure 8)

Basionym. *Melosira arenaria* Moore ex Ralfs

Ref. Krammer and Lange-Bertalot, 1991 (p. 17, fig. 14: 1–5); Wojtal, 2009 (p. 198, fig. 1: 5a, b); Bey and Ector, 2013 (Vol. 1, p. 44).

Dimensions: Valve diameter 65.3–74.2 µm.

Distribution in river catchments: 17 (Sakarya river catchment).

Distribution in Turkey: This is a common species.

3.7. *Lindavia* (Schütt) De Toni & Forti (Figure 9)

3.7.1. *Lindavia balatonis* (Pantocsek) Nakov et al. (Figure 9)

Basionym. *Cyclotella balatonis* Pantocsek

Ref. Budzyńska and Wojtal, 2011 (p. 512, figs. 1–22); Kiss et al., 2012 (p. 340, fig. 15: D–F); Bey and Ector, 2013 (Vol. 1, p. 56); Houk et al., 2010 (p. 39, fig. 269: 1-11).

Dimensions: Valve diameter 9.1–27.6 µm. Valves have 13–18 interstriae in 10 µm.

Distribution in river catchments: 24 (Gediz river catchment) and 20 (Sakarya river catchment).

Distribution in Turkey: This is a rare species in Western Anatolia (Sakarya river catchment).

3.7.2. *Lindavia praetermissa* (Lund) Nakov et al. (Figures 9 and 11)

Basionym. *Cyclotella praetermissa* J.W.G. Lund

Ref. Krammer and Lange-Bertalot, 1991 (p. 58, fig. 60: 7–10); Håkansson, 2002 (p. 116, figs. 422–426); Kiss et al., 2012 (p. 341, fig. 16: A–C); Houk et al., 2010 (p. 41, fig. 280: 1–11).

Dimensions: Valve diameter 6.9–10.3 µm.

Distribution in river catchments: 3 (Marmara river catchment).

Distribution in Turkey: This is a rare species in Western Anatolia (Sakarya river catchment) and the Western Black Sea regions.

3.7.3. *Lindavia radiosa* (Grunow) De Toni & Forti (Figure 11)

Basionym. *Cyclotella comta* var. *radiosa* Grunow

Ref. Krammer and Lange-Bertalot, 1991 (p. 57, fig. 62: 1–6, 9–12); Håkansson, 2002 (p. 114, figs. 415–421); Wojtal and Kwandrans, 2006 (p. 195, fig. 12: 17–22, 15: 4–7); Kiss et al., 2012 (p. 342, Fig. 16: D–F); Bey and Ector, 2013 (Vol. 1, p. 60); Houk et al., 2010 (p. 37, fig. 261: 1–11).

Dimensions: Valve diameter 10.8–15.6 µm. Valves have 27 interstriae in 10 µm.

Distribution in river catchments: 24 (Gediz river catchment).

Distribution in Turkey: This is a very common species.

3.8. *Melosira* C.Agardh

3.8.1. *Melosira varians* C. Agardh (Figures 9 and 11)

Ref. Krammer and Lange-Bertalot, 1991 (p. 7, fig. 4: 1–8); Wojtal, 2009 (p. 238, fig. 1: 1–4); Bey and Ector, 2013 (Vol. 1, p. 48); Cavalcante et al., 2013 (p. 246, fig. 11: A).

Dimensions: Valve diameter 6.7–30.0 µm, with a valve mantle height of 13.4–27.2 µm.

Distribution in river catchments: 15, 16, 17, 20 (Sakarya river catchments), 22 (Susurluk river catchment).

Distribution in Turkey: This is a very common species.

3.9. *Orthoseira* Thwaites

3.9.1. *Orthoseira dendroteres* (Ehrenberg) Genkal & Kulikovskiy (Figure 9)

Basionym. *Liparogyra dendroteres* Ehrenberg

Ref. Krammer and Lange-Bertalot, 1991 (p. 14, fig. 127: 1–7).

Dimensions: Valve diameter 19.6–21.1 µm. There are 11 interstriae in 10 µm.

Distribution in river catchments: 11, 12, 14 (Marmara river catchment), 20 (Sakarya river catchment), 23 (Susurluk river catchment), 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.10. *Pantocsekiella* K.T.Kiss & Ács

3.10.1. *Pantocsekiella delicatula* (Hustedt) K.T.Kiss & Ács (Figures 9 and 12)

Basionym. *Cyclotella delicatula* Hustedt

Ref. Krammer and Lange-Bertalot, 1991 (p. 51, fig. 52: 3); Wojtal and Kwandrans, 2006 (p. 7: 14–19, 8: 1–7); Houk et al., 2010 (p. 32, fig. 228: 1–19).

Dimensions: Valve diameter 5.3–22.5 µm. There are 16–22 interstriae in 10 µm.

Distribution in river catchments: 17 (Sakarya river catchment) and 24 (Gediz river catchment).

Distribution in Turkey: This is a new record for Turkey.

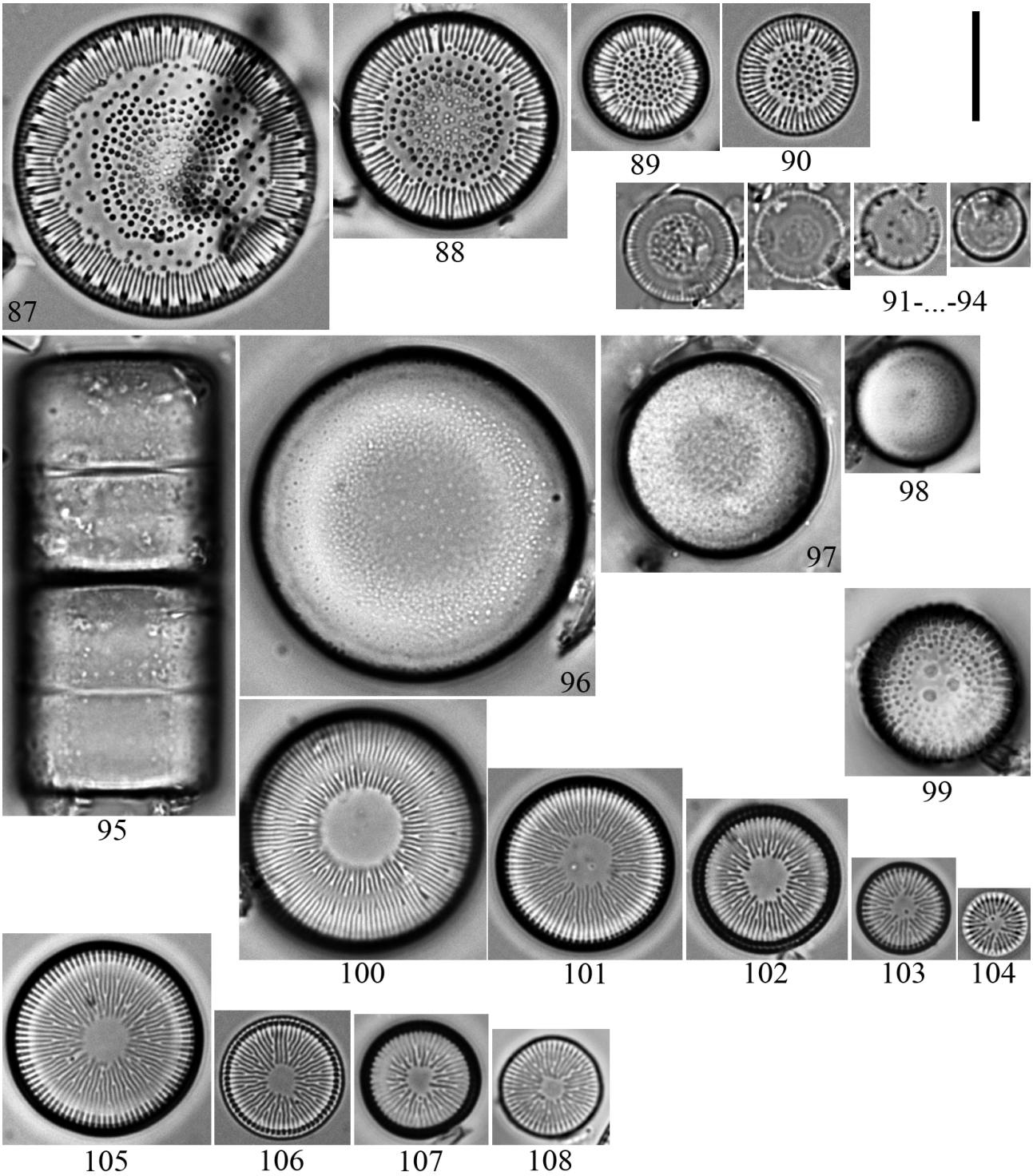

Figure 9. 87–90 – *Lindavia balatonis* (Pantocsek) Nakov et al.; 91–94 – *Lindavia praetermissa* (Lund) Nakov et al.; 95–98 – *Melosira varians* C. Agardh; 99 – *Orthoseira dendroteres* (Ehrenberg) Genkal & Kulikovskiy; 100–104 – *Pantocsekiella delicatula* (Hustedt) K.T.Kiss & Ács; 105–108 – *Pantocsekiella iranica* (Nejadsattari et al.) Kiss, Ector & **Ács;** all LM. Scale bar: 10 µm.

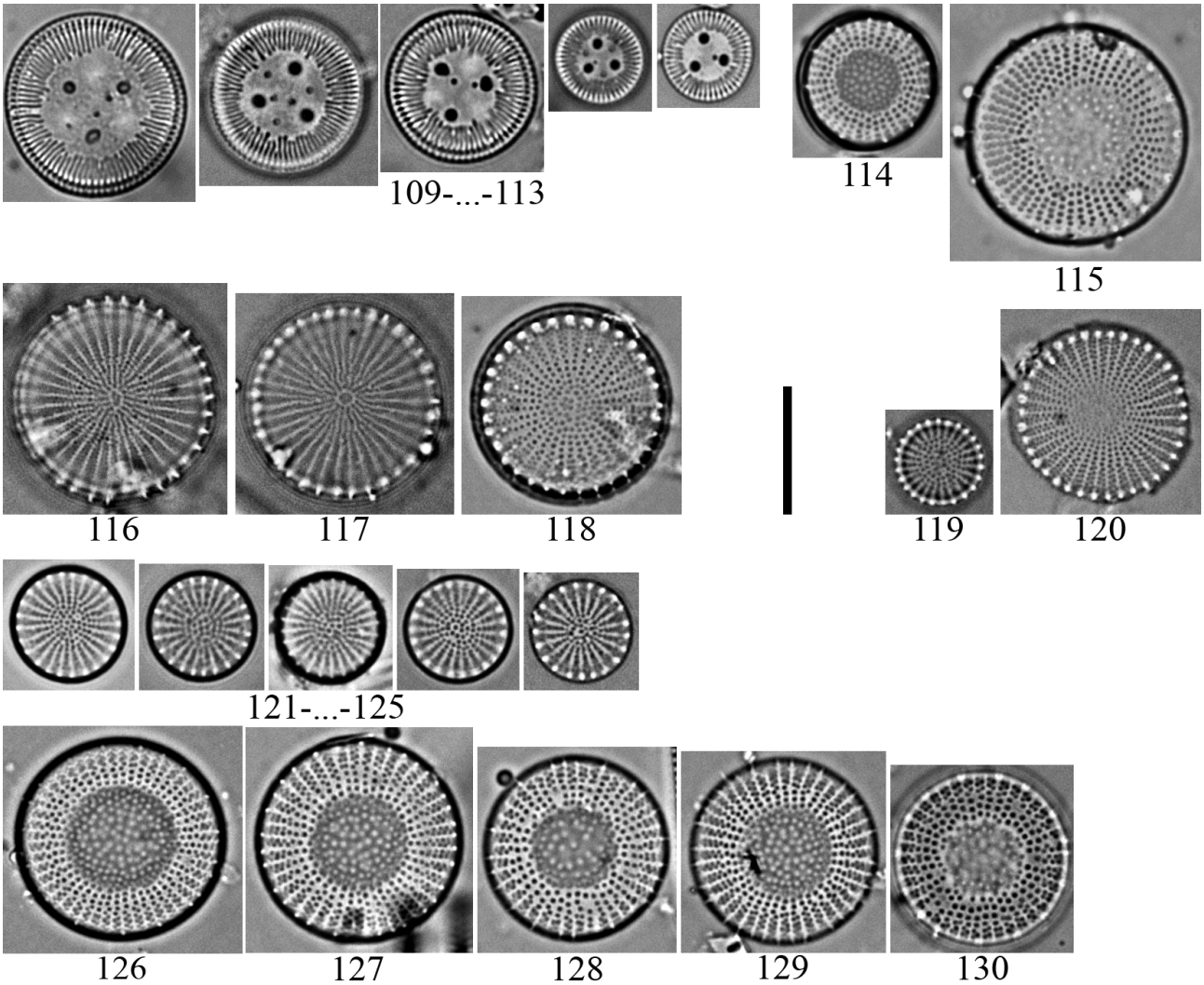

Figure 10. 109–113 – *Pantocsekiella ocellata* (Pantocsek) K.T.Kiss & Ács; 114, 115 – *Stephanodiscus balatonis* Pantocsek; 116–120 – *S. hantzschii* Grunow in Cleve & Grunow; 121–125 – *S. minutulus* (Kützing) Cleve & Möller; 126–130 – *S. neoastraea* Håkansson & Hickel; all LM. Scale bar: 10 µm.

3.10.2. *Pantocsekiella iranica* (Nejadsattari et al.) Kiss, Ector &Ács (Figures 9 and 12)

Basionym. *Cyclotella iranica* Nejadsattari, Kheiri, Spaulding & Edlund

Ref. Kheiri et al., 2013 (p. 37, fig. 2–10).

Dimensions: Valve diameter 9.3–17.9 µm. There are 15–19 interstriae in 10 µm.

Distribution in river catchments: 17 (Sakarya river catchment) and 24 (Gediz river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.10.3. *Pantocsekiella ocellata* (Pantocsek) K.T.Kiss & Ács (Figures 10 and 13)

Basionym. *Cyclotella ocellata* Pantocsek

Ref. Krammer and Lange-Bertalot, 1991 (p. 51, fig. 50: 1–11); Håkansson, 2002 (p. 85, figs. 309–318); Wojtal and Kwandrans, 2006 (p. 188, fig. 7: 26–27); Kiss et al., 2012 (p. 339, fig. 15: A–C); Bey and Ector, 2013 (Vol. 1, p. 32); Houk et al., 2010 (p. 26, fig. 197: 1–10),

Dimensions: Valve diameter 6.7–14.5 µm. Valves have 14–20 interstriae in 10 µm.

Distribution in river catchments: 11, 12, 14 (Marmara river catchment), 20 (Sakarya river catchment), 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a very common species (Solak and Kulikovskiy, 2013).

3.11. *Stephanodiscus* Ehrenberg

3.11.1. *Stephanodiscus balatonis* Pantocsek (Figure 10)

Ref. Houk et al., 2014 (p. 33, fig. 29: 1–8).

Dimensions: Valve diameter 11.0–17.5 µm. There are 10 interstriae in 10 µm.

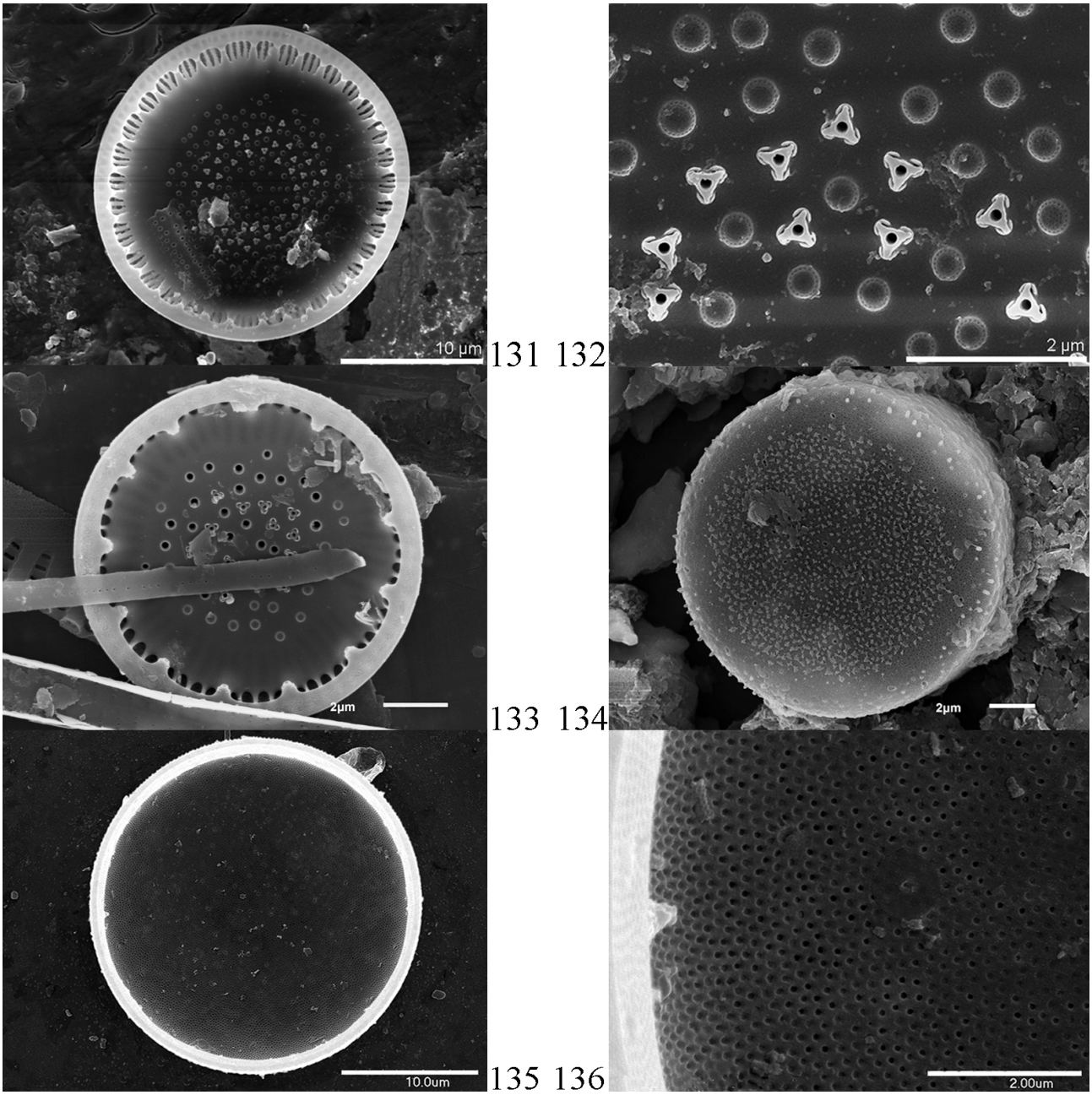

Figure 11. 131, 132 – *Lindavia radiosa* (Grunow) De Toni & Forti (internal view); 133 – *L. radiosa* (Grunow) De Toni & Forti (internal view); 134–136 – *Melosira varians* C. Agardh (135, 136 – internal view, 135 – external view); all SEM. Scale bars: 131 & 135 – 10 µm; 132–134 & 136 – 2 µm.

Distribution in river catchments: 30 (Akarçay river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.11.2. *Stephanodiscus hantzschii* Grunow in Cleve & Grunow (Figures 10 and 13)

Ref. Krammer and Lange-Bertalot, 1991 (p. 73, fig. 74: 12–16, 75: 4–11); Wojtal and Kwandrans, 2006 (p. 199, fig. 18: 3–8, 19: 1–9); Kiss et al., 2012 (p. 346, fig. 19: A–F); Bey and Ector, 2013 (Vol. 1, p. 64); Houk et al., 2014 (p. 40, fig. 129: 1–17).

Dimensions: Valve diameter 7.0–14.0 µm. There are 9–11 interstriae in 10 µm.

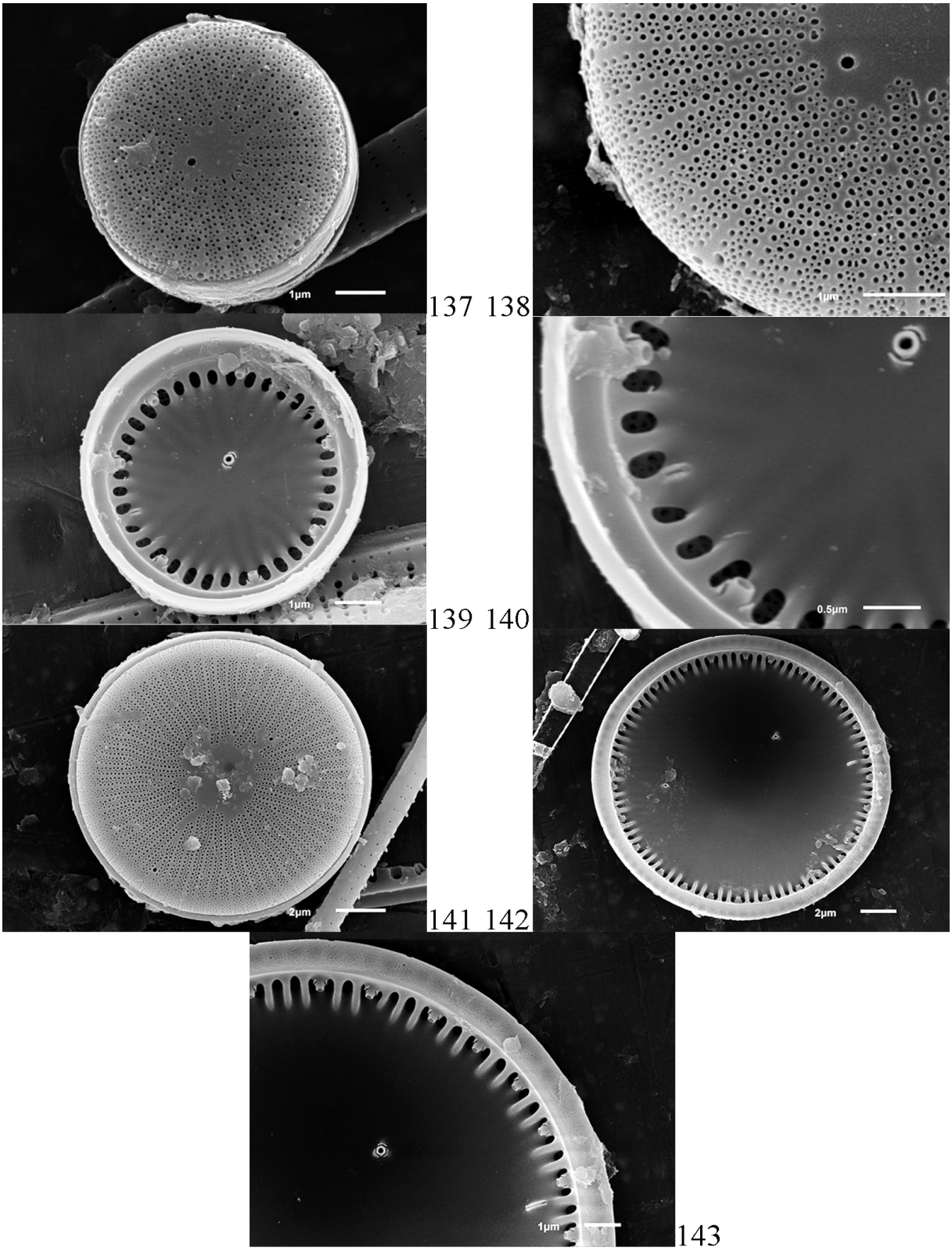

Figure 12. 137–140 – *Pantocsekiella delicatula* (Hustedt) K.T.Kiss & Ács (137, 138 – external view, 139, 140 – internal view); 141–143 – *Pantocsekiella iranica* (Nejadsattari, Kheiri, Spaulding & Edlund) K.T.Kiss, Ector & Ács (141 – external view, 142, 143 – internal view); 141, 142 – 2 µm; 137–139 & 143 – 1 µm; 140 – 0.5 µm.

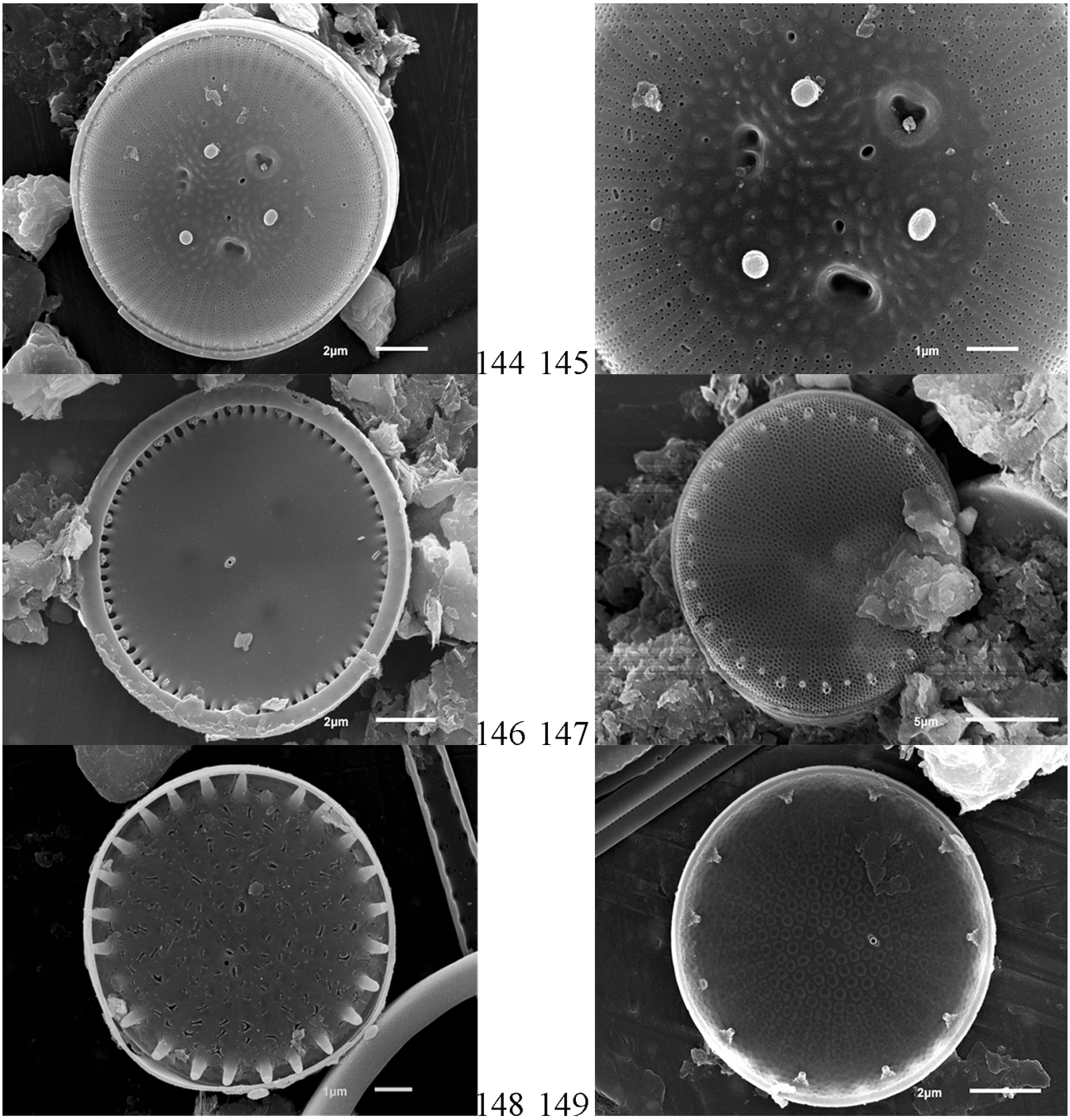

Figure 13. 144–146 – *Pantocsekiella ocellata* (Pantocsek) K.T.Kiss & Ács (144, 145 – external view, 146 – internal view); 147 – *Stephanodiscus hantzschii* Grunow in Cleve & Grunow; 148, 149 – *Stephanodiscus minutulus* (Kützing) Cleve & Möller; Scale bars: 147 – 5 µm; 144, 146 & 149 – 2 µm; 145 & 148 – 1 µm.

Distribution in river catchments: 6, 9 (Marmara river catchment), 20 (Sakarya river catchment), 33 (Meriç-Ergene river catchment).

Distribution in Turkey: This is a very rare species. It was found in the Eastern Black Sea and Anatolia (Fırat, Dicle, Aras, and Çoruh river catchments) regions.

3.11.3. *Stephanodiscus hantzschii* f. *tenuis* (Hustedt) Håkansson & Stoermer (Figure 10)

Basionym. *Stephanodiscus hantzschii* Hustedt

Ref. Krammer and Lange-Bertalot, 1991 (p. 74, fig. 75: 12, 14); Houk et al., 2014 (p. 43, fig. 139: 1–12, 140: 1–6).

Dimensions: Valve diameter 15.9–16.6 µm. There are 6–7 interstriae in 10 µm.
Distribution in river catchments: 9 (Marmara river catchment).
Distribution in Turkey: This is a new record for Turkey.

3.11.4. *Stephanodiscus minutulus* (Kützing) Cleve & Möller (Figures 10 and 13)

Basionym. *Cyclotella minuta* Kützing

Ref. Krammer and Lange-Bertalot, 1991 (p. 71, fig. 74: 5–7); Wojtal and Kwandrans, 2006 (p. 203, fig. 16: 21, 22, 18: 1, 2, 19: 11–19, 20: 1–7); Kiss et al., 2012 (p. 348, fig. 20: A–C); Bey and Ector, 2013 (Vol. 1, p. 70); Houk et al., 2014 (p. 37, fig. 118: 1–12).

Dimensions: Valve diameter 7.9–9.3 µm. There are 8–10 interstriae in 10 µm.

Distribution in river catchments: 20 (Sakarya river catchment) and 24 (Gediz river catchment).

Distribution in Turkey: This is a very rare species. The taxon was found only in the Fırat river catchment.

3.11.5. *Stephanodiscus neoastraea* Håkansson & Hickel (Figure 10)

Ref. Krammer and Lange-Bertalot, 1991 (p. 68, fig. 69: 3, 71: 3a–5b); Kiss et al., 2012 (p. 348, fig. 20: D–F); Bey and Ector 2013 (Vol. 1, p. 68); Houk et al., 2014 (p. 31, fig. 89: 1–6).

Dimensions: Valve diameter 12.8–19.5 µm. There are 7–10 interstriae in 10 µm.

Distribution in river catchments: 30 (Akarçay river catchment).

Distribution in Turkey: This is a new record for Turkey.

3.12. Relative abundances of the species

Regarding to relative abundance of the species, Samanlı Stream is remarkable with high centric diatom relative abundances: *Aulacoseira ambigua* was about 10%, *A. pusilla* and *Discostella pseudostelligera* were 5%–10%, and *A. granulata* and *Puncticulata ocellata* were about 5% each; hence, centric diatoms constituted between 35% and 40% of the diatoms in this stream. Murat and Şeytan Streams were also important stations with high relative abundances of *Conticribra weissflogii*, *Cyclotella distinguenda*, *Discostella stelligera*, and *D. stelligera* var. *tenuis* (5%–10%) (Table 2). Among the species, *Aulacoseira granulata* and *A. pusilla* were found in maximum relative abundances in 7 sampling sites (21.2%). The following taxa were found in samples at over 10% of the overall relative abundances: *Conticribra weissflogii*, *Cyclostephanos invisitatus*, *Cyclotella meneghiniana*, *Discostella pseudostelligera*, *Melosira varians*, *Pantocsekiella ocellata*, and *Stephanodiscus hantzschii*. *Aulacoseira ambigua*, *Cyclostephanos dubius*, *Cyclotella distinguenda*, *Lindavia balatonis*, *Pantocsekiella delicatula*, *P. iranica*, and *Stephanodiscus minutulus* were found in 5%–10% of the investigated sites (Figure 14).

The results of the principal coordinates analysis clearly demonstrated the separation of the diatom composition of the Marmara and Sakarya river catchments along the first axis (Figure 15). The explained variance for the first axis (λ1) is 11.02%, while it is 9.6% for the second axis (λ2) and 9.12% (λ3) for the third axis.

According to the SDR analysis results, the species replacement is higher in the rivers of the Marmara regions than in Sakarya and the richness difference is higher in rivers of the Sakarya region (Figure 16). The beta diversity is higher in the rivers of the Marmara region (Table 3).

4. Discussion

In this study, 30 centric diatoms in total were found from different river catchments in Central and Western Anatolia (Marmara, Aegean, and Thrace regions). Among them, *Aulacoseira pusilla*, *C. invisitatus*, *Cyclotella atomus* var. *gracilis*, *C. cryptica*, *Discostella pseudostelligera*, *D. stelligera* var. *tenuis*, *D. stelligeroides*, *Lindavia praetermissa*, *Orthoseira dendroteres*, *Pantocsekiella delicatula*, *P. iranica*, *Stephanodiscus balatonis*, *S. hantzschii* f. *tenuis*, and *S. neoastraea* are new records for the Turkish freshwater diatom flora.

Regarding the occurrence of species in Turkish freshwaters, *Conticribra weissflogii* and *Stephanodiscus minutulus* were reported only from the Fırat river catchment while *Cyclotella atomus* was identified from Inner Anatolia only. On the other hand, some rare species including *Aulacoseira ambigua*, *A. italica*, *Conticribra weissflogii*, *Cyclostephanos dubius*, *Cyclotella atomus*, *C. distinguenda*, *Discostella stelligera*, *Stephanodiscus hantzschii*, and *S. minutulus* and some common species in Turkish freshwaters, including *Aulacoseira granulata*, *Cyclotella meneghiniana*, *Lindavia radiosa*, and *Ellerbeckia arenaria*, were also found in the study. Considering the distribution of species in this study, *Aulacoseira ambigua*, *C. dubius*, *Cyclotella atomus* var. *atomus*, *C. atomus* var. *gracilis*, and *Lindavia praetermissa* were only found in the Marmara region. Moreover, *Aulacoseira pusilla* and *Stephanodiscus hantzschii* were found only in Yalova streams. *Cyclotella cryptica* and *Stephanodiscus triporus* were only found in Central Anatolia, while *Discostella stelligera* var. *stelligera*, *D. stelligera* var. *tenuis*, and *D. stelligeroides* were only found in the Thrace region (Meriç-Ergene river catchment). *Cyclotella distinguenda*, *Ellerbeckia arenaria*, *Lindavia radiosa*, *Lindavia balatonis*, *Melosira varians*, *Orthoseira dendroteres*, *Puncticulata delicatula*, *P. iranica*, and *Stephanodiscus minutulus* were only found in Kütahya streams. However, *Conticribra weissflogii*, *Cyclostephanos invisitatus*, and *Pantocsekiella ocellata* were commonly found in Central and Western Anatolia (Table 3). Among the species identified, *Lindavia balatonis* was recently cited as a rare and less widespread species (Kiss et al., 2012).

Table 2. Occurrence and abundance (%) of diatoms of the Coscinodiscophyceae recorded at 33 sampling points (Marmara River Catchment: 1- Ömerli Reservoir, 2- Terkos Reservoir, 3- Riva Stream, 4- Biga Stream, 5- Gönen Stream, 6- Korudere Stream-1,7- Korudere Stream-2, 8- Korudere Stream-3, 9- Korudere stream-4, 10- Gökçedere Stream, 11- Samanlıdere Stream-1, 12- Samanlıdere Stream-2, 13- Samanlıdere Stream-3, 14- Havuzdere Stream; Sakarya River Catchment: 15- Felent Stream, 16- Porsuk Stream, 17- Murat Stream, 18- Kokar Stream, 19- Türkmen Mountain-Darıpınar plateau, 20- Türkmen Mountain-İdris plateau; Susurluk River Catchment: 21- Topuk Stream, 22- Safa Stream, 23- spring in Domaniç forest; Gediz River Catchment: 24- Kocasu Stream, 25- Simav Stream; Kızırlırmak River Catchment: 26- Kızılırmak River-Karasu District, 27- Kızılırmak River-Osmancık District; Konya Closed Catchment: 28- Beyşehir Lake, 29- Çeltik Canal; Akarçay River Catchment: 30- Karadirek Stream, 31- spring in Sandıklı; Küçük Menderes River Catchment: 32- Beydağı Reservoir; Meriç-Ergene River Catchment: 33- Şeytan Stream).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Aulacoseira ambigua	1.7	--	--	--	--	--	--	--	--	--	10.4	6.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A. granulata	0.3	--	--	--	--	--	--	--	--	0.3	4.3	5.0	0.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	0.3	--
A. italica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--
A. pusilla	--	--	--	--	--	--	0.5	1.6	--	1.7	6.6	0.6	0.3	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conticribra weissflogii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	2.2	--	--	--	--	--	--	--	3.7	1.5	2.0	--	--	--	--	--
C. dubius	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.3	--	--	--	--	--	--	--	--	--	--	0.9	0.3	--	--
C. invisitatus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	5.3	--	1.3	--	--	--	3.0	--
Cyclotella var. *atomus*	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C. atomus var. *gracilis*	--	--	--	1.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C. cryptica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--
C. distinguenda	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C. meneghiniana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.2	3.4	--	1.3	--	--	--	--	1.0	--	--	--	--	--	--	--	1.0
Discostella pseudostelligera	0.3	--	--	--	--	--	--	--	--	--	5.2	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
D. stelligera	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.3
D. stelligera var. tenuis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.3
D. stelligeroides	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.3
Ellerbeckia arenaria	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lindavia balatonis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0	--	--	--	--	2.9	--	--	--	--	--	--	--	--	--
L. praetermissa	--	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
L. radiosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--
Melosira varians	--	--	--	--	--	--	--	--	--	--	--	--	--		1.0	0.7	0.6	--	1.7	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--
Orthoseira dendroteres	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--
Pantocsekiella delicatula	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--
P. iranica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	1.3	--	--	--	--	--	--	--	--	--
P. ocellata	--	--	--	--	--	--	--	--	--	--	4.7	5.7	--	1.2	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
Stephanodiscus balatonis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--
S. hantzschii	--	--	--	--	--	0.5	--	--	0.5	--	--	--	--	--	--	--	--	--	2.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
S. hantzschii f. *tenuis*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--
S. minutulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.7	--	--	--	--	4.7	--	--	--	--	--	--	--	--	--
S. neoastraea	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.9	--	--	--

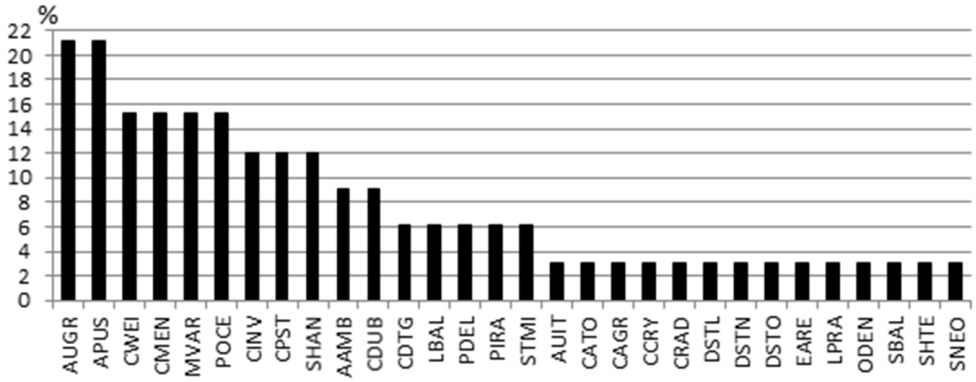

Figure 14. The occurrence frequency of centric diatom species in the investigated waters, expressed as the percentage of all sampling sites in this study where given species occurred (abbreviations of species names corresponding to the OMNIDIA program).

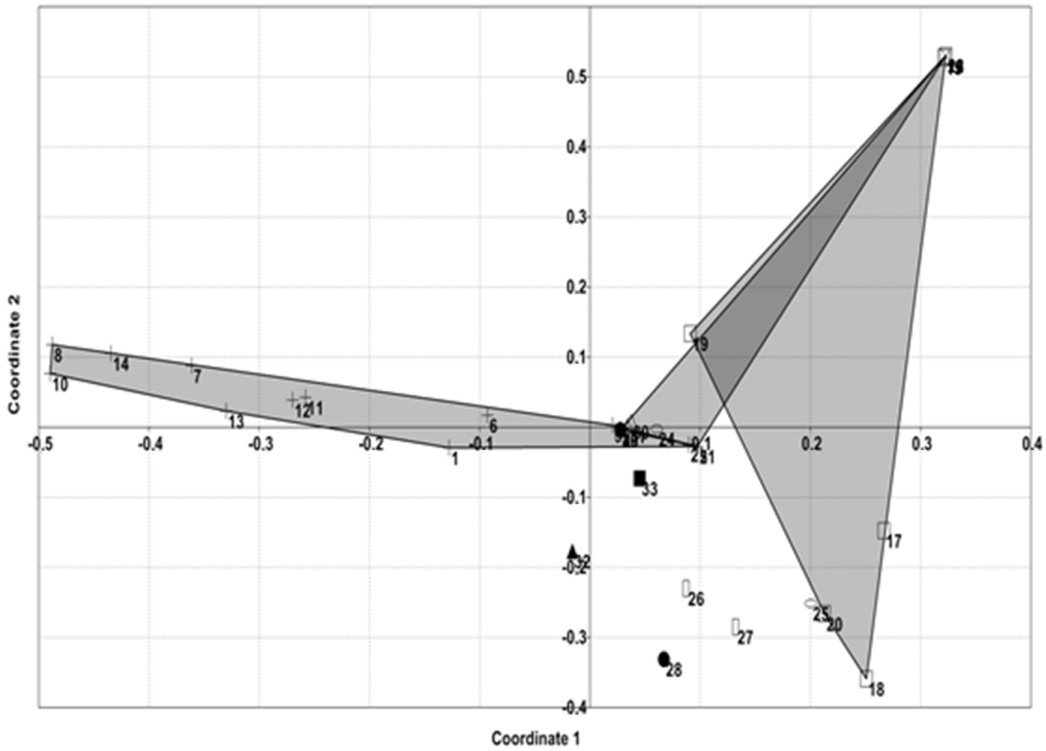

Figure 15. The distribution of the localities on the principal coordinates analyses axis (stations 1–14 in Marmara River Catchment - plus sign; 15–20 in Sakarya River Catchment - empty square; 21–23 in Susurluk River Catchment - cross; 24 and 25 in Gediz River Catchment - ellipse; 26 and 27 in Kızılırmak River Catchment - rectangle; 28 and 29 in Konya Closed Catchment - black circle; 30 and 31 in Akarçay River Catchment - empty triangle; 32 in Küçük Menderes River Catchment - black triangle; 33 in Meriç-Ergene River Catchment - black square).

In this study, almost half of the identified taxa were recorded as new for the Turkish freshwater diatom flora. The recorded diversity of diatoms in Turkey is relatively low compared to other parts of the world (e.g., in England by Hartley et al., 1996; in the Netherlands by Cremer and Koolmees, 2010; in Poland by Bąk et al., 2012). There are several reasons why the Turkish freshwater diatom flora, especially the centric diatoms, appears depauperate.

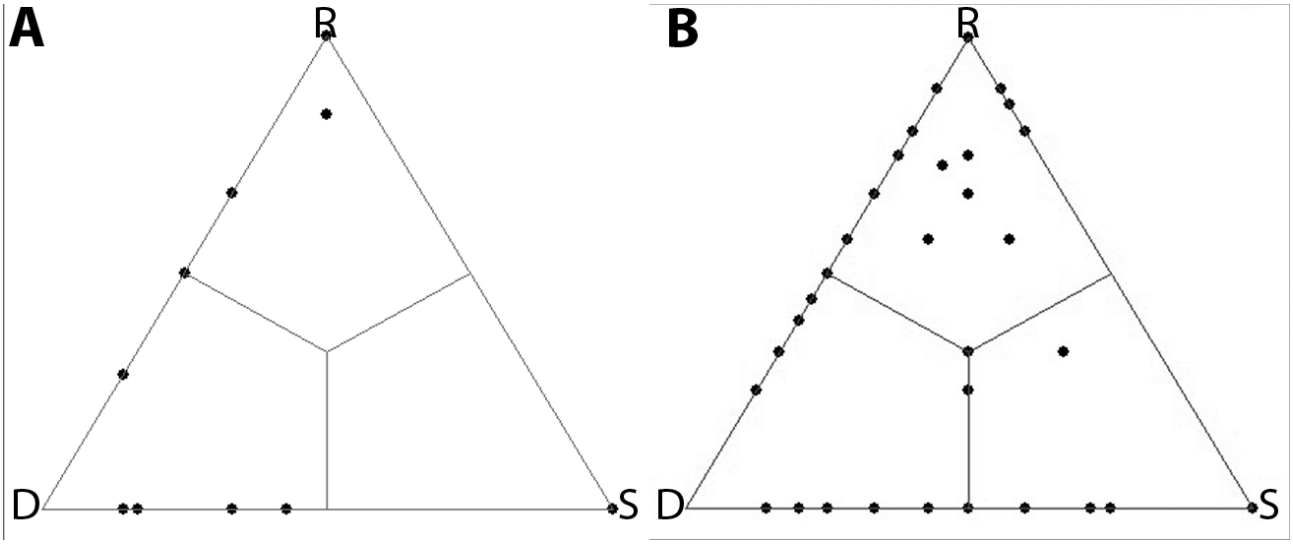

Figure 16. SDR simplex analysis results of Sakarya (a) and Marmara (b) rivers.

Table 3. SDR simplex analysis results of Sakarya and Marmara rivers.

	Marmara	Sakarya
Similarity (S)	11.2	17.4
Species replacement (R)	48.9	31.9
Richness difference (D)	39.9	50.7
Beta diversity	88.8	82.6
Nestedness (D + S)	51.1	78.1

First, some species have probably been confused with morphologically similar taxa. Second, most samples analyzed for diatom identification have been from periphyton (epilithon and epipelon) samples, and centric diatoms in particular occur mainly in the phytoplankton. A paradox is that studies of running waters are far less common than those from lakes and reservoirs in Turkish inland waters. Although phytoplankton studies dominate the literature with regard to the Turkish diatom flora, centric diatom reports are far less common than works on pennate diatoms.

Studies on the diatom flora of Turkey are important at local, regional, and national levels. The local flora should be carefully studied by using light and electron microscopes to accurately reveal the diversity of the country. These kinds of studies are also important for monitoring programs. The Turkish government has decided to follow the Water Framework Directive and the government is also trying to improve specific diatom indices for Turkish inland waters. For these reasons, some standards have been published about sampling and monitoring of waters recently. However, these indices assume correct taxonomic identification. It is hoped that studies such as this one will facilitate identification of the most common, and perhaps even some rare, species that occur in the Turkish freshwater flora.

Another important point is the distribution and occurrence of the identified taxa (e.g., rare or common). In this study, only the Marmara and Sakarya river catchments were compared by using similarity analysis because the number of the sampling points in these two catchments was larger than the other river catchments (14 and 6, respectively) (Table 4; Figures 15 and 16). The results showed that the diatom assemblages would be different in different regions.

Biogeographically, Turkey is not homogeneous; there are different climate zones in the country (Solak et al., 2012). Moreover, there are upland plateaus in Eastern Turkey (e.g., Aras or Çoruh river catchments in Erzurum or Kars) and lowland plateaus in Western Turkey (e.g., Gediz or Küçük Menderes river catchments in Aydın or

Table 4. The distribution of the species in Turkey according to Aysel (2005) and the current study (AKR- Akarçay, GDZ- Gediz, KN- Konya, KZ- Kızılırmak, MR- Marmara, MrEr- Meriç-Ergene, SKR- Sakarya, SSR- Susurluk river catchments).

	In Turkey	Current study	
	(Gönülol, 2006)	Status	River catchment
Aulacoseira ambigua	Rare	Rare	MR (Ömerli, Samanlıdere)
A. italica	Common	Rare	KZ (Karasu)
A. granulata	Common	Rare	MR (Ömerli, Gökçedere, Samanlıdere); MrEr (Beydağı)
A. pusilla	New record	Rare	MR (Korudere, Gökçedere, Samanlıdere, Havuzdere)
Aulacoseira sp	--	Rare	MR (Riva)
Conticribra weissflogii	Rare	Common	SKR (Kokar & Murat); KZ (Karasu); KN (Çeltik)
C. dubius	Rare	Common	SKR (Idris); AKR (Karadirek); KM (Sandıklı)
C. invisitatus	New record	Common	SKR(Kokar & Murat); KZ (Karasu); KN (Beyşehir)
Cyclotella atomus var. *atomus*	Rare	Rare	MR (Gökçedere)
C. atomus var. *gracilis*	New record	Rare	MR (Biga)
C. cryptica	New record	Rare	KN (Çeltik)
C. distinguenda	Rare	Rare	SKR (Kokar & Murat)
C. meneghiniana	Common	Common	SKR (Kokar & Murat, Darıpınar); GDZ (Simav); MrEr (Şeytan)
Discostella pseudostelligera	New record	Rare	MR (Ömerli, Samanlıdere & Havuzdere); MrEr (Şeytan)
D. stelligera	Rare	Rare	MrEr (Şeytan)
D. stelligera var. tenuis	New record	Rare	MrEr (Şeytan)
D. stelligeroides	New record	Rare	MrEr (Şeytan)
Ellerbeckia arenaria	Common	Rare	SKR (Murat)
Lindavia balatonis	Rare	Rare	SKR (Darıpınar); GDZ (Kocasu)
L. praetermissa	Rare	Rare	MR (Riva)
L. radiosa	Common	Rare	GDZ (Kocasu)
Melosira varians	Common	Rare	SKR (Porsuk, Felent, Murat & Kokar)
Orthoseira dendroteres	New record	Rare	SSR (a spring in Domaniç)
Pantocsekiella delicatula	New record	Rare	SKR (Murat); GDZ (Kocasu)
P. iranica	New record	Rare	SKR (Murat); GDZ (Kocasu)
P. ocellata	Common	Common	MR (Havuzdere & Samanlıdere); SKR (Darıpınar); MrEr (Şeytan)
Stephanodiscus balatonis	New record	Rare	AKR (Karadirek)
S. hantzschii	Common	Rare	MR (Korudere); SKR (Darıpınar); MrEr (Şeytan)
S. hantzschii f. *tenuis*	New record	Rare	MR (Korudere)
S. minutulus	Rare	Rare	SKR (Darıpınar); GDZ (Kocasu)
S. neoastraea	New record	Rare	AKR (Karadirek)

İzmir). The Marmara region comprises the coastal region encircling the Marmara Sea and Eastern Thrace. It belongs to both the Mediterranean and Black Sea climates and combines the vegetation appropriate to each. The central region, which includes the Konya closed and Kızılırmak river catchments, is characterized by dry plateau (Semple, 1921). It is expected that the presence, absence, and distribution of the species would be different in these regions. In many cases rare taxa are not recorded in the results of different publications about Turkish inland waters. However, these taxon records are important to biodiversity assessments (Gillett et al., 2011). We recommend that the species occurrences should be noted in water quality monitoring studies.

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