

Rare and new records of diatoms in Turkey from Kütahya flowing waters

by

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Abstract

Diatoms are one of the key organisms used in biomonitoring studies and they occur in a wide variety of environments, exhibiting a broad range of tolerance to abiotic factors. Historically, the first freshwater diatom study in Turkey was conducted in 1844 by Ehrenberg based on the material collected from the Murat and Aras Rivers. Situated between large continents (Eurasia and Africa), Turkey comprises areas of very diverse geological, climatic and environmental conditions, so we should expect that organisms such as diatoms show high diversity in this region. The aim of this study is to present new sites of rare and new records in Turkey from different genera along with morphological and ecological characteristics. As a result, a total of 73 species (24 rare and 49 new records) are presented in this study.

Key words: Diatom, New records, Kütahya, Running waters, Turkey

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Introduction

Ecologically and economically, aquatic ecosystems are important resources and, to this end, a framework for the management and protection of water resources in each main catchment basin across Europe was established in 2000, known as the European Water Framework Directive (WFD; Directive, 2000) (Kaiblinger et al. 2009). Diatoms are a very diverse group of algae (Mann 1999; Wojtal 2009) and good indicators in aquatic ecosystems. They occur in a wide variety of environments and show a broad range of tolerance along several gradients of abiotic factors (Blanco et al. 2008, Alakananda et al. 2011, Rimet 2012, Tornes & Sabater 2015).

Historically, the first freshwater diatom study in Turkey was conducted by Ehrenberg (1844) based on the material collected from the Murat and Aras Rivers. Subsequently, Schröder (1895) collected samples from Anatolia (the Tarsus River in Mersin) and Brunnthaler (1903) investigated diatoms from Lake Iznik. The above studies were followed by the study of Lake Van (the largest lake in Turkey) performed by Legler & Krasske (1940) and Gessner (1957). Numerous phycological studies have since been performed in different catchments in Turkey. These additional studies focused primarily on plankton diatoms, while riverine systems have received less attention. Situated between large continents (Eurasia and Africa), Turkey comprises areas of very diverse geological, climatic and environmental conditions, so we should expect that the diversity of diatoms is high in this region. The aim of this study is to present new sites of rare and new records of diatoms in Turkey from different genera along with morphological characteristics of the species identified.

Materials and methods

Study Area

Kütahya is a border between Inner and Western Anatolia, and Türkmen Mountain is particularly important because it serves as a barrier between the regions. There are three different river catchments in the study area: Sakarya, Susurluk and Gediz. In total, 21 locations were investigated in this study (Figure 1).

Sampling

Samples were collected at 21 locations. Epilithic samples were collected by brushing submerged stones and epipelagic samples were obtained by using a pipette aspirator. The samples were boiled with H_2O_2 and HCl

to remove the organic matter. After repeated washing with distilled water, the material was air-dried on cover glasses and mounted in Naphrax. Observations of the diatoms were performed partly at Szczecin University and Dumlupınar University. The micrographs were taken with a Nikon DS-Fi1 camera.

Diatoms were identified according to Krammer & Lange-Bertalot (1986-1991b), Reichardt (1999, 2001, 2009), Krammer (2000, 2002), Lange-Bertalot (2001), Lange-Bertalot et al. (2003), Werum & Lange-Bertalot (2004), Houk et al. (2010), Hofmann et al. (2011), Levkov et al. (2013), Lange-Bertalot & Wojtal (2014). The distribution of Turkish flora was prepared according to Gönülol (2016). We have attempted to use the latest classification system for freshwater diatoms (Fourtanier & Kociolek, 2011, Guiry & Guiry, 2016). Species and infraspecific taxa are arranged alphabetically in the text and plates. The size (length & breadth) of the species were measured using the ImageJ software program. Regarding the distribution within the borders of Turkey, taxa occurring in a limited number of studies are indicated as "rare". There are approximately 400 studies related to the diatoms in Turkish freshwaters and *rare* taxa are defined as those occurring in less than 2% of these studies.

Results

A total of 73 species (24 recognized as rare and 49 as new records) were identified in this study (Table 1).

Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkasson Fig. 2: 1, 2

Basionym. *Stephanodiscus invisitatus* Hohn & Hellermann

Ref. Krammer & Lange-Bertalot 1991a (p. 63, fig. 67: 3, 4).

Dimensions. Valve 8.03-9.89 μm in diameter and 15-16 striae in 10 μm .

Distribution in Kütahya running waters. Kocasu Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Cyclotella distinguenda Hustedt Fig. 2: 3-5

Ref. Krammer & Lange-Bertalot 1991a (p. 43, fig. 43: 1-11).



Figure 1

Distribution of the investigated localities (Sakarya River Catchment 1 – Türkmen Mountain spring, 2 – Felent Stream, 3 – Porsuk Stream, 4 – Murat Stream, 5 – Kokar Stream, 6 – Ilıca Stream; Susurluk river catchment 7 – Ilıcaksu, 8 – Kocasu Stream, 9 – Emet Stream, 10 – Hisarcık Stream, 11 – Domaniç forest, 12 – Safa Stream, 13 – Muhacırköy district, 14 – Güneyköy district, 15 – Kırık Stream; Gediz river catchment, 16 – Gediz river, 17 – Simav Stream, 18 – Kocaçay Stream, 19 – Naşa district, 20 – Eynal district, 21 – Maden Mountain)

Dimensions. Valve 9.72-16.16 μm in diameter and 12-20 striae in 10 μm .

Distribution in Kütahya running waters. Kokar Stream (Sakarya river catchment) and Gediz Stream (Gediz river catchment).

Distribution in Turkey. Previously found at a few sites in Western Anatolia (Sakarya river catchment-Acarlar forest– Tunca et al. 2014, Poyrazlar reservoir – Olgun-Sevindik et al. 2015), Northern Anatolia (Yeşilirmak river catchment-Simenit Lake – Ersanlı & Gönülol 2006), Eastern Anatolia (Fırat river catchment-Köprüköy – Altuner & Pabuçcu 1993, 1994, Aras-Demirdöven Reservoir – Kıvrak & Gürbüz 2005 and Tortum Lake – Altuner 1984).

Lindavia balatonis (Pantocsek) T. Nakov et al. Fig. 2: 6, 7

Basionym. *Cyclotella balatonis* Pantocsek

Ref. Houk et al. 2010 (p. 39, pl. 269).

Dimensions. Valve 8.71-27.32 μm in diameter and 13-19 striae in 10 μm .

Distribution in Kütahya running waters. Kocasu and Emet Stream (Gediz river catchment) and spring in Türkmen Mountain (Sakarya river catchment).

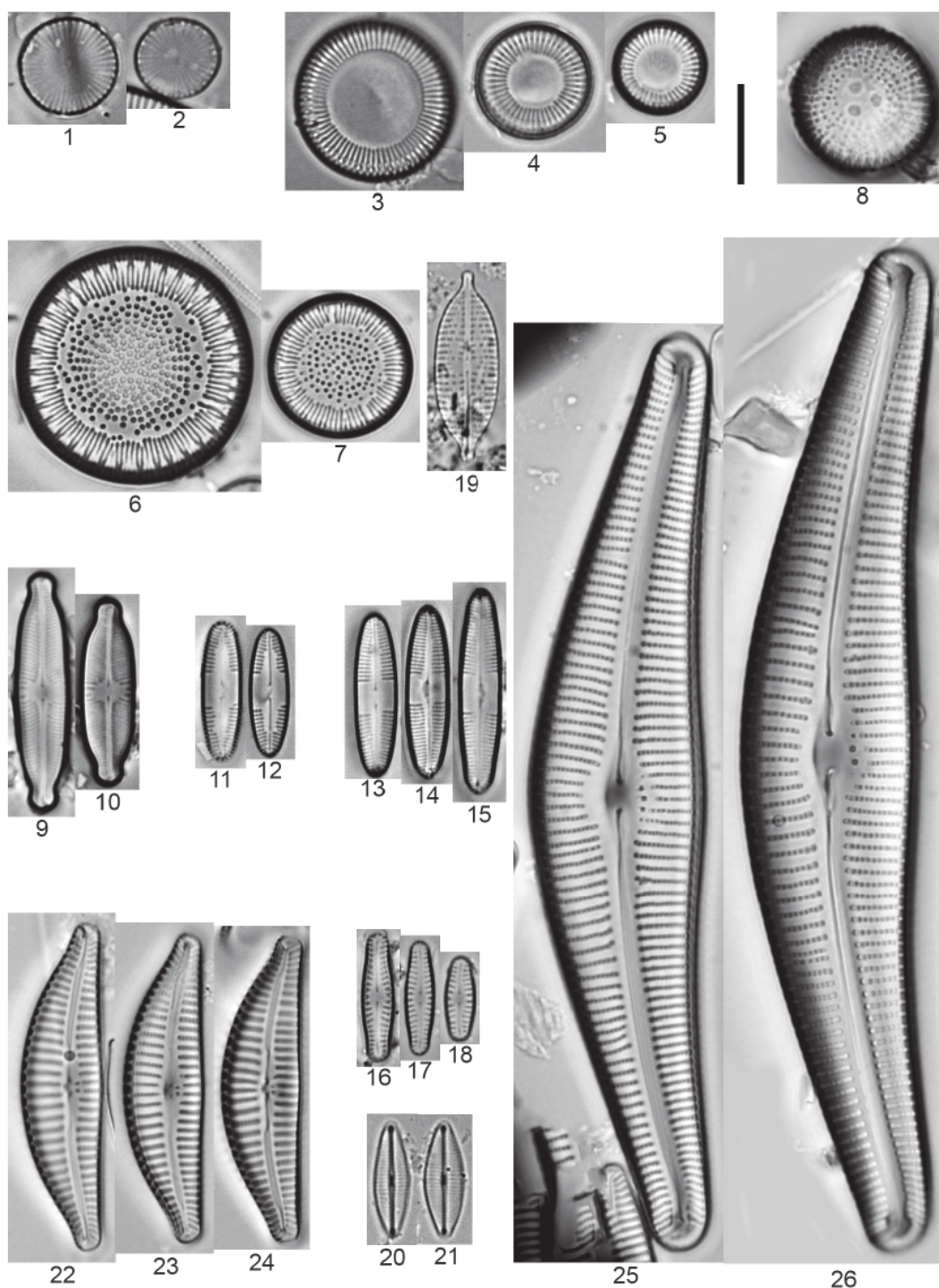
Distribution in Turkey. It was found in Western Anatolia (Susurluk river catchment-Felent Creek – Solak & Kulikovskiy 2013).

Table 1

Occurrence of diatoms from Coscinodiscophyceae recorded at 21 sampling points (Sakarya River Catchment 1 – Türkmen Mountain spring, 2 – Felent Stream, 3 – Porsuk Stream, 4 – Murat Stream, 5 – Kocar Stream, 6 – Ilıca Stream; Susurluk river catchment 7 – Ilıcaksu, 8 – Kocasu Stream, 9 – Emet Stream, 10 – Hisarcık Stream, 11 – Domaniç forest, 12 – Safa Stream, 13 – Muhacırköy district, 14 – Güneyköy district, 15 – Kırık Stream; Gediz river catchment 16 – Gediz river, 17 – Simav Stream, 18 – Kocaçay Stream, 19 – Naşa district, 20 – Eynal district, 21 – Maden Mountain. Abbreviation: NR – New record)

		Sakarya						Susurluk									Gediz					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Centric Diatoms																						
<i>Cyclostephanos invisitatus</i> (Hohn & Helleman) Theriot et al.	NR								+													
<i>Cyclotella distinguenda</i> Hustedt						+											+					
<i>Lindavia balatonis</i> (Pantocsek) T.Nakov et al.		+							+	+												
<i>Orthoseira dendroteres</i> (Ehrenberg) Genkal & Kulikovskiy	NR											+										
Pennate Diatoms																						
<i>Adlafia brockmannii</i> (Hustedt) Bruder & Hinz	NR	+																				
<i>Caloneis fontinalis</i> (Grunow) A.Cleve	NR	+																				
<i>Caloneis lancettula</i> (Schulz) Lange-Bertalot & Witkowski	NR	+																				
<i>Chamaepinnularia submuscicola</i> (Krasske) Lange-Bertalot	NR	+				+							+									
<i>Craticula citrus</i> (Krasske) Reichardt	NR		+																			
<i>Craticula molestiformis</i> (Hustedt) Lange-Bertalot	NR	+											+						+			
<i>Cymbella affinis</i> Krammer	NR	+																				
<i>Cymbella neocistula</i> Krammer		+																				
<i>Cymbella subleptoceros</i> Krammer	NR	+																				
<i>Decussata hexagona</i> (Torka) Lange-Bertalot	NR	+																				
<i>Eolimna subminuscula</i> (Manguin) Moser et al.		+																				
<i>Fallacia insociabilis</i> (Krasske) D.G.Mann	NR																		+			
<i>Fallacia monoculata</i> (Hustedt) D.G.Mann	NR		+		+							+										
<i>Fallacia pygmaea subsp. subpygmaea</i> Lange-Bertalot et al.	NR				+																	
<i>Fallacia subhamulata</i> (Grunow) D.G.Mann	NR		+	+	+		+		+													
<i>Fistulifera saprophila</i> (Lange-Bertalot & Bonik) Lange-Bertalot	NR	+																				
<i>Fragilaria famelica</i> (Kützing) Lange-Bertalot		+												+								
<i>Fragilaria perminuta</i> (Grunow) Lange-Bertalot	NR															+						
<i>Fragilaria recapitellata</i> Lange-Bertalot& Metzeltin					+								+					+				
<i>Frustulia spicula</i> Amossé	NR	+																				
<i>Gomphonema insigne</i> W. Gregory					+															+		
<i>Gomphonema angustius</i> Reichardt	NR																	+				
<i>Gomphonema insignifine</i> Reichardt	NR																			+		
<i>Gomphonema vibrio</i> Ehrenberg					+				+													
<i>Gomphonema italicum</i> Kützing	NR			+	+																	
<i>Gomphonema laticollum</i> Reichardt	NR	+		+																		
<i>Gomphonema pumilum</i> (Grunow) Reichardt & Lange-Bertalot	NR												+		+	+						
<i>Gomphonema pumilum var. rigidum</i> Reichardt & Lange-Bertalot	NR												+			+						

<i>Gomphonema stoei</i> Reichardt	NR					+													
<i>Gomphonema supertergestinum</i> Reichardt	NR		+				+												
<i>Gomphonema tergestinum</i> (Grunow) Fricke									+								+		
<i>Humidophila contenta</i> (Grunow) Lowe et al.				+		+			+										
<i>Luticola angusta</i> Solak & Levkov		+																	
<i>Luticola kemalii</i> Solak & Levkov		+																	
<i>Luticola rotunda</i> Solak & Levkov		+																	
<i>Luticola vesnea</i> Levkov	NR	+																	
<i>Mayamaea agrestis</i> (Hustedt) Lange-Bertalot	NR	+																	
<i>Mayamaea aliena</i> (Krasske) Lange-Bertalot	NR	+																	
<i>Mayamaea asellus</i> (Weinhold ex Hustedt) L-B	NR								+										
<i>Mayamaea excelsa</i> (Krasske) Lange-Bertalot		+																	
<i>Mayamaea permitis</i> (Hustedt) Bruder & Medlin	NR	+																	
<i>Muelleria gibbula</i> (Cleve) Spaulding & Stoermer		+																	
<i>Navicula antonii</i> Lange-Bertalot	NR			+			+	+		+			+			+	+		+
<i>Navicula arvensis</i> var. <i>major</i> Lange-Bertalot	NR	+																	
<i>Navicula cariocincta</i> Lange-Bertalot	NR	+																	
<i>Navicula cryptotenelloides</i> Lange-Bertalot		+																	
<i>Navicula kotschy</i> Grunow							+							+					
<i>Navicula libonensis</i> Schoeman			+	+					+	+						+			
<i>Navicula novaesiberica</i> Lange-Bertalot	NR									+									
<i>Navicula reichardtiana</i> Lange-Bertalot			+	+					+							+			
<i>Navicula seibigiana</i> Lange-Bertalot	NR	+																	
<i>Navicula subalpina</i> Reichardt	NR								+										
<i>Navicula tantula</i> Hustedt	NR	+																	
<i>Navicula tenelloides</i> Hustedt	NR	+																	
<i>Navicula viridulacalis</i> Lange-Bertalot	NR								+										
<i>Nitzschia angustatula</i> Lange-Bertalot				+	+	+			+										
<i>Nitzschia bruno</i> Lange-Bertalot	NR			+	+	+			+										
<i>Nitzschia draveillensis</i> Coste & Ricard				+													+	+	+
<i>Nitzschia thermaloides</i> Hustedt	NR													+					
<i>Nitzschia vitrea</i> var. <i>salinarum</i> Grunow	NR													+					
<i>Pinnularia nodosa</i> (Ehrenberg) W. Smith		+																	
<i>Pinnularia viridiformis</i> Krammer		+																	
<i>Placoneis cracoviensis</i> Lange-Bertalot & Wojtal	NR	+																	
<i>Placoneis undulata</i> (Østrup) Lange-Bertalot	NR																		+
<i>Sellaphora bacilloides</i> (Hustedt) Levkov et al.		+																	
<i>Sellaphora radiosa</i> (Hustedt) H. Kobayasi		+																	
<i>Sellaphora seminulum</i> (Grunow) D.G. Mann		+																	
<i>Sellaphora stroemii</i> (Hustedt) H. Kobayasi	NR									+									
<i>Sellaphora verecundiae</i> Lange-Bertalot	NR	+																	

**Figure 2**

1, 2 – *Cyclostephanos invisitatus* (Hohn & Hellerman) Theriot, Stoermer & Håkasson; 3–5 – *Cyclotella distinguenda* Hustedt; 6, 7 – *Lindavia balatonis* (Pantocsek) T. Nakov et al.; 8 – *Orthoseira dendroteres* (Ehrenberg) Genkal & Kulikovskiy; 9, 10 – *Adlafia brockmannii* (Hustedt) Bruder & Hinz; 11, 12 – *Caloneis fontinalis* (Grunow) Lange-Bertalot & Reichardt; 13–15 – *C. lancettula* (Schulz) Lange-Bertalot & Witkowski; 16–18 – *Chamaepinnularia submusculicola* (Krasske) Lange-Bertalot; 19 – *Craticula citrus* (Krasske) Reichardt; 20, 21 – *C. molestiformis* (Hustedt) Lange-Bertalot; 22–24 – *Cymbella affniformis* Krammer; 25, 26 – *C. neocistula* Krammer. Scale bar: 10 µm

Orthoseira dendroteres (Ehrenberg) Genkal & Kulikovskiy Fig. 2: 8

Basionym. *Liparogyra dendroteres* Ehrenberg

Ref. Krammer & Lange-Bertalot 1991a (p. 12, fig. 12: 1-7).

Dimensions. Valve 14.69 µm in diameter and 11 striae in 10 µm.

Distribution in Kütahya running waters. Spring in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Adlafia brockmannii (Hustedt) Bruder & Hinz Fig. 2: 9, 10

Basionym. *Navicula brockmannii* Hustedt

Ref. Krammer & Lange-Bertalot 1986 (p. 183, fig. 79: 16-17).

Dimensions. Valve 18.98-24.07 µm length and 5.65-5.82 µm breadth, 25-28 striae in 10 µm.

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Caloneis fontinalis (Grunow) Lange-Bertalot & Reichardt Fig. 2: 11, 12

Basionym. *Navicula fontinalis* Grunow

Ref. Hofmann et al. 2011 (p. 117, fig. 67: 15-19).

Dimensions. Valve 12.92-14.05 µm length and 4.18 µm breadth, 24-28 striae in 10 µm.

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Caloneis lancettula (Schulz) Lange-Bertalot & Witkowski Fig. 2: 13-15

Basionym. *Caloneis aemula* var. *lancettula* Schultz

Ref. Hofmann et al. 2011 (p. 117, fig. 67: 1-9).

Dimensions. Valve 14.21-22.53 µm length and 4.05-4.48 µm breadth, 22-30 striae in 10 µm.

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Chamaepinnularia submusculicola (Krasske) Lange-Bertalot Fig. 2: 16-18

Basionym. *Navicula submusculicola* Krasske

Ref. Hofmann et al. 2011 (p. 129, fig. 50: 31-36)

Dimensions. Valve 7.22-14.12 µm length and 2.24-3.35 µm breadth, 18-22 striae in 10 µm.

Distribution in Kütahya running waters. Spring in Türkmen Mountain, Kokar Stream (Sakarya river catchment) and Safa Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Craticula citruss (Krasske) Reichardt Fig. 2: 19

Basionym. *Navicula citruss* Krasske

Ref. Krammer & Lange-Bertalot 1986 (p. 169, fig. 58: 6-8).

Dimensions. Valve 19.15 µm length and 6.61 µm breadth, 17 striae in 10 µm.

Distribution in Kütahya running waters. Felent Stream (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Craticula molestiformis (Hustedt) Lange-Bertalot Fig. 2: 20, 21

Basionym. *Navicula molestiformis* Hustedt

Ref. Hofmann et al. 2011 (p. 140, fig. 45: 16-20).

Dimensions. Valve 11.70-11.87 µm length and 3.25-4.18 µm breadth.

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment), Sefa Streams (Susurluk river catchment) and Kocaçay (Gediz river catchment).

Distribution in Turkey. NEW RECORD.

Cymbella affiniformis Krammer Fig. 2: 22-24

Ref. Krammer 2002 (p. 45, fig. 25; 1-8).

Dimensions. Valve 23.41-37.12 μm length and 6.71-10.07 μm breadth, 10-12 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Cymbella neocistula Krammer Fig. 2: 25, 26

Ref. Krammer 2002 (p. 94, fig. 85: 1-4; 86: 1-7; 87: 1-9; 88: 1-8), Hofmann et al. 2011 (p. 155, fig. 79: 11-15).

Dimensions. Valve 32.25-100.17 μm length and 12.23-18.08 μm breadth, maximum length/breadth ratios about 6.1 and 9-11 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. It was found only in Western Anatolia (Sakarya river catchment-Felent Creek – Solak et al. 2012).

Cymbella subleptoceros Krammer Fig. 3: 27-29

Ref. Krammer 2002 (p. 133, fig. 154: 2-17; 155: 1-7).

Dimensions. Valve 14.21-7.36 μm length and 6.12-10.47 μm breadth, 9-13 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Decussata hexagona (Torka) Lange-Bertalot Fig. 3: 30

Basionym. *Navicula hexagona* Torka

Ref. Krammer & Lange-Bertalot 1986 (p. 235, fig. 82: 5, 6).

Dimensions. Valve 16.21-41.48 μm length and 8.48-12.35 μm breadth, 23-28 striae 10 μm .

Distribution in Turkey. NEW RECORD.

Eolimna subminuscula (Manguin) Moser, Lange-Bertalot & D.Metzeltin Fig. 3: 31, 32

Basionym. *Navicula subminuscula* Manguin

Ref. Krammer & Lange-Bertalot 1986 (p. 223, fig. 76: 21-26).

Dimensions. Valve 8.36-12.41 μm length and 3.73-5.57 μm breadth, 17-27 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously found only in Inner Anatolia (Kızılırmak river catchment-Karagöl Lake – Açıkgöz & Baykal 2005).

Fallacia insociabilis (Krasske) D.G.Mann Fig. 3: 33, 34

Basionym. *Navicula insociabilis* Krasske

Ref. Krammer & Lange-Bertalot 1986 (p. 175, fig. 66: 1-4).

Dimensions. Valve 9.53-9.79 μm length and 3.75-3.99 μm breadth, 24-26 striae in 10 μm .

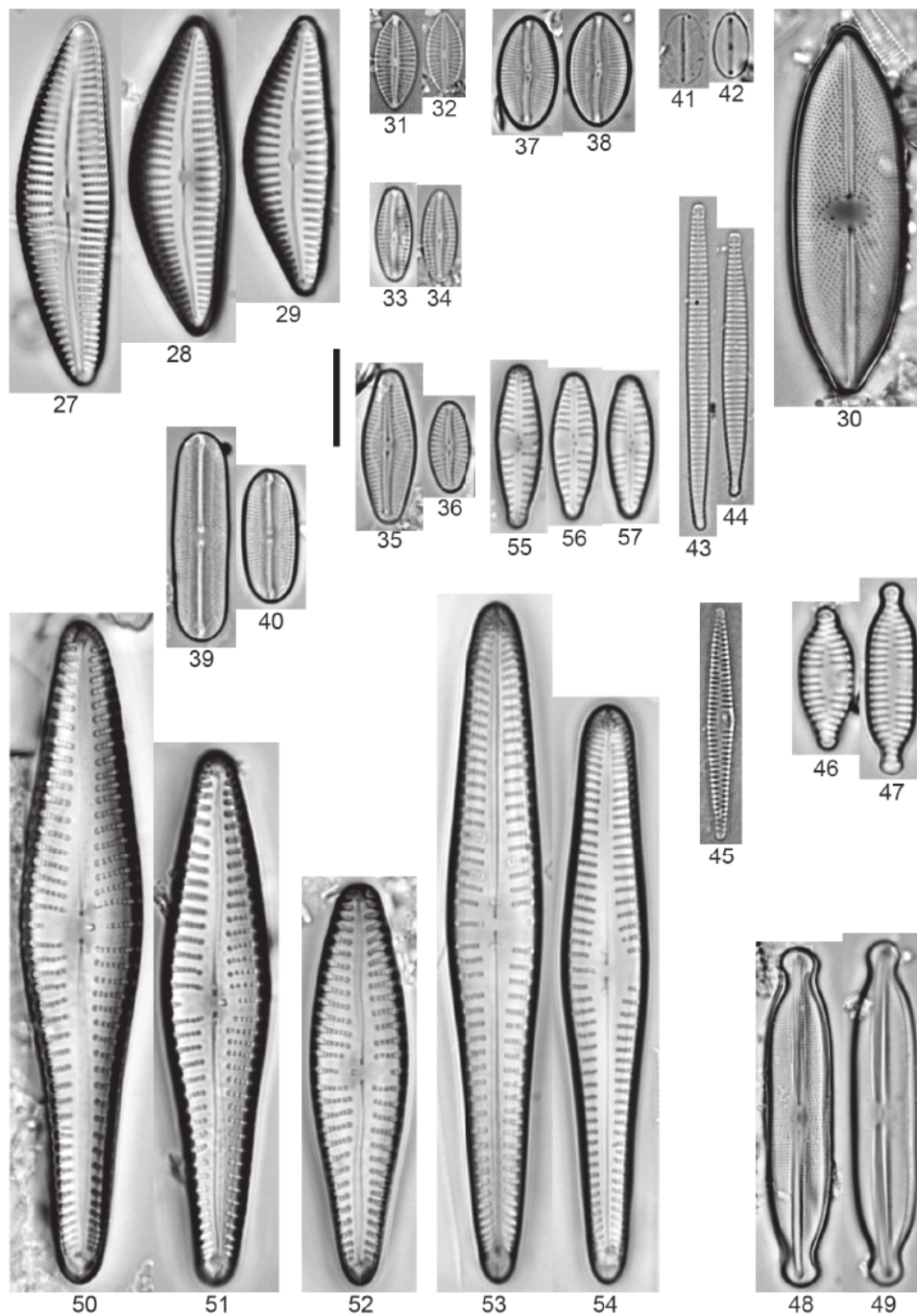
Distribution in Kütahya running waters. Kocaçay Stream (Gediz river catchment).

Distribution in Turkey. NEW RECORD.

Fallacia monoculata (Hustedt) D.G.Mann Fig. 3: 35, 36

Basionym. *Navicula monoculata* Hustedt

Ref. Krammer & Lange-Bertalot 1986 (p. 174, fig. 66: 17, 18).

**Figure 3**

27-29 – *Cymbella subleptoceros* Krammer; 30 – *Decussata hexagona* (Torka) Lange-Bertalot; 31, 32 – *Eolimna subminuscule* (Manguin) Moser, Lange-Bertalot & Metzeltin; 33, 34 – *Fallacia insociabilis* (Krasske) Mann; 35, 36 – *F. monoculata* (Hustedt) Mann; 37, 38 – *F. pygmaea* ssp. *subpygmaea* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito; 39, 40 – *F. subhamulata* (Grunow) Mann; 41, 42 – *Fistulifera saprophila* (Lange-Bertalot & Bonik) Lange-Bertalot; 43, 44 – *Fragilaria famelica* (Kützinger) Lange-Bertalot; 45 – *F. perminuta* (Grunow) Lange-Bertalot; 46, 47 – *F. recapitulata* Lange-Bertalot & Metzeltin; 48, 49 – *Frustulia spicula* Amossé; 50, 51 – *Gomphonema insigne* W. Gregory Andrews; 52 – *G. angustius* Reichardt; 53, 54 – *G. insignifforme* Reichardt; 55-57 – *G. vibrio* Ehrenberg. Scale bar: 10 µm

Dimensions. Valve 8.16–15.82 μm length and 4.13–5.71 μm breadth, 21–24 striae in 10 μm .

Distribution in Kütahya running waters. Felent and Murat Stream (Sakarya river catchment) and spring in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Fallacia pygmaea ssp. subpygmaea Lange-Bertalot, Cavacini, Tagliaventi & Alfinito Fig. 3: 37, 38

Ref. Lange-Bertalot et al. 2003 (p. 46, fig. 81: 1–9).

Dimensions. Valve 11.33–11.87 μm length and 6.21–6.67 μm breadth, 29–30 striae in 10 μm .

Distribution in Kütahya running waters. Murat Stream (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Fallacia subhamulata (Grunow) D.G.Mann Fig. 3: 39, 40

Basionym. *Navicula subhamulata* Grunow

Ref. Krammer & Lange-Bertalot 1986 (p. 192, fig. 66: 32–34).

Dimensions. Valve 11.71–24.81 μm length and 5.88–6.05 μm breadth.

Distribution in Kütahya running waters. İlica, Felent, Murat, Porsuk Streams (Sakarya river catchment) and Kocasu Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Fistulifera saprophila (Lange-Bertalot & Bonik) Lange-Bertalot Fig. 3: 41, 42

Basionym. *Navicula saprophila* Lange-Bertalot & Bonik

Ref. Krammer & Lange-Bertalot 1986 (p. 207, fig. 74: 34, 35).

Dimensions. Valve 6.21–7.81 μm length and 3.73–4.43 μm breadth.

Distribution in Kütahya running waters. Spring

in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Fragilaria famelica (Kützinger) Lange-Bertalot Fig. 3: 43, 44

Basionym. *Synedra famelica* Kützinger

Ref. Hofmann et al. 2011 (p. 263, fig. 8: 11–21).

Dimensions. Valve 26.82–43.54 μm length and 2.18–2.34 μm breadth, 17–19 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment) and Muhacırköy district (Susurluk river catchment).

Distribution in Turkey. Previous record of this taxon is from Eastern Anatolia (Çoruh river catchment-Tortum Waterfall-Kivrak & Gürbüz 2006), Inner Anatolia (Konya closed basin-Melendiz Stream – Sivacı & Dere 2007) and Southern Anatolia (Burdur river catchment-Darıören & Isparta Streams – Çiçek et al. 2010).

Fragilaria perminuta (Grunow) Lange-Bertalot Fig. 3: 45

Basionym. *Synedra perminuta* Grunow in Van Heurck

Ref. Hofmann et al. 2011 (p. 271, fig. 8: 28–31).

Dimensions. Valve 23.69 μm length and 2.79 μm breadth, 20 striae in 10 μm .

Distribution in Kütahya running waters. Güneyköy district (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Fragilaria recapitellata Lange-Bertalot & Metzeltin Fig. 3: 46, 47

Ref. Hofmann et al. 2011 (p. 271, fig. 8: 28–31).

Dimensions. Valve 11.22–24.41 μm length and 3.84–5.57 μm breadth, 14–17 striae in 10 μm .

Distribution in Kütahya running waters. Safa Stream (Susurluk river catchment), Murat Stream (Sakarya river catchment), Simav Stream (Gediz river catchment).

Distribution in Turkey. It was found only in Inner Anatolia (Konya-closed basin-Beyşehir Lake – Cirić et al. 1991).

Frustulia spicula Amossé Fig. 3: 48, 49

Ref. Lange-Bertalot 2001 (p. 174, fig. 138: 1-4).

Dimensions. Valve 34.80-36.54 μm length and 6.44-7.23 μm breadth, 31-33 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment)

Distribution in Turkey. NEW RECORD.

Gomphonema insigne W. Gregory Fig. 3: 50, 51

Ref. Krammer & Lange-Bertalot 1986 (p. 366, fig. 161).

Dimensions. Valve 54.69-68.02 μm length and 11.07-12.66 breadth, 7-8 striae in 10 μm .

Distribution in Kütahya running waters. Murat Stream (Sakarya river catchment) and Naşa district (Gediz river catchment).

Distribution in Turkey. It was found only in Inner Anatolia (Kızılırmak river catchment-Karagöl Lake – Açıkgöz & Baykal 2005), Southern Anatolia (Antalya river catchment-Darıören and Isparta Streams – Çiçek et al. 2010).

Gomphonema angustius Reichardt Fig. 3: 52

Ref. Reichardt 2009 (p. 161, fig. 9-30).

Dimensions. Valve 14.97-16.94 μm length and 5.01-5.11 breadth, 11-13 striae in 10 μm .

Distribution in Kütahya running waters. Simav Stream (Gediz river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema insignaffine Reichardt Fig. 3: 53, 54

Ref. Reichardt 2009 (p. 164, fig. 31-42).

Dimensions. Valve 41.13 μm length and 9.94 breadth, 7 striae in 10 μm .

Distribution in Kütahya running waters. Naşa district (Gediz river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema vibrio Ehrenberg Fig. 3: 55-57

Ref. Bık et al. 2012 (p. 184, pl. 66).

Dimensions. Valve 59.1-69.60 μm length and 8.93-10.06 μm breadth, 7-11 striae in 10 μm .

Distribution in Kütahya running waters. Murat Stream (Sakarya river catchment) and Kocasu Stream (Susurluk river catchment).

Distribution in Turkey. This species was previously found only in Blacksea (Eastern Blacksea river catchment-Uzungöl Lake – Şahin 1998) and Western Anatolia (Büyük Menderes river catchment-Akçay Stream-Solak et al. 2005 and Sakarya river catchment-Porsuk River – Yıldız 1987).

Gomphonema italicum Kützing Fig. 4: 58, 59

Ref. Reichardt 2001 (p. 202, fig. 6: 1-24).

Dimensions. Valve 35.48-41.54 μm length and 10.73-13.08 breadth, 11-13 striae in 10 μm .

Distribution in Kütahya running waters. Porsuk and Murat Streams (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema laticollum Reichardt Fig. 4: 60, 61

Ref. Reichardt 2001 (p. 199, fig. 5: 1-14).

Dimensions. Valve 49.38-52.98 μm length and 11.44-11.98 breadth, 10-11 striae in 10 μm .

Distribution in Kütahya running waters. Porsuk Stream and Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot Fig. 4: 62-64

Ref. Hofmann et al. 2011 (p. 315, fig. 97: 10-14).

Dimensions. Valve 18.23-24.14 μm length and 3.80-5.27 μm breadth, 12-13 striae in 10 μm .

Distribution in Kütahya running waters. Muhacırköy district, Güneyköy district and spring in Domanıç forests (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema pumilum* var. *rigidum Reichardt & Lange-Bertalot Fig. 4: 65-67

Ref. Hofmann et al. 2011 (p. 315, fig. 97: 15-20).

Dimensions. Valve 17.78-25.61 μm length and 4.40-5.42 μm breadth, 12-13 striae in 10 μm .

Distribution in Kütahya running waters. Güneyköy district and spring in Domanıç forests (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema stonei Reichardt Fig. 4: 68, 69

Ref. Reichardt 1999 (p. 16, fig. 13: 1-17).

Dimensions. Valve 33.50-41.88 μm length and 8.66-9.60 μm breadth, 10-13 striae in 10 μm .

Distribution in Kütahya running waters. Ilıcaksu (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema supertergestinum Reichardt Fig. 4: 70, 71

Ref. Reichardt 2009 (p. 168, fig. 66-81, 93-96).

Dimension. Valve 25.58-32.21 μm length and 7.31-8.63 μm breadth, 11-12 striae in 10 μm .

Distribution in Kütahya running waters. Porsuk Stream (Sakarya river catchment), Kocasu (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Gomphonema tergestinum (Grunow) Fricke Fig. 4: 72-74

Basionym. *Gomphonema semiapertum* var. *tergestinum* Grunow

Ref. Hofmann et al. 2011 (p. 317, fig. 96: 22-26).

Dimensions. Valve 17.30-19.74 μm length and 5.70-5.92 μm breadth, 14-15 striae in 10 μm .

Distribution in Kütahya running waters. Hisarcık Stream (Gediz river catchment) and Kocaçay Stream (Gediz river catchment).

Distribution in Turkey. This taxon was previously found only in Inner Anatolia (Konya closed basin-Hotamış Marshes – Yıldız et al. 1998, Hirfanlı reservoir – Baykal & Açıkgöz 2004 & Çamlıdere reservoir – Baykal 2006) and Blacksea (Eastern Blacksea river catchment-Uzungöl Lake – Şahin 1998).

Humidophila contenta (Grunow) Lowe, Kociolek, Johansen, Van de Vijver, Lange-Bertalot & Kopalová Fig. 4: 75-77

Basionym. *Navicula contenta* Grunow

Ref. Hofmann et al. 2011 (p. 170, fig. 49: 36-40).

Dimensions. Valve 7.32-13.22 μm length and 2.49-3.52 μm breadth.

Distribution in Kütahya running waters. Kokar Stream (Sakarya river catchment) and spring in Domanıç forest, Ilıcaksu (Susurluk river catchment).

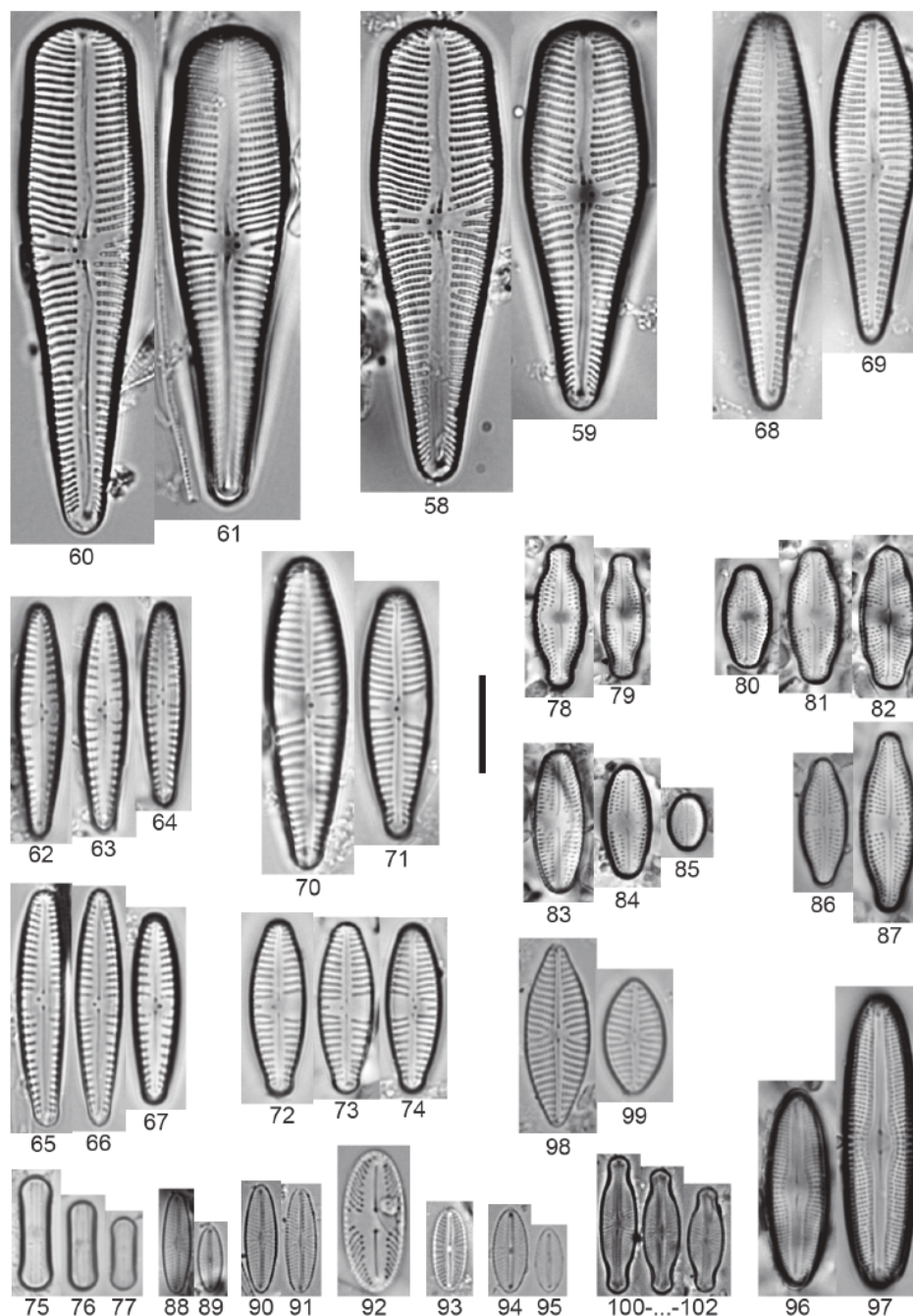
Distribution in Turkey. It was found only in Inner Anatolia (Kızılırmak river catchment-Çamlıdere Reservoir – Baykal 2006).

Luticola angusta Solak & Levkov Fig. 4: 78, 79

Ref. Levkov 2013 (p. 65, fig. 139: 36-43).

Dimensions. Valve 11.98-19.93 μm length and 4.52-6.52 μm breadth, 18-22 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

**Figure 4**

58, 59 – *Gomphonema italicum* Kützing; 60, 61 – *G. laticollum* Reichardt; 62-64 – *G. pumilum* (Grunow) Reichardt & Lange-Bertalot; 65-67 – *G. pumilum* var. *rigidum* Reichardt & Lange-Bertalot; 68, 69 – *G. stonei* Reichardt; 70, 71 – *G. supertergestinum* Reichardt; 72-74 – *G. tergestinum* (Grunow) Schmidt; 75-77 – *Humidophila contenta* (Grunow) Lowe, Kociolek, Johansen, Van de Vijver, Lange-Bertalot & Kopalová; 78, 79 – *L. angusta* Solak & Levkov; 80-82 – *L. kemalii* Solak & Levkov; 83-85 – *L. rotunda* Solak & Levkov; 86, 87 – *L. vesnae* Levkov, Metzeltin & Pavlov; 88, 89 – *Mayamaea agrestis* (Hustedt) Lange-Bertalot; 90, 91 – *M. aliena* (Krasske) Lange-Bertalot; 92 – *M. asellus* (Weinhold) Lange-Bertalot; 93 – *M. excelsa* (Krasske) Lange-Bertalot; 94, 95 – *M. permitis* (Hustedt) Bruder & Medlin; 96, 97 – *M. gibbula* (Cleve) Spaulding & Stoermer; 98, 99 – *N. antonii* Lange-Bertalot; 100-102 – *N. arvensis* var. *major* Lange-Bertalot. Scale bar: 10 µm

Distribution in Turkey. Previous records indicate this taxon was found only in Western Anatolia (Sakarya river catchment-Türkmen Mountain – Levkov et al. 2013).

Luticola kemalii Solak & Levkov Fig. 4: 80-82

Ref. Levkov 2013 (p. 142, fig. 139: 26-40).

Dimensions. Valve 10.57-20.13 μm length and 5.25-8.13 μm breadth, 18-22 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously known only from Western Anatolia (Sakarya river catchment-Türkmen Mountain – Levkov et al. 2013).

Luticola rotunda Solak & Levkov Fig. 4: 83-85

Ref. Levkov 2013 (p. 212, fig. 26: 31-54).

Dimensions. Valve 6.05-19.21 μm length and 4.13-6.51 μm breadth, 18-22 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. This endemic species was previously found in Turkey in Western Anatolia (Sakarya river catchment-Türkmen Mountain – Levkov et al. 2013).

Luticola vesnae Levkov, Metzeltin & Pavlov Fig. 4: 86, 87

Ref. Levkov 2013 (p. 254, fig. 15: 5, 6).

Dimensions. Valve 13.45-18.53 μm length and 4.51-5.99 μm breadth, 20-22 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Mayamaea agrestris (Hustedt) Lange-Bertalot Fig. 4: 88, 89

Basionym. *Navicula agrestris* Hustedt

Ref. Lange-Bertalot 2001 (p. 134, fig. 105: 7-16).

Dimensions. Valve 6.89-10.40 μm length and 2.64-3.41 μm breadth, 26-28 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Mayamaea aliena (Krasske) Lange-Bertalot Fig. 4: 90, 91

Basionym. *Navicula aliena* Krasske

Ref. Lange-Bertalot 2001 (p. 134, fig. 105: 17, 18).

Dimensions. Valve 10.77-12.13 μm length and 3.28-3.71 μm breadth, 26-28 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Mayamaea asellus (Weinhold) Lange-Bertalot Fig. 4: 92

Basionym. *Navicula asellus* Weinhold ex Hustedt

Ref. Lange-Bertalot 2001 (p. 135, fig. 104: 21, 22).

Dimensions. Valve 9.21-14.65 μm length and 4.27-6.25 μm breadth, 15-18 striae in 10 μm .

Distribution in Kütahya running waters. Emet Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Mayamaea excelsa (Krasske) Lange-Bertalot Fig. 4: 93

Basionym. *Navicula excelsa* Krasske

Ref. Lange-Bertalot 2001 (p. 138, fig. 104: 35-40).

Dimensions. Valve 8.57 μm length and 3.47 μm

breadth, 18 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously found only in Eastern Anatolia (Aras river catchment-Deli Çermik – Altuner & Gürbüz 1993, 1994).

Mayamaea permitis (Hustedt) K. Bruder & L. K. Medlin Fig. 4: 94, 95

Basionym. *Navicula permitis* Hustedt

Ref. Lange-Bertalot 2001 (p. 136, fig. 104: 7-13).

Dimensions. Valve 6.67-8.78 μm length and 2.86-3.62 μm breadth.

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Muelleria gibbula (Cleve) S. A. Spaulding & E. F. Stoermer Fig. 4: 96, 97

Basionym. *Navicula gibbula* Cleve

Ref. Krammer & Lange-Bertalot 1986 (p. 235, fig. 65: 14, 15).

Dimensions. Valve 20.43-30.34 μm length and 6.56-7.80 μm breadth, 22-26 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously found in Inner Anatolia (Kızılırmak river catchment-Hirfanlı Reservoir – Baykal & Açıkgöz 2004).

Navicula antonii Lange-Bertalot Fig. 4: 98, 99

Ref. Lange-Bertalot 2001 (p. 15, fig. 13: 1-15).

Dimensions. Valve 11.92-20.71 μm length and 6.44-7.27 μm breadth, 14-16 striae in 10 μm .

Distribution in Kütahya running waters. The species

is common in all river catchments.

Distribution in Turkey. NEW RECORD.

Navicula arvensis var. major Lange-Bertalot Fig. 4: 100-102

Ref. Krammer & Lange-Bertalot 1986 (p. 211, fig. 80: 10-12).

Dimensions. Valve 10.81-14.20 μm length and 3.55-3.99 μm breadth, 28-32 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Navicula cariocincta Lange-Bertalot Fig. 5: 103, 104

Ref. Lange-Bertalot 2001 (p. 23, fig. 11: 21-30).

Dimensions. Valve 29.46-49.85 μm length and 6.08-7.52 μm breadth, 12-14 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Navicula cryptotenelloides Lange-Bertalot Fig. 5: 105, 106

Ref. Lange-Bertalot 2001 (p. 29, fig. 26: 8-16).

Dimensions. Valve 15.82-20.47 μm length and 4.03-4.31 μm breadth, 18-20 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously found only in Western Anatolia (Sakarya river catchment-Türkmen Mountain – Solak & Wojtal 2012).

Navicula kotschy Grunow Fig. 5: 107, 108

Ref. Krammer & Lange-Bertalot 1986 (p. 169, fig. 60: 10-15).

Dimensions. Valve 20.82-26.51 μm length and 6.58-7.42 μm breadth, 21-24 striae in 10 μm .

Distribution in Kütahya running waters. Kırık Stream and Ilıcaksu (Susurluk river catchment).

Distribution in Turkey. Previously found only in Inner Anatolia (Kızılırmak river catchment-Hirfanlı Reservoir – Baykal & Açıkgöz 2004) and Northern Anatolia (Yeşilirmak river catchment-Ladik Lake – Maraşlıoğlu et al. 2005).

Navicula libonensis Schoeman Fig. 5: 109, 110

Ref. Lange-Bertalot 2001 (p. 45, fig. 43: 7-14).

Dimensions. Valve 29.31-38.22 μm length and 6.33-7.23 μm breadth, 13-14 striae in 10 μm .

Distribution in Kütahya running waters. The species is common in all river catchments.

Distribution in Turkey. Previously found in Northern Anatolia (Sakarya river catchment-Acarlar forest – Tunca et al. 2014).

Navicula novaesiberica Lange-Bertalot Fig. 5: 111, 112

Ref. Lange-Bertalot 2001 (p. 89, fig. 36: 10-14).

Dimensions. Valve 37.51-44.22 μm length and 8.27-9.67 μm breadth, 9-11 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Navicula reichardtiana Lange-Bertalot Fig. 5: 113, 114

Ref. Lange-Bertalot 2001 (p. 63, fig. 13: 25-35).

Dimensions. Valve 12.91-20.73 μm length and 4.75-5.56 μm breadth, 16-19 striae in 10 μm .

Distribution in Kütahya running waters. The species is common in all river catchments.

Distribution in Turkey. Previously reported by Atıcı

& Obalı (2010) from Inner Anatolia (Kızılırmak river catchment-Asartepe Reservoir).

Navicula seibigiana Lange-Bertalot Fig. 5: 115, 116

Ref. Lange-Bertalot 2001 (p. 66, fig. 16: 22-34).

Dimensions. Valve 17.81-26.73 μm length and 4.80-5.48 μm breadth, 12-13 striae in 10 μm .

Distribution in Kütahya running waters. Spring is Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Navicula subalpina Reichardt Fig. 5: 117, 118

Ref. Lange-Bertalot 2001 (p. 71, fig. 20: 1-10).

Dimensions. Valve 28.64-30.11 μm length and 6.33-6.81 μm breadth, 16 striae in 10 μm .

Distribution in Kütahya running waters. Emet Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Navicula tantula (Hustedt) Lange-Bertalot Fig. 5: 119, 120

Basionym. *Navicula tantula* Hustedt

Ref. Werum & Lange-Bertalot 2004 (p. 147, fig. 39: 8, 9).

Dimensions. Valve 11.36-16.78 μm length and 2.81-3.92 μm breadth, 23-28 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Navicula tenelloides Hustedt Fig. 5: 121, 122

Ref. Lange-Bertalot 2001 (p. 72, fig. 32: 1-10).

Dimensions. Valve 18.23-21.24 μm length and 3.68-3.95 μm breadth, 16-17 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Navicula viridulacalis Lange-Bertalot Fig. 5: 123

Ref. Lange-Bertalot 2001 (p. 95, fig. 36: 4-7).

Dimensions. Valve 50.61 μm length and 12.82 μm breadth, 9 striae in 10 μm .

Distribution in Kütahya running waters. Emet Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Nitzschia angustatula Lange-Bertalot Fig. 5: 124, 125

Ref. Hofmann et al. 2011 (p. 434, fig. 104: 8-12).

Dimensions. Valve 18.81-22.98 μm length and 3.93-4.83 μm breadth, 17-18 fibulae in 10 μm .

Distribution in Kütahya running waters. Porsuk, Kokar and Murat Streams (Sakarya river catchment) and Kocasu Stream (Susurluk river catchment).

Distribution in Turkey. Previously found only in Southern Anatolia (Dicle river catchment – Varol & Şen 2014).

Nitzschia brunoi Lange-Bertalot Fig. 5: 126, 127

Ref. Hofmann et al. 2011 (p. 437, fig. 104: 1-2).

Dimensions. Valve 67.29-112.09 μm length and 9.49-11.86 μm breadth, 11-12 fibulae in 10 μm .

Distribution in Kütahya running waters. Porsuk, Kokar and Murat (Sakarya river catchment), Kocasu Stream (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Nitzschia draveillensis Coste & Ricard Fig. 5: 128, 129

Ref. Krammer & Lange-Bertalot 1988 (p. 123, fig. 85: 5, 6).

Dimensions. Valve 30.56-54.58 μm length and

2.38-3.15 μm breadth, 18-21 fibulae in 10 μm .

Distribution in Kütahya running waters. Murat Stream (Sakarya river catchment), Kocaçay Stream, Simav Stream, Eynal district (Gediz river catchment).

Distribution in Turkey. Previously found only in Inner Anatolia (Kızılırmak river catchment-Çanılı reservoir – Atıcı et al. 2008 and Asartepe reservoir – Atıcı & Obalı 2010).

Nitzschia thermaloides Hustedt Fig. 5: 130, 131

Ref. Krammer & Lange-Bertalot 1988 (p. 59, fig. 44: 1-7).

Dimensions. Valve 34.79-48.93 μm length and 4.06-5.88 μm breadth, 16-18 fibulae in 10 μm .

Distribution in Kütahya running waters. Muhacırköy district (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Nitzschia vitrea var. salinarum Grunow Fig. 6: 132, 133

Ref. Krammer & Lange-Bertalot 1988 (p. 72, fig. 56: 3-5).

Dimensions. Valve 37.51-38.87 μm length and 5.81-6.71 μm breadth, 7-8 fibulae and 24-26 striae in 10 μm .

Distribution in Kütahya running waters. Muhacırköy district (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Pinnularia nodosa (Ehrenberg) W. Smith Fig. 6: 134, 135

Basionym. *Navicula nodosa* Ehrenberg

Ref. Hofmann et al. 2011 (p. 487, fig. 76: 7-8).

Dimensions. Valve 20.63-54.72 μm length and 6.65-8.42 μm breadth, 11-13 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Solak & Wojtal (2012) found this taxon previously in Western Anatolia (Sakarya river

catchment-Türkmen Mountain).

Pinnularia viridiformis Krammer Fig. 6: 136

Ref. Krammer 2000 (p. 167, fig. 160-162), Hofmann et al. 2011 (p. 493, fig. 72: 3-4).

Dimensions. Valve 58.05-82.85 μm length and 12.07-14.31 μm breadth, 9-11 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously found only in Northern Anatolia (Eastern Blacksea- Uzungöl Lake-Şahin 1998) and Inner Anatolia (Kızılırmak river catchment-Kuzgun Reservoir – Gürbüz & Kıvrak 2003).

Placoneis cracoviensis Lange-Bertalot & Wojtal Fig. 6: 137, 138

Ref. Lange-Bertalot & Wojtal 2014 (p. 410, fig. 49-55).

Dimensions. Valve 30.25-42.15 μm length and 12.16-16.21 μm breadth, 8-11 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Placoneis undulata (Østrup) Lange-Bertalot Fig. 6: 139

Basionym. *Navicula dicephala* var. *undulata* Østrup

Ref. Hofmann et al. 2011 (p. 504, fig. 47: 20-26).

Dimensions. Valve 19.89 μm length and 7.16 μm breadth, 12 striae in 10 μm .

Distribution in Kütahya running waters. Maden Mountain (Gediz river catchment).

Distribution in Turkey. NEW RECORD.

Sellaphora bacilloides (Hustedt) Z. Levkov, S. Kirstic & T. Nakov Fig. 6: 140, 141

Basionym. *Navicula bacilloides* Hustedt

Ref. Hofmann et al. 2011 (p. 374, fig. 40: 18-22).

Dimensions. Valve 18.78-21.54 μm length and 7.21-10.17 μm breadth, 21-27 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. Previously known only from Inner Anatolia (Kızılırmak river catchment-Hirfanlı Reservoir – Baykal & Açıkgöz 2004) and Northern Anatolia (Sakarya river catchment-Melen River – Baykal et al. 2011).

Sellaphora radiosa (Hustedt) H. Kobayasi Fig. 6: 142, 143

Basionym. *Navicula seminulum* var. *radiosa* Hustedt

Ref. Krammer & Lange-Bertalot (p. 231, fig. 76: 37, 38).

Dimensions. Valve 6.71-18.73 μm length and 3.21-4.82 μm breadth, 19-24 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment) and some springs in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. Previously found only in Northern Anatolia (Sakarya river catchment-Acarlar forest – Tunca et al. 2014).

Sellaphora seminulum (Grunow) D. G. Mann Fig. 6: 144, 145

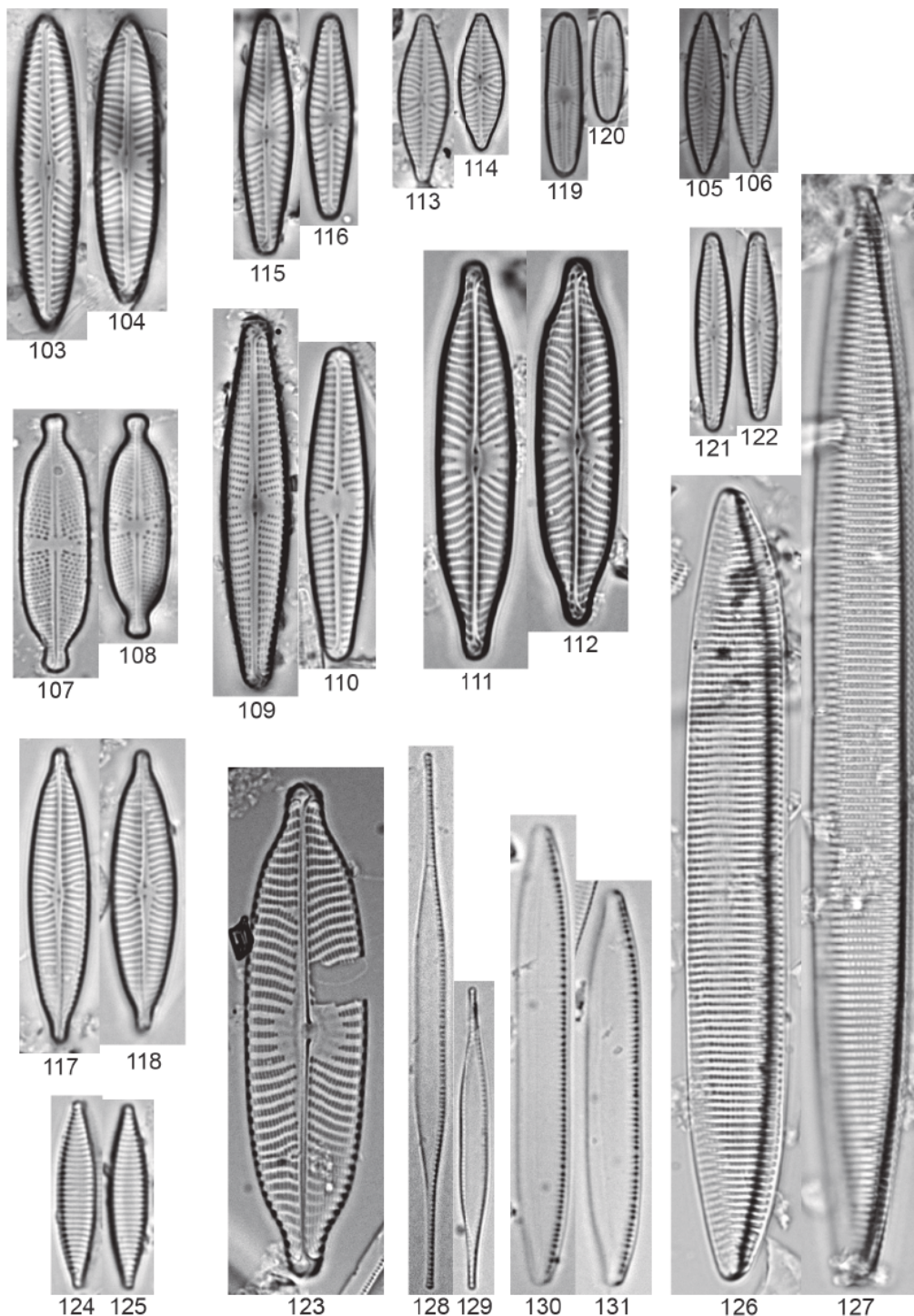
Basionym. *Navicula seminulum* Grunow

Ref. Hofmann et al. 2011 (p. 537, fig. 42: 22-26).

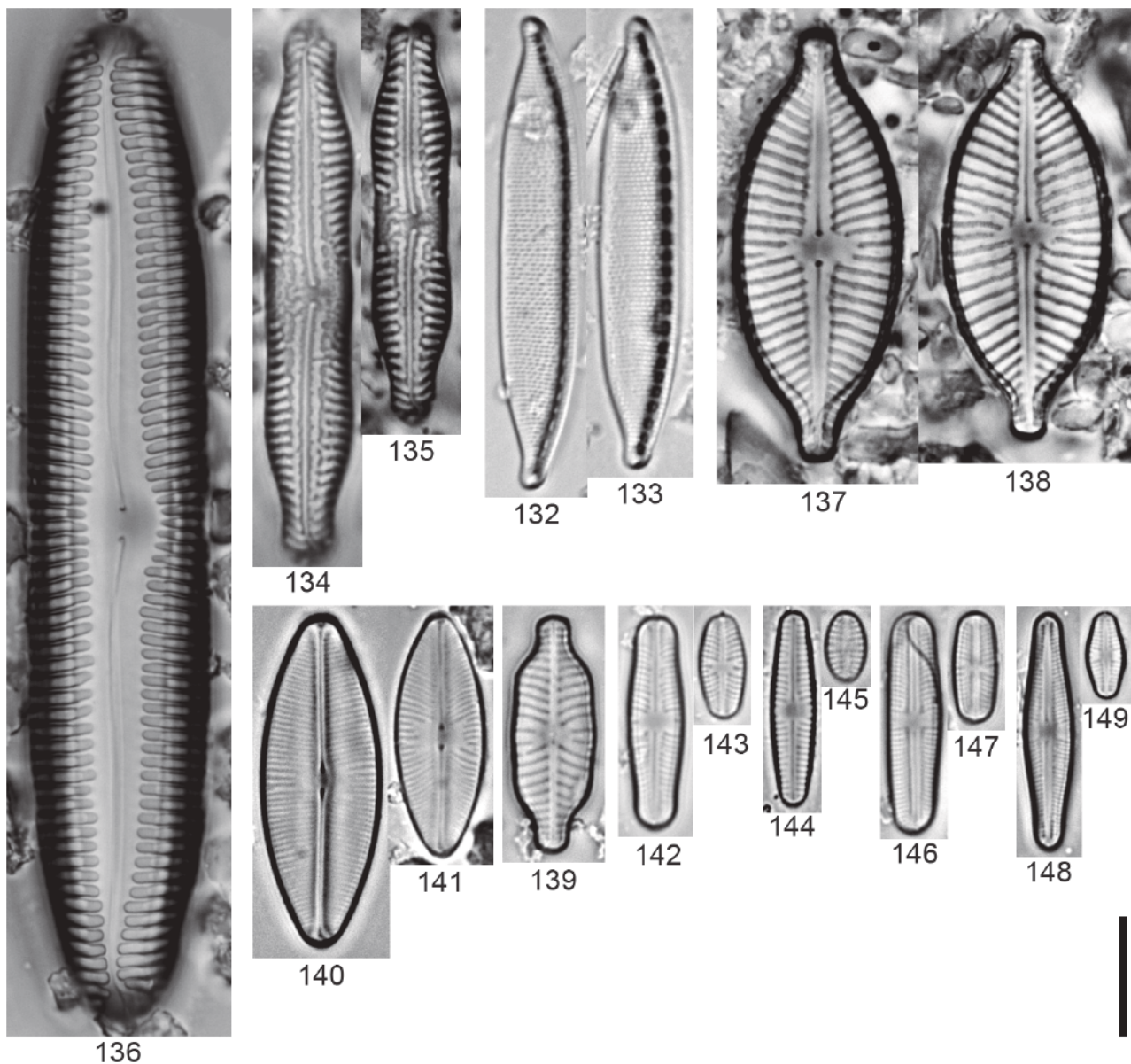
Dimensions. Valve 5.21-16.34 μm length and 3.12-4.42 μm breadth, 10-22 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment) and some springs in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. Previously known only from Inner Anatolia (Kızılırmak river catchment-Hirfanlı

**Figure 5**

103, 104 – *Navicula cariocincta* Lange-Bertalot; 105, 106 – *N. cryptotenelloides* Lange-Bertalot; 107, 108 – *N. kotschy* Grunow; 109, 110 – *N. libonensis* Schoeman; 111, 112 – *N. novaesiberica* Lange-Bertalot; 113, 114 – *N. reichardtiana* Lange-Bertalot; 115, 116 – *N. seibigiana* Lange-Bertalot; 117, 118 – *N. subalpina* Reichardt; 119, 120 – *N. tantula* (Hustedt) Lange-Bertalot; 121, 122 – *N. tenelloides* Hustedt; 123 – *N. viridulacalis* Lange-Bertalot; 124, 125 – *Nitzschia angustatula* Lange-Bertalot; 126, 127 – *N. brunoi* Lange-Bertalot; 128, 129 – *N. draveillensis* Coste & Ricard; 130, 131 – *N. thermaloides* Hustedt. Scale bar: 10 µm

**Figure 6**

132, 133 – *Nitzschia vitrea* var. *salinarum* Grunow; 134, 135 – *Pinnularia nodosa* (Ehrenberg) W. Smith; 136 – *Pinnularia viridiformis* Krammer; 137, 138 – *Placoneis cracoviensis* Lange-Bertalot & Wojtal; 139 – *P. undulata* (Østrup) Lange-Bertalot; 140, 141 – *Sellaphora bacilloides* (Hustedt) Z. Levkov, S. Kirstic & T. Nakov; 142, 143 – *S. radiosa* (Hustedt) H. Kobayasi; 144, 145 – *S. seminulum* (Grunow) D. G. Mann; 146, 147 – *S. stroemii* (Hustedt) H. Kobayasi; 148, 149 – *S. verecundiae* Lange-Bertalot. Scale bar: 10 µm

Reservoir – Baykal & Açıkgöz 2004).

Ref. Hofmann et al. 2011 (p. 538, fig. 42: 17-21).

Sellaphora stroemii (Hustedt) H. Kobayasi Fig. 6:
146, 147

Dimensions. Valve 7.45-18.65 µm length and 3.35-4.63 µm breadth, 18-27 striae in 10 µm.

Basionym. *Navicula stroemii* Hustedt

Distribution in Kütahya running waters. Spring in Domaniç forest (Susurluk river catchment).

Distribution in Turkey. NEW RECORD.

Sellaphora verecundiae Lange-Bertalot Fig. 6: 148, 149

Ref. Hofmann et al. 2011 (p. 538, fig. 42: 32-36).

Dimensions. Valve 6.82-19.94 μm length and 3.45-4.52 μm breadth, 16-30 striae in 10 μm .

Distribution in Kütahya running waters. Spring in Türkmen Mountain (Sakarya river catchment).

Distribution in Turkey. NEW RECORD.

Discussion

Of the study sites on which this work is based, the Sakarya River catchment is one of the most extensively studied areas, while only a few previous studies have addressed Gediz and Susurluk River catchments (detailed in Solak et al. 2012). Among the study sites, the Sakarya River catchment is especially important since many of the new records (50 species, 68.5%) were noted from Türkmen Mountain and the Murat River. Türkmen Mountain is located between two different climatic zones; the Aegean region has cool, rainy winters and hot, moderately dry summers, while Inner Anatolia experiences extremes of hot summers and cold winters with reduced rainfall (Ünal et al. 2003). Most of the identified species from this area would be considered indicators of eutrophic conditions, while several species identified from Türkmen Mountain, including the Kocaçay Stream and the Kırık Stream, would be classified as characteristic of oligotrophic conditions (e.g. *Cymbella subleptoceros*, *Fallacia insociabilis*, *Navicula kotschy*, *Nitzschia bruno*i, *Pinnularia nodosa* and *Sellaphora stroemii*).

In total, more than 800 diatom taxa have been found in Turkish lentic and lotic systems to date. However, many of the diatoms commonly reported from very diverse water bodies in Turkey are taxa known from European and Asiatic areas (Solak & Wojtal 2012). The number of diatoms has been estimated to include approximately 100,000 species in over 1,000 genera (Mann 1999, Fourtanier and Kociolek 1999, 2003). The diversity of diatoms in Turkey is relatively low compared to the total number worldwide. The number of species in Turkey is also low compared to other countries, such as Korea (Park et al. 2014). Some species probably have been confused with morphologically similar taxa. For example, *Cymbella*

affinis Kützing is one of the most common species in the Turkish flora. However, the species was split into several new species by Krammer (2002), similarly to what was done with the *C. cistula* group. *Navicula cryptotenella* Lange-Bertalot is also very common in Turkey and *N. cryptotenelloides* Lange-Bertalot (reported here as a new record for Turkey) is morphologically very similar to *N. cryptotenella* (valve breadth and striation are important to distinguish between the two taxa). The tendency to use older taxonomy that recognizes fewer species is one of the reasons the freshwater diatom flora of Turkey may apparently seem to have a reduced number of species.

The fact that some species occur only in specific environments could be another reason why the freshwater diatom flora of Turkey may appear poorer in species than it might be expected. For example, *Pinnularia nodosa* is common only in Türkmen Mountain springs. Many of these unique environments in Turkey have not been researched yet. It is extremely important to pay constant attention via continuous monitoring of diverse areas to understand the diversity of diatoms in Turkey. In this regard, the Murat Stream was an important sampling site. This system has brought some new records and rare species in this study. A detailed investigation of this system may reveal additional interesting taxa for the flora of Turkey.

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