

## Distribution of nitzschioid diatoms in Kütahya waters

by

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### Abstract

The family of Bacillariaceae Ehrenberg is a group of well-known raphid diatoms, associated with water quality. Our current knowledge of the species diversity of this group in Turkey is still incomplete. There are three river basins in the Kütahya region in Turkey, located in the eastern part of the country, including the Gediz, Sakarya and Susurluk basins, thus the region is rich in lotic waters. We present each taxon based on our observations of specimens collected in the Kütahya region. A total of 53 sites were surveyed in this study and a total of 65 taxa from Bacillariaceae were identified. Of these 65 taxa, 15 are recognized as the first records for Turkey. For each taxon, we indicate the reference(s) used for its identification. To facilitate the identification by others working on the Turkish freshwater diatom flora, we also present dimensions of the taxa identified, the distribution of each taxon in the Kütahya region, the distribution of each taxon in Turkey as well as one or more figures for each taxon.

**Key words:** Bacillariaceae, first records, Kütahya, Turkey

## Introduction

Diatoms are a very diverse group (Mann 1999; Wojtal 2009) and good indicators of water quality in freshwater ecosystems (Bere & Tundusi 2011; Alakananda et al. 2011). Bacillariaceae are a group of diatoms associated with water quality. They comprise well-known raphid diatoms that have the raphe positioned near the valve margin and enclosed within a canal raised onto a keel on one side of the valve (including such genera as *Nitzschia*, *Tryblionella*, *Grunowia*, *Hantzschia* and *Simonsenia*) or in a spiral way (*Cylindrotheca*) (Round et al. 1990). Many members of this group are associated with fine sediments (Kociolek et al. 2015) and some taxa are apochlorotic and secondarily heterotrophic (Blackburn et al. 2009). Many species of Bacillariaceae are considered to be indicative of degraded environmental conditions (McPherson 1996–98; Beyene et al. 2009).

Although many Bacillariaceae are associated with degraded environmental conditions and some species (such as *Nitzschia palea* among many others) are indicative of eutrophic waters, the number of publications documenting species of this group, either reporting new records or being floristic studies, is surprisingly limited. Mann (1978) reviewed much of the historical literature for the group, with publications by Smith (1853; 1856), Grunow (1862) and Cleve and Grunow (1880) being the most outstanding in terms of species descriptions in the 19th century. During his long career, from the early to mid-20th century, Hustedt described 271 taxa of Bacillariaceae. Also in the 20th century, but later, an approach developed that tended to “lump” many species together (Archibald 1966; 1972; Lange-Bertalot & Simonsen 1978). Subsequently, new species descriptions were presented by Hlúbíková et al. (2009), Zidarova et al. (2010), Alakananda et al. (2012, 2015), Trobajo et al. (2013) and Kociolek et al. (2014).

The challenging taxonomy of the group, especially in the case of the genus *Nitzschia* (where many species have very similar shapes and very fine striae, i.e. the “Lanceolatae” group), the number of features available for the species identification by both light and electron microscopy is limited. Therefore, there are only a few floristic studies dealing with Bacillariaceae, most of which are from Europe (e.g. Hustedt 1930; Cleve-Euler 1952), but also from Africa (Hustedt 1955), South America (Metzeltin & Witkowski 1998) and Asia (Alakananda et al. 2012; You & Wang 2011).

Knowledge about the freshwater diatom flora of Turkey is still advancing. Despite the long history of reports on freshwater diatoms in Turkey, dating back to the work of Ehrenberg (1844), and including modern

studies, the current work has recently accelerated, driven by taxonomic and ecological research. Our current knowledge of the species diversity of freshwater diatoms in Turkey is still growing (Solak et al. 2016). This is particularly true for Bacillariaceae in Turkish freshwaters. A total of 895 freshwater diatom taxa have so far been documented from Turkey (Solak et al. 2012; Gönüloğlu 2017), including some new records in recent years (e.g. Baykal et al. 2009; Ongun-Sevindik & Gönüloğlu 2011; Baytut & Gönüloğlu 2016; Solak et al. 2016; 2018; Varol et al. 2018), as well as a single species from the genus *Nitzschia* – *Nitzschia incognita* Legler & Krasske (1940).

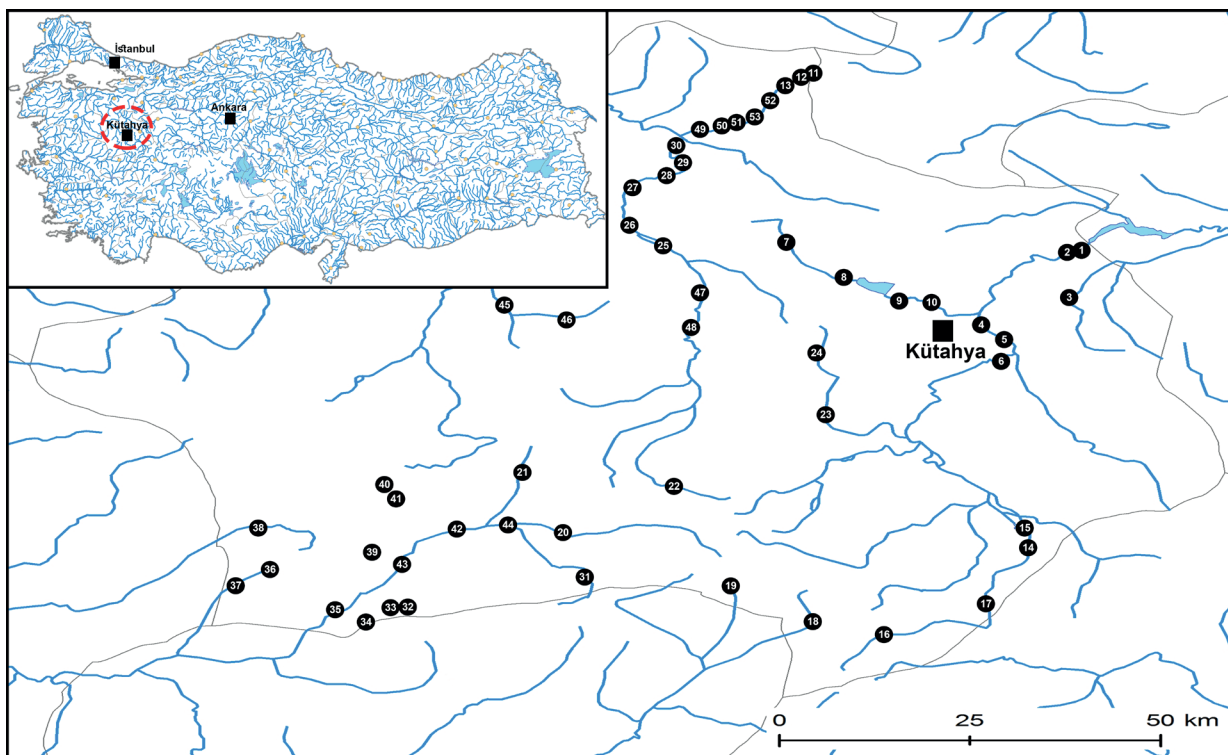
Kütahya has a rich water network with three different river catchments, including the Gediz, Sakarya and Susurluk basins. Of these basins, the Sakarya river basin has been surveyed most often (e.g. Yıldız 1987; Yıldız & Atıcı 1996; Atıcı 1997; Atıcı & Ahıska 2005; Solak & Wojtal 2012; Solak et al. 2016), while the Susurluk and Gediz river basins are much less frequently researched (e.g. Dere et al. 2002; 2006).

The objective of this study is to present the species richness of diatoms (Bacillariaceae) in the three major river basins of the Kütahya region in Turkey.

## Materials and methods

### Study Area

Kütahya is located between Inner and Western Anatolia and has a rich river and stream network, which includes three different river catchments (Susurluk, Sakarya and Gediz). A total of 53 sites were surveyed in the rivers and streams of these catchments. Samples were collected from large and fast flowing rivers (Emet, Gediz, Kocasu, Simav Rivers etc.) and some from slow flowing streams (Felent, Kokar, Kırık, Murat, Porsuk, Safa Streams) and from two thermal discharge waters (Eynal & Naşa thermals). Some of them were collected from small streams, located near villages of the Kütahya Province (e.g. Tiraz, Altıntaş, Domaniç, Eynal etc.; Fig. 1, Table 1). The Emet River, about 90 km long, is located in the village of Saruhan and some small springs join together to form a river called the Kocadere Stream. Then, it flows into Lake Uluabat (Ramsar area). The Gediz River, approximately 400 km long, is one of the largest and most important rivers in the Aegean region. It originates in the village of Akkaya and flows into the Aegean Sea in İzmir. The Kocasu River, approximately 45 km long, originates in the Naşa village and is one of the largest tributaries of the Emet River. The Simav River, 321 km long, has its sources in Simav and flows



**Figure 1**

Distribution of the surveyed localities

into the Sea of Marmara. The Kırk and Safa Streams are small tributaries of the Emet River. The Felent, Kokar and Murat Streams are also small streams and main tributaries of the Porsuk River (Akbulut et al. 2009).

### Diatom Analyses

Some physicochemical parameters – dissolved oxygen (DO,  $\text{mg l}^{-1}$ ), temperature (TEMP,  $^{\circ}\text{C}$ ) and conductivity (COND,  $\mu\text{S cm}^{-1}$ ) – were measured in the field using Lange Hach 40d (Table 2). The conductivity was classified according to Taylor et al. (2006):  $< 50 \mu\text{S cm}^{-1}$  – very low electrolyte content;  $50\text{--}100 \mu\text{S cm}^{-1}$  – low electrolyte content;  $100\text{--}500 \mu\text{S cm}^{-1}$  – moderate electrolyte content;  $> 500 \mu\text{S cm}^{-1}$  – high electrolyte content;  $> 1000 \mu\text{S cm}^{-1}$  – very high electrolyte content. The general distribution and ecological features of the species are presented according to Krammer & Lange-Bertalot (1988), Van Dam et al. (1994) and Wojtal (2013).

Epilithic samples (38 samples in total) were collected by brushing submerged stones, while epipellic samples (15 samples in total) were obtained by using a pipette aspirator. Samples were boiled with  $\text{H}_2\text{O}_2$  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 both at the University of Szczecin, Poland, and Dumlupınar University. Light microscope (LM) observations were conducted using an OLYMPUS BX-51 and a NIKON Eclipse e800 light microscope. Micrographs were taken with a Nikon DS-Fi1 camera. Diatoms were identified according to Krammer & Lange-Bertalot (1991), Hofmann et al. (2011), Bık et al. (2012), Bey & Ector (2013) and Wojtal (2013). The size (length & breadth) of the species was measured using the ImageJ software (Schneider et al. 2012). The distribution of the Turkish flora is presented according to Gönülol (2017). We have tried to use the latest classification system for freshwater diatoms (Fourtanier & Kociolek 2011). Species and infraspecific taxa are arranged alphabetically in the text and figures.

### Results

Based on our observations of benthic diatom samples collected from 53 sites across the three major river basins of the Kütahya region in Turkey, a total of 65 taxa from Bacillariaceae were identified. Of these 65 taxa, 15 are recognized as the first records for Turkey. The list of identified taxa is presented in Table 3.

Table 1

## Sampling sites

Site	River basin name	Waterbody name	Coordinates		Altitude	
K1	Sakarya RB	Porsuk River_1	39°34.130'N	30°06.109'E	890 m	
K2		Ilica Stream	39°35.606'N	30°05.129'E	888 m	
K3		Porsuk River_2	39°29.061'N	30°02.199'E	925 m	
K4		Porsuk River_3	39°26.918'N	30°01.196'E	917 m	
K5		Porsuk River_4	39°22.644'N	30°04.030'E	914 m	
K6		Porsuk River_5	39°19.846'N	30°00.384'E	947 m	
K7		Felent Stream_1	39°30.808'N	29°44.148'E	1017 m	
K8		Felent Stream_2	39°30.506'N	29°45.037'E	1022 m	
K9		Felent Stream_3	39°29.414'N	29°49.850'E	1008 m	
K10		Felent Stream_4	39°29.110'N	29°50.450'E	999 m	
K11	Susurluk RB	Safa Stream	39°49.651'N	29°39.120'E	1118 m	
K12		Small stream in Tiraz village	39°49.161'N	29°38.370'E	870 m	
K13		Small stream in Tiraz village	39°50.039'N	29°33.252'E	1299 m	
K14	Sakarya RB	Kokar Stream_1	39°07.545'N	30°06.511'E	1005 m	
K15		Kokar Stream_2	39°06.925'N	30°06.913'E	1017 m	
K16		Murat Stream	39°01.548'N	29°58.958'E	1040 m	
K17	Gediz RB	Small stream in Altıntaş village	39°04.908'N	30°07.629'E	1012 m	
K18		Gediz River_1	38°59.170'N	29°36.476'E	960 m	
K19		Gediz River_1	38°58.627'N	29°23.823'E	831 m	
K20		Emet River_1	39°14.859'N	29°14.215'E	752 m	
K21		Emet River_2	39°20.453'N	29°14.956'E	772 m	
K22		Emet River_3	39°19.089'N	29°23.962'E	1118 m	
K23		Susurluk RB	Kocasu Stream_1	39°21.824'N	29°36.529'E	916 m
K24			Kocasu Stream_2	39°26.493'N	29°36.922'E	917 m
K25			Kocasu Stream_3	39°31.637'N	29°30.328'E	829 m
K26			Kocasu Stream_4	39°35.114'N	29°27.775'E	814 m
K27	Kirik Stream		39°48.081'N	29°36.746'E	926 m	
K28	Small stream in Domaniç village		39°51.464'N	29°67.943'E	1234 m	
K29	Kocasu Stream_5		39°41.762'N	29°30.674'E	674 m	
K30	Kocasu Stream_6	39°36.314'N	29°27.782'E	731 m		
K31	Gediz RB	Small stream in Simav village	38°56.359'N	28°15.738'E	927 m	
K32		Eynal thermal discharge water	39°07.345'N	28°59.270'E	794 m	
K33		Simav Stream_1	39°08.213'N	28°57.806'E	788 m	
K34		Simav Stream_2	39°06.899'N	28°52.848'E	833 m	
K35		Simav Stream_3	39°09.933'N	28°45.037'E	596 m	
K36		Simav Stream_4	39°10.016'N	28°39.801'E	515 m	
K37		Simav Stream_5	39°09.854'N	28°46.753'E	613 m	
K38		Small stream in Eğir village	39°12.714'N	28°52.016'E	931 m	
K39		Small stream in Eğir village	39°14.033'N	28°14.667'E	1432 m	
K40		Susurluk RB	Kocasu Stream_7	39°18.771'N	28°57.724'E	805 m
K41	Kocasu Stream_8		39°17.738'N	28°58.567'E	714 m	
K42	Naşa thermal discharge water		39°08.701'N	28°57.397'E	789 m	
K43	Small stream in Naşa village		39°08.747'N	28°57.577'E	780 m	
K44	Gediz RB	Simav Stream_6	39°07.772'N	28°58.196'E	794 m	
K45		Small stream in Değirmisaz village	39°30.476'N	29°18.741'E	690 m	
K46		MustafaKemalPaşa Stream	39°29.439'N	29°12.258'E	513 m	
K47	Susurluk RB	Small stream in Hamidat village	39°39.45'N	29°29.451'E	812 m	
K48		Small stream in Domaniç village	39°34.29'N	29°27.503'E	818 m	
K49		Small stream in Güneyköy village	39°43.11'N	29°30.420'E	662 m	
K50		Small stream in Domaniç village	39°44.37'N	29°33.135'E	743 m	
K51		Small stream in Domaniç village	39°47.28'N	29°35.437'E	833 m	
K52		Small stream in Sefaköy village	39°49.25'N	29°38.160'E	913 m	
K53		Ilicaksu Stream	39°46.21'N	29°38.492'E	804 m	

Table 2

Selected physicochemical parameters of the sampling sites (EPL – epilithic, EPP – epipelagic, DO – dissolved oxygen, TEMP – temperature, COND – conductivity)

Site	Physicochemical parameters				
	Habitat	DO (mg l <sup>-1</sup> )	TEMP (°C)	COND (µS cm <sup>-1</sup> )	pH
K1	EPL	4.6	11.7	723	7.9
K2	EPL	8.9	17.6	806	8.7
K3	EPL	2.3	12.1	665	7.7
K4	EPL	5.5	14.2	913	7.4
K5	EPL	10.2	12.6	515	8.4
K6	EPL	11.6	9.6	478	8.4
K7	EPL	9.2	5.6	541	8.1
K8	EPL	8.4	10.1	609	7.8
K9	EPL	11.9	5.6	634	8.5
K10	EPP	8.6	15.9	758	8.1
K11	EPL	10.8	11.0	130	8.0
K12	EPL	11.1	7.6	88	7.5
K13	EPL	9.2	10.7	689	8.4
K14	EPP	8.3	9.7	514	8.2
K15	EPL	8.5	9.3	550	8.3
K16	EPP	10.1	9.0	405	8.5
K17	EPL	5.8	10.9	751	7.5
K18	EPP	9.7	8.4	368	8.4
K19	EPP	9.7	9.7	1077	8.3
K20	EPL	8.5	14.6	758	8.2
K21	EPL	6.9	22.8	737	8.2
K22	EPP	9.6	9.3	534	7.8
K23	EPP	9.5	12.8	496	8.2
K24	EPL	10.0	10.4	435	8.4
K25	EPP	9.6	10.9	539	8.5
K26	EPL	2.5	15.4	1125	7.5
K27	EPP	7.5	15.1	765	8.6
K28	EPL	9.2	10.9	118	8.1
K29	EPL	6.7	17.2	864	8.4
K30	EPL	1.7	15.6	717	7.8
K31	EPL	6.5	18.3	1365	7.8
K32	EPL	11.1	17.2	658	8.5
K33	EPL	4.9	20.3	834	8.4
K34	EPL	10.7	9.9	307	8.6
K35	EPL	9.8	16.6	609	8.6
K36	EPL	10.9	17.0	572	9.0
K37	EPL	8.4	16.3	587	8.0
K38	EPL	6.8	14.0	292	7.3
K39	EPL	9.8	7.6	599	7.6
K40	EPL	9.4	17.9	314	8.4
K41	EPL	10.9	16.2	370	8.6
K42	EPL	5.8	33.7	1449	8.6
K43	EPP	9.2	21.3	829	8.2
K44	EPL	8.9	22.9	745	8.5
K45	EPL	5.5	16.8	1502	8.9
K46	EPL	10.1	19.2	895	8.5
K47	EPP	6.4	14.4	973	7.8
K48	EPP	7.4	12.5	338	7.9
K49	EPL	9.3	13.1	263	8.7
K50	EPP	8.9	14.7	362	8.6
K51	EPP	8.4	15.0	341	8.8
K52	EPL	9.1	9.5	107	8.4
K53	EPP	8.6	15.8	327	7.5

Table 3

Species of Bacillariales examined in the present study (\*first record for Turkish Freshwater Diatom Flora)

Species
<i>Cylindrotheca gracilis</i> (Brébisson) Grunow
<b><i>Denticula subtilis</i> Grunow *</b>
<b><i>Hantzschia abundans</i> Lange-Bertalot *</b>
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow
<b><i>Hantzschia calcifuga</i> Reichardt &amp; Lange-Bertalot *</b>
<i>Hantzschia cf. abundans</i> Lange-Bertalot
<b><i>Nitzschia abbreviata</i> Hustedt*</b>
<i>Nitzschia acicularis</i> (Kützing) W. Smith
<b><i>Nitzschia acidoclinata</i> Lange-Bertalot *</b>
<i>Nitzschia alpina</i> Hustedt
<i>Nitzschia amphibia</i> Grunow
<i>Nitzschia angustata</i> (W. Smith) Grunow
<i>Nitzschia angustatula</i> Lange-Bertalot
<b><i>Nitzschia archibaldii</i> Lange-Bertalot *</b>
<b><i>Nitzschia bacilliformis</i> Hustedt *</b>
<b><i>Nitzschia bergii</i> Cleve-Euler *</b>
<i>Nitzschia brunoi</i> Lange-Bertalot
<i>Nitzschia capitellata</i> Hustedt
<i>Nitzschia clausii</i> Hantzsch
<i>Nitzschia communis</i> Rabenhorst
<i>Nitzschia denticula</i> Grunow
<i>Nitzschia desertorum</i> Hustedt
<i>Nitzschia dissipata</i> (Kützing) Rabenhorst
<i>Nitzschia dissipata</i> var. <i>media</i> (Hantzsch) Grunow
<i>Nitzschia draveillensis</i> Coste & Ricard
<i>Nitzschia dubia</i> W. Smith
<b><i>Nitzschia elegantula</i> Grunow *</b>
<i>Nitzschia flexa</i> Schumann
<i>Nitzschia fonticola</i> (Grunow) Grunow
<b><i>Nitzschia graciliformis</i> Lange-Bertalot &amp; Simonsen *</b>
<i>Nitzschia gracilis</i> Hantzsch
<i>Nitzschia hantzschiana</i> Rabenhorst
<i>Nitzschia heufferiana</i> Grunow
<i>Nitzschia hamburgiensis</i> Lange-Bertalot
<i>Nitzschia inconspicua</i> Grunow
<b><i>Nitzschia leistikowii</i> Lange-Bertalot *</b>
<i>Nitzschia linearis</i> (C. Agardh) W. Smith
<i>Nitzschia microcephala</i> Grunow
<i>Nitzschia palea</i> (Kützing) W. Smith
<b><i>Nitzschia paleacea</i> (Grunow) Grunow *</b>
<i>Nitzschia pusilla</i> Grunow
<i>Nitzschia recta</i> Hantzsch
<b><i>Nitzschia rosenstockii</i> Lange-Bertalot *</b>
<i>Nitzschia sigma</i> (Kützing) W. Smith
<i>Nitzschia sigmoidea</i> (Nitzsch) W. Smith
<i>Nitzschia sociabilis</i> Hustedt
<i>Nitzschia solgensis</i> A. Cleve-Euler
<i>Nitzschia solita</i> Hustedt
<b><i>Nitzschia soratensis</i> Morales &amp; Vis *</b>
<i>Nitzschia subacicularis</i> Hustedt
<b><i>Nitzschia subtilis</i> (Grunow) Hustedt *</b>
<i>Nitzschia supralitorea</i> Lange-Bertalot
<i>Nitzschia tabellaria</i> (Grunow) Grunow
<i>Nitzschia thermaloides</i> Hustedt
<i>Nitzschia umbonata</i> (Ehrenberg) Lange-Bertalot
<i>Nitzschia vermicularis</i> (Kützing) Hantzsch
<i>Nitzschia vitrea</i> Norman
<i>Nitzschia vitrea</i> var. <i>salinarum</i> Grunow
<i>Nitzschia wuellerstorffii</i> Grunow
<i>Simonsenia delognei</i> (Grunow) Lange-Bertalot
<i>Tryblionella apiculata</i> W. Gregory
<i>Tryblionella calida</i> (Grunow) D.G. Mann
<i>Tryblionella debilis</i> Arnott
<i>Tryblionella hungarica</i> (Grunow) Frenguelli
<i>Tryblionella</i> sp.

***Cylindrotheca gracilis*** (Brébisson) Grunow in Van Heurck; Fig. 2: 1, 2

Basionym: *Ceratoneis gracilis* Brébisson

Ref. Hofmann et al. 2011 (p. 142, pl. 118: 6).

Dimensions of the examined specimens. 65.3–128.7  $\mu\text{m}$  long; 4.0–5.6  $\mu\text{m}$  wide.

Distribution and ecology in Kütahya waters. K19, K32, K33, K42, K48, K52. The species was found in samples characterized by moderate to very high electrolyte content (107–1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon occurs in the Inner Anatolia and Aegean regions (Gönüloğlu 2017).

General distribution and ecology. It is a  $\beta$ -mesosaprobious, eutrathentic, aerophile and brackish water species (Van Dam et al. 1994). According to Wojtal (2009), the species is also rarely found in Polish waters.

***Denticula subtilis*** Grunow; Fig. 2: 3, 4

Ref. Krammer & Lange-Bertalot 1991 (p. 140, pl. 96: 1–9), Hofmann et al. 2011 (p. 168, pl. 117: 38–42).

Dimensions of the examined specimens. 12.0–13.3  $\mu\text{m}$  long; 3.2–3.3  $\mu\text{m}$  wide; 9 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K42. The species was found only in one sample, characterized by a very high electrolyte content (1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Hantzschia abundans*** Lange-Bertalot; Fig. 2: 5, 6

Ref. Hofmann et al. 2011 (p. 333, pl. 102: 6–10).

Dimensions of the examined specimens. 40.8–67.5  $\mu\text{m}$  long; 8.3–10.2  $\mu\text{m}$  wide; 4–7 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K13, K15, K16, K40. The species was found in several samples characterized by moderate or high electrolyte content (314–689  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora. The species is likely confused with *H. amphioxys* in Turkish waters.

General distribution and ecology. The species is cosmopolitan (Lange-Bertalot 1993). According to Van Dam et al. (1994), it is a neutrophilous,  $\alpha$ -mesosaprobious, eurytrathentic and fresh-brackish water species.

***Hantzschia amphioxys*** (Ehrenberg) Grunow; Fig. 2: 9, 10

Basionym: *Eunotia amphioxys* Ehrenberg

Ref. Krammer & Lange-Bertalot (1991 p. 128, pl. 88: 1–7), Hofmann et al. 2011 (p. 333, pl. 102: 1–5).

Dimensions of the examined specimens. 30.0–46.7  $\mu\text{m}$  long; 5.3–8.3  $\mu\text{m}$  wide; 19–26 striae and 6–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K13, K14, K15, K22, K27, K38, K39, K40. The species was found in samples characterized by moderate or high electrolyte content (292–765  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017).

General distribution and ecology. It is a neutrophilous,  $\alpha$ -mesosaprobious, eurytrathentic and fresh-brackish water species (Van Dam et al. 1994). According to Wojtal (2009), the species is also rarely found in Polish waters.

***Hantzschia cf. abundans***; Fig. 2: 7, 8

Dimensions of the examined specimens. 36.7–61.7  $\mu\text{m}$  long; 6.7–8.3  $\mu\text{m}$  wide; 20–23 striae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K12, K22, K40. The species was found in a few samples characterized by low to high electrolyte content (88–534  $\mu\text{S cm}^{-1}$ ).

Remarks. The species is similar to *H. abundans* and *H. amphioxys*. However, striation and areolation are more visible and the dorsal outline is more rounded. The striae density in this species (21 in 10  $\mu\text{m}$ ) is similar to *H. amphioxys* (20–29 striae in 10  $\mu\text{m}$ , according to Hofmann et al. 2011).

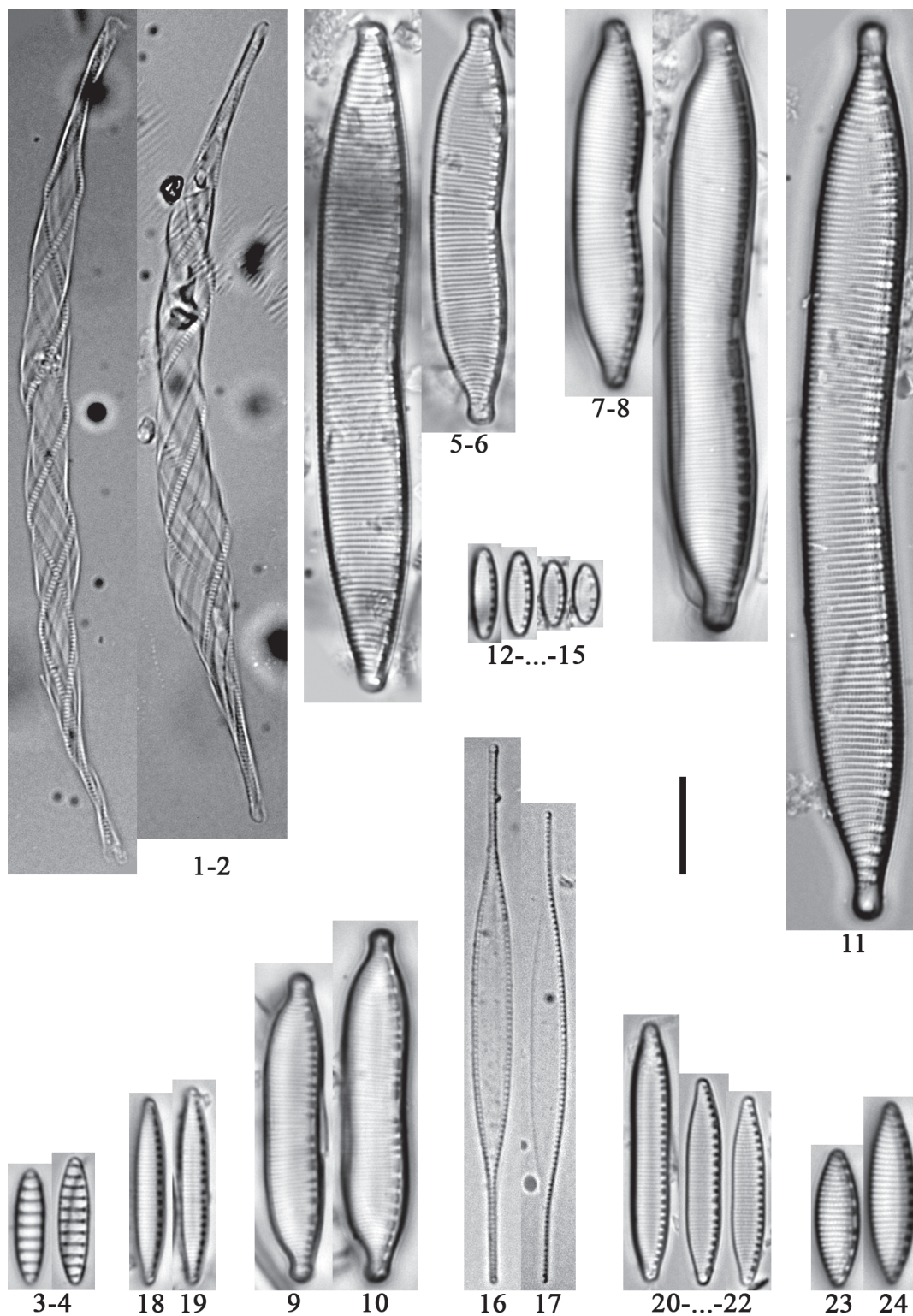
***Hantzschia calcifuga*** Reichardt & Lange-Bertalot; Fig. 2: 11

Ref. Hofmann et al. 2011 (p. 334, pl. 102: 11).

Dimensions of the examined specimens. Only one valve was found: 90.0  $\mu\text{m}$  long; 8.3  $\mu\text{m}$  wide; 14 striae and 5 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K39. The species was found in one sample characterized by high electrolyte content (599  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.



**Figure 2**

1, 2 – *Cylindrotheca gracilis* (Brébisson) Grunow in Van Heurck; 3, 4 – *Denticula subtilis* Grunow; 5, 6 – *Hantzschia abundans* Lange-Bertalot; 7, 8 – *H. cf. abundans*; 9, 10 – *H. amphioxys* (Ehrenberg) Grunow; 11 – *H. calcifuga* Reichardt & Lange-Bertalot; 12–15 – *Nitzschia abbreviata* Hustedt; 16, 17 – *N. acicularis* (Kützing) W.Smith; 18, 19 – *N. acidoclinata* Lange-Bertalot; 20–22 – *N. alpina* Hustedt; 23–24 – *N. amphibia* Grunow. Scale bar: 10  $\mu$ m

***Nitzschia abbreviata*** Hustedt; Fig. 2: 12–15

Ref. Hofmann et al. 2011 (p. 431, pl. 112: 21–27).

Dimensions of the examined specimens. 6.1–9.3  $\mu\text{m}$  long; 2.1–2.6  $\mu\text{m}$  wide; 28–30 striae and 10–14 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K10, K11, K31, K46, K52. The species was found in several samples characterized by moderate to very high electrolyte content (130–1365  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia acicularis*** (Kützinger) W. Smith; Fig. 2: 16, 17

Basionym. *Synedra acicularis* Kützinger

Ref. Krammer & Lange-Bertalot 1991 (p. 123, pl. 85: 1–4), Hofmann et al. 2011 (p. 123, pl. 107: 20–24).

Dimensions of the examined specimens. 45.2–65.3  $\mu\text{m}$  long; 3.7–4.8  $\mu\text{m}$  wide; 17–21 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K14, K32, K33, K36, K37, K41, K44. The species was found in several samples characterized by moderate to high electrolyte content (370–814  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017). Most of the data on the distribution of *N. acicularis* come from Turkish lakes (Solak et al. 2002). This diatom was also found in rivers, in plankton and benthic samples. Its saprobity was estimated as euryhalobous-indifferent (Özer et al. 2018).

General distribution and ecology. The species is also very common in Poland. According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobious, eutrphentic and fresh-brackish water species.

***Nitzschia acidoclinata*** Lange-Bertalot; Fig. 2: 18, 19

Ref. Hofmann et al. 2011 (p. 431, pl. 112: 50–54), Bey & Ector 2013 (p. 996).

Dimensions of the examined specimens. 19.2–20.0  $\mu\text{m}$  long; 2.7–3.0  $\mu\text{m}$  wide; 25 striae and 10–11 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K41, K52. The species was found in two samples characterized by moderate electrolyte content (107–370  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora. General distribution and ecology. The species is also

common in Poland. It prefers oligotrophic waters with low conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobious, mesotrphentic and freshwater. It was observed in waters with very low to high conductivity, but high dissolved oxygen concentrations in the Tatra springs (Wojtal 2013).

***Nitzschia alpina*** Hustedt; Fig. 2: 20–22

Ref. Hofmann et al. 2011 (p. 432, pl. 112: 41–45), Wojtal 2013 (p. 117, pl. 114: 1–12).

Dimensions of the examined specimens. 19.1–31.2  $\mu\text{m}$  long; 3.2–3.7 wide; 25–26 striae and 10–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K3, K7, K11, K13, K30, K42, K52. The species was found in samples characterized by moderate to very high electrolyte content (130–1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The species was found only in the Black Sea region by Tunca et al. (2014). General distribution and ecology. The species was found in waters characterized by low to moderate conductivity and high to very high dissolved oxygen concentrations (Wojtal 2013).

***Nitzschia amphibia*** Grunow; Fig. 2: 23, 24

Ref. Hofmann et al. 2011 (p.433,- pl.117: 9–15).

Dimensions of the examined specimens. 8.9–41.7  $\mu\text{m}$  long; 4.1–5.3  $\mu\text{m}$  wide; 16–20 striae and 6–9 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K8, K9, K10, K28. The species was found in samples characterized by moderate to high electrolyte content (118–758  $\mu\text{S cm}^{-1}$ ).

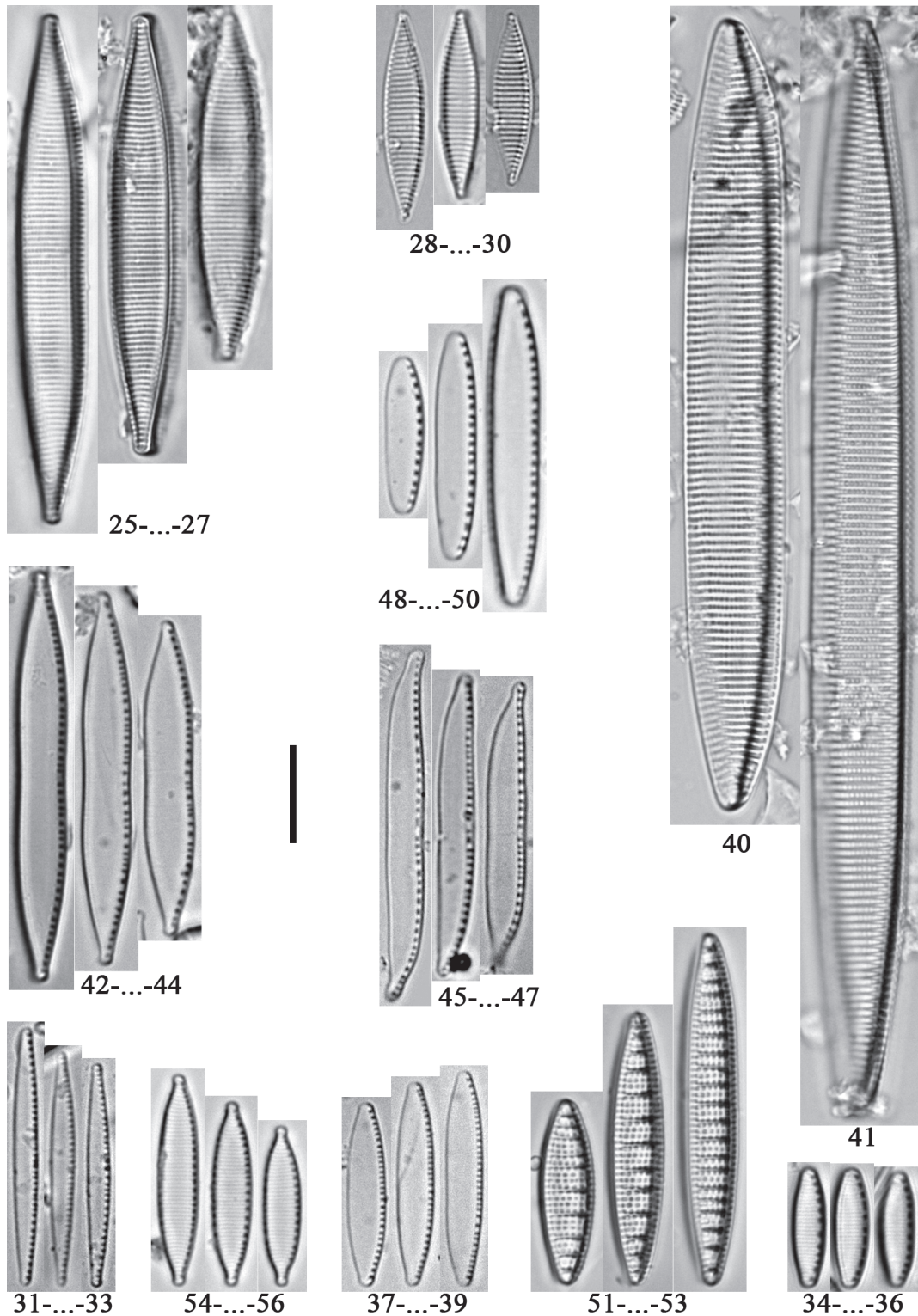
Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017). General distribution and ecology. The species is a cosmopolitan diatom, occurring in waters characterized by a wide range of conductivity (Krammer & Lange-Bertalot 1998). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobious, eutrphentic and fresh-brackish water species. It was also found in waters with moderate specific conductivity and high dissolved oxygen concentrations (Wojtal 2013).

***Nitzschia angustata*** (W. Smith) Grunow; Fig. 3: 25–27

Basionym. *Tryblionella angustata* W. Smith

Ref. Krammer & Lange-Bertalot 1991 (p. 48, pl. 36: 1–5),





**Figure 3**

25–27 – *Nitzschia angustata* (W.Smith) Grunow; 28–30 – *N. angustatula* Lange-Bertalot; 31–33 – *N. archibaldii* Lange-Bertalot; 34–36 – *N. bacilliformis* Hustedt; 37–39 – *N. bergii* Cleve-Euler; 40, 41 – *N. brunoi* Lange-Bertalot; 42–44 – *N. capitellata* Hustedt; 45–47 – *N. clausii* Hantzsch; 48–50 – *N. communis* Rabenhorst; 51–53 – *N. denticula* Grunow; 54–56 – *N. desertorum* Hustedt. Scale bar: 10  $\mu\text{m}$

Hofmann et al. 2011 (p. 434, pl. 104: 13–17).

Dimensions of the examined specimens. 35.8–64.7  $\mu\text{m}$  long; 5.1–7.5  $\mu\text{m}$  wide; 16–18 striae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K5, K6, K14, K16, K23, K24, K25. The species was found in samples characterized by moderate electrolyte content (405–539  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Nitzschia angustatula*** Lange-Bertalot; Fig. 3: 28–30

Ref. Krammer & Lange-Bertalot 1991 (p. 48, pl. 36: 6–10), Hofmann et al. 2011 (p. 434, pl. 104: 8–12).

Dimensions of the examined specimens. 16.6–26.3  $\mu\text{m}$  long; 3.8–4.9  $\mu\text{m}$  wide; 17–18 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K6, K14, K16. The species was found in a few samples characterized by moderate electrolyte content (405–515  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in Western Anatolia (Kütahya lotic waters) by Solak et al. (2016) and Inner Anatolia (the Dicle River by Varol & Şen 2014).

***Nitzschia archibaldii*** Lange-Bertalot; Fig. 3: 31–33

Ref. Krammer & Lange-Bertalot 1991 (p. 115, pl. 81: 10–12), Hofmann et al. 2011 (p. 435, pl. 111: 30–34).

Dimensions of the examined specimens. 22.6–26.3  $\mu\text{m}$  long; 2.3–2.6  $\mu\text{m}$  wide; 14–18 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K23, K32, K34, K51, K52. The species was found in samples characterized by moderate to high electrolyte content (107–638  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

General distribution and ecology. The species is widespread in oligosaprobic to  $\beta$ -mesosaprobic waters with moderate conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobous, eutrathentic and fresh-brackish water species.

***Nitzschia bacilliformis*** Hustedt; Fig. 3: 34–36

Ref. Krammer & Lange-Bertalot 1991 (p. 102, pl. 74: 18–26).

Dimensions of the examined specimens. 11.6–16.3  $\mu\text{m}$  long; 3.0–3.4  $\mu\text{m}$  wide; 24–28 striae and 10–13

fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K13, K28, K52. The species was found in a few samples characterized by moderate to high electrolyte content (107–689  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia bergii*** Cleve-Euler; Fig. 3: 37–39

Ref. Krammer & Lange-Bertalot 1991 (p. 113, pl. 80: 10–15).

Dimensions of the examined specimens. 18.0–21.9  $\mu\text{m}$  long; 3.4–4.0  $\mu\text{m}$  wide; 14–19 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K12, K32, K33, K34, K36, K37, K40, K41, K44, K48, K52. The species was commonly found in waters characterized by low to high electrolyte content (88–814  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia brunoi*** Lange-Bertalot; Fig. 3: 40, 41

Ref. Hofmann et al. 2011 (p. 437, pl. 104: 1–2).

Dimensions of the examined specimens. 67.3–112.1  $\mu\text{m}$  long; 9.5–11.9  $\mu\text{m}$  wide; 12–13 striae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K3, K14, K15, K16, K50. The species was found in several samples characterized by moderate to high electrolyte content (362–665  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the Aegean region (Kütahya lotic waters) by Solak et al. (2016).

***Nitzschia capitellata*** Hustedt; Fig. 3: 42–44

Ref. Krammer & Lange-Bertalot 1991 (p. 88, pl. 62: 1–12), Hofmann et al. 2011 (p. 438, pl. 113: 11–16).

Dimensions of the examined specimens. 18.5–49.7  $\mu\text{m}$  long; 4.5–5.2  $\mu\text{m}$  wide; 12–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K1, K4, K28. The species was found in a few samples characterized by moderate to high electrolyte content (118–913  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan, reported frequently from waters with moderate conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -meso-polysaprobous,

hypereutraphentic and brackish water species.

***Nitzschia clausii*** Hantzsch; Fig. 3: 45–47

Ref. Krammer & Lange-Bertalot 1991 (p. 27, pl. 19: 1–6), Hofmann et al. 2011 (p. 438, pl. 116: 15–18).

Dimensions of the examined specimens. 31.6–35.6  $\mu\text{m}$  long; 3.5  $\mu\text{m}$  wide; 9 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K15. The species was found in one sample characterized by moderate electrolyte content (550  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobous, eutraphentic and brackish water species.

***Nitzschia communis*** Rabenhorst; Fig. 3: 48–50

Ref. Krammer & Lange-Bertalot 1991 (p. 110, pl. 79: 1–6), Hofmann et al. 2011 (p. 439, pl. 112: 1–5).

Dimensions of the examined specimens. 16.1–32.7  $\mu\text{m}$  long; 3.9–5.1  $\mu\text{m}$  wide; 9–12 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K3, K4, K5, K7, K16, K28, K35, K36, K37, K38, K40, K41, K44, K45, K50. The species was commonly found in samples characterized by moderate to very high electrolyte content (118–1502  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan, preferring waters with high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -meso-polysaprobous, eutraphentic and fresh-brackish water species. It was found in waters with moderate to very high conductivity (Wojtal 2013).

***Nitzschia denticula*** Grunow; Fig. 3: 51–53

Ref. Krammer & Lange-Bertalot 1991 (p. 143, pl. 99: 11–23), Hofmann et al. 2011 (p. 441, pl. 26–31).

Dimensions of the examined specimens. 18.7–38.7  $\mu\text{m}$  long; 5.3–7.0  $\mu\text{m}$  wide; 5–7 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K15, K16, K24, K31, K47. The species was found in several samples characterized by moderate to very high electrolyte content (405–1365  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in

Turkey (Gönüloğlu 2017).

***Nitzschia desertorum*** Hustedt; Fig. 3: 54–56

Ref. Krammer & Lange-Bertalot 1991 (p. 98, pl. 70: 10–13).

Dimensions of the examined specimens. 14.7–26.4  $\mu\text{m}$  long; 4.4–4.7  $\mu\text{m}$  wide; 21–22 striae and 9–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K8, K9, K10, K25, K32, K33, K40, K42, K44. The species was commonly found in samples characterized by moderate to high electrolyte content (314–1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia dissipata*** (Kützing) Rabenhorst; Fig. 4: 57–59

Basionym: *Synedra dissipata* Kützing

Ref. Hofmann et al. 2011 (p. 441, pl. 109: 8–13), Hofmann et al. 2011 (p. 441: 8–13).

Dimensions of the examined specimens. 16.7–28.4  $\mu\text{m}$  long; 4.8–5.2  $\mu\text{m}$  wide; 9–12 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K6, K7, K8, K9, K10. The species was found in samples characterized by moderate to high electrolyte content (478–806  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan, one of the most frequently reported diatoms from waters with moderate and high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, meso- to eutraphentic and fresh-brackish water species.

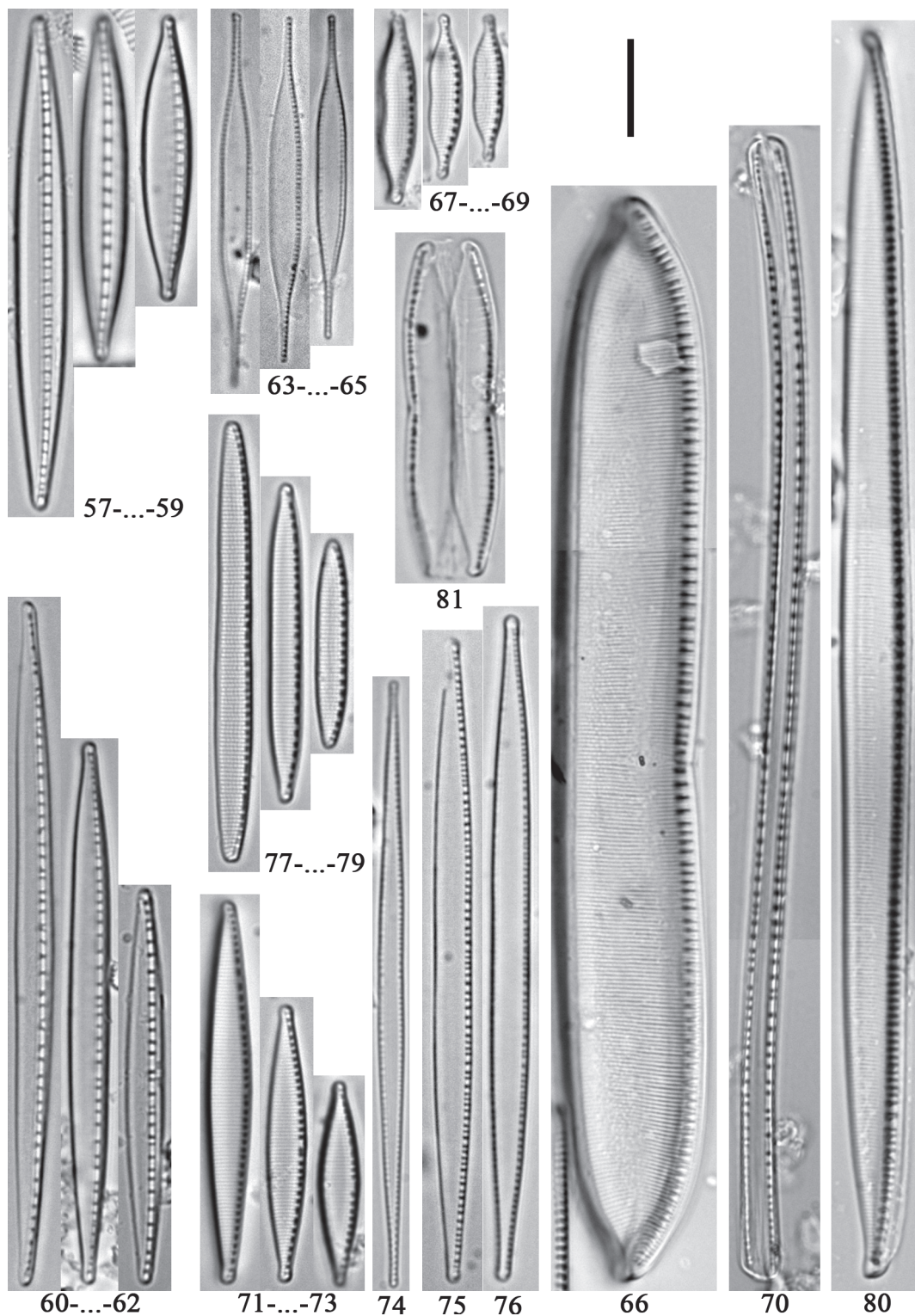
***Nitzschia dissipata* var. *media*** (Hantzsch) Grunow; Fig. 4: 60–62

Basionym: *Nitzschia media* Hantzsch

Ref. Krammer & Lange-Bertalot 1991 (p. 19, pl. 11: 8–14), Hofmann et al. 2011 (p. 441: 14–18).

Dimensions of the examined specimens. 32.4–73.4  $\mu\text{m}$  long; 3.6–5.1  $\mu\text{m}$  wide; 6–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K5, K6, K7, K9. The species was found in several samples characterized by moderate to high electrolyte content



**Figure 4**

57–59 – *Nitzschia dissipata* (Kützing) Rabenhorst; 60–62 – *N. dissipata* var. *media* (Hantzsch) Grunow; 63–65 – *N. draveillensis* Coste & Ricard; 66 – *N. dubia* W.Smith; 67–69 – *N. elegantula* Grunow; 70 – *N. flexa* Schumann; 71–73 – *N. fonticola* (Grunow) Grunow; 74 – *N. graciliformis* Lange-Bertalot & Simonsen; 75, 76 – *N. gracilis* Hantzsch; 77–79 – *N. hantzschiana* Rabenhorst; 80 – *N. heufleriana* Grunow; 81 – *N. humbergiensis* Lange-Bertalot. Scale bar: 10 µm

(478–806  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species occurs in waters with a wide trophic spectrum (Lange-Bertalot 1993). According to Van Dam et al. (1994), it is an alkaliphilous and fresh-brackish water species.

***Nitzschia draveillensis*** Coste & Ricard; Fig. 4: 63–65

Ref. Krammer & Lange-Bertalot 1991 (p. 123, pl. 85: 5, 6), Hofmann et al. 2011 (p. 463, pl. 106: 13).

Dimensions of the examined specimens. 32.9–38.3  $\mu\text{m}$  long; 3.0–3.2  $\mu\text{m}$  wide; 19–21 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K35, K41. The species was found in two samples characterized by moderate to high electrolyte content (370–609  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the Inner Anatolia (Çanıllı and Asartepe Reservoirs by Atıcı et al. 2008 and Atıcı & Obalı 2010) and Aegean regions (Kütahya lotic waters by Solak et al. 2016).

***Nitzschia dubia*** W.Smith; Fig. 4: 66

Ref. Krammer & Lange-Bertalot 1991 (p. 55, pl. 41: 1, 2), Hofmann et al. 2011 (p. 442, pl. 105: 1, 2)

Dimensions of the examined specimens. 109.4–111.9  $\mu\text{m}$  long; 14.0–16.5  $\mu\text{m}$  wide; 23 striae and 8–10 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K8, K25. The species was found in a few samples characterized by high electrolyte content (539–641  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan, especially in brackish waters (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobous, eutraphentic and brackish-freshwater species.

***Nitzschia elegantula*** Grunow; Fig. 4: 67–69

Ref. Krammer & Lange-Bertalot 1991 (p. 120, pl. 83: 20–24).

Dimensions of the examined specimens. 13.7–19.4  $\mu\text{m}$  long; 2.8–3.8  $\mu\text{m}$  wide; 26–28 striae and 12–14 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K48.

The species was found in one sample characterized by moderate electrolyte content (338  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia flexa*** Schumann; Fig. 4: 70

Ref. Krammer & Lange-Bertalot 1991 (p. 16, pl. 4: 6, 9: 1–4).

Dimensions of the examined specimens. 77.1–116.8  $\mu\text{m}$  long; 3.3–5.4  $\mu\text{m}$  wide; 7–10 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K14, K16. The species was found in two samples characterized by moderate electrolyte content (405–514  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the regions of Western Anatolia (Tunca River by Öterler et al. 2014) and the Black Sea (Kızılırmak River by Baytut & Gönüloğlu 2016).

***Nitzschia fonticola*** (Grunow) Grunow; Fig. 4: 71–73

*Basionym:* *Nitzschia palea* var. *fonticola* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 103, pl. 75: 1–22), Hofmann et al. 2011 (p. 444, pl. 108: 9–15).

Dimensions of the examined specimens. 20.4–40.7  $\mu\text{m}$  long; 3.8–4.3  $\mu\text{m}$  wide; 26–28 striae and 10–12 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K6, K7, K9, K11, K20, K23, K27, K35, K36, K41, K49, K50, K52, K53. The species was commonly found in samples characterized by moderate to high electrolyte content (107–765  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017).

General distribution and ecology. The species is probably cosmopolitan and common in European waters characterized by a broad range of conductivity and oligosaprobic to  $\beta$ -mesosaprobic conditions (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, meso- to eutraphentic and fresh-brackish water species. It was found in waters with moderate conductivity (Wojtal 2013).

***Nitzschia graciliformis*** Lange-Bertalot & Simonsen; Fig. 4: 74

Ref. Krammer & Lange-Bertalot (p. 115, pl. 81: 8, 9).

Dimensions of the examined specimens. Only one valve was found: 62.0  $\mu\text{m}$  long; 2.6  $\mu\text{m}$  wide; 18 fibulae

in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K6. The species was found in one sample characterized by moderate electrolyte content ( $478 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia gracilis*** Hantzsch; Fig. 4: 75, 76

Ref. Krammer & Lange-Bertalot 1991 (p. 93, pl. 66: 1–11), Hofmann et al. 2011 (p. 447, pl. 107: 10–14).

Dimensions of the examined specimens. 65.2–68.2  $\mu\text{m}$  long; 3.5–3.8  $\mu\text{m}$  wide; 13–16 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K17. The species was found in one sample characterized by high electrolyte content ( $751 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). Most of the data on the distribution of the species come from rivers (Solak et al. 2002).

General distribution and ecology. According to Van Dam et al. (1994), the species is a neutrophilous,  $\beta$ -mesosaprobous, mesotraphentic strictly aquatic and freshwater species.

***Nitzschia hantzschiana*** Rabenhorst; Fig. 4: 77–79

Ref. Krammer & Lange-Bertalot 1991 (p. 101, pl. 73: 9–18), Hofmann et al. 2011 (p. 448, pl. 112: 61–65).

Dimensions of the examined specimens. 15.2–45.3 long; 3.1–3.5 wide; 22–25 striae and 10–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K12, K13, K38, K41, K49, K50, K52. The species was found in samples characterized by low to high electrolyte content ( $88$ – $689 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). General distribution and ecology. The species is probably cosmopolitan (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous, oligosaprobous, mesotraphentic, aerophilous and freshwater species.

***Nitzschia heufleriana*** Grunow; Fig. 4: 80

Ref. Krammer & Lange-Bertalot 1991 (p. 22, pl. 13: 1–5), Hofmann et al. 2011 (p. 448, pl. 109: 19–23).

Dimensions of the examined specimens. 112.1–152.1  $\mu\text{m}$  long; 5.8–7.1  $\mu\text{m}$  wide; 24–25 striae and 9–11 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K25.

The species was found in one sample characterized by moderate electrolyte content ( $539 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Nitzschia homburgiensis*** Lange-Bertalot; Fig. 4: 81

Ref. Hofmann et al. 2011 (p. 449, pl. 105: 9–13), Hofmann et al. 2011 (p. 449, pl. 105: 9–13).

Dimensions of the examined specimens. 32.2  $\mu\text{m}$  long; 4.4  $\mu\text{m}$  wide; 15 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K39. The species was found in one sample characterized by moderate to high electrolyte content ( $118$ – $758 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon occurs rarely in the Inner Anatolia and Aegean regions (Pamukkale travertines by Güner 1966 and some lakes in Anatolia – Işıklı, Uluabat, İznik, Salda, Burdur – by Skuja 1937).

***Nitzschia inconspicua*** Grunow; Fig. 5: 82–84

Ref. Krammer & Lange-Bertalot 1991 (p. 95, pl. 69: 1–13), Hofmann et al. 2011 (p. 446, pl. 112: 35–40).

Dimensions of the examined specimens. 5.0–12.3  $\mu\text{m}$  long; 2.9–3.2  $\mu\text{m}$  wide; 10–11 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K2, K5, K6, K7, K9, K10, K11, K28, K31, K35, K45, K52. The species was commonly found in samples characterized by moderate to very high electrolyte content ( $118$ – $1365 \mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

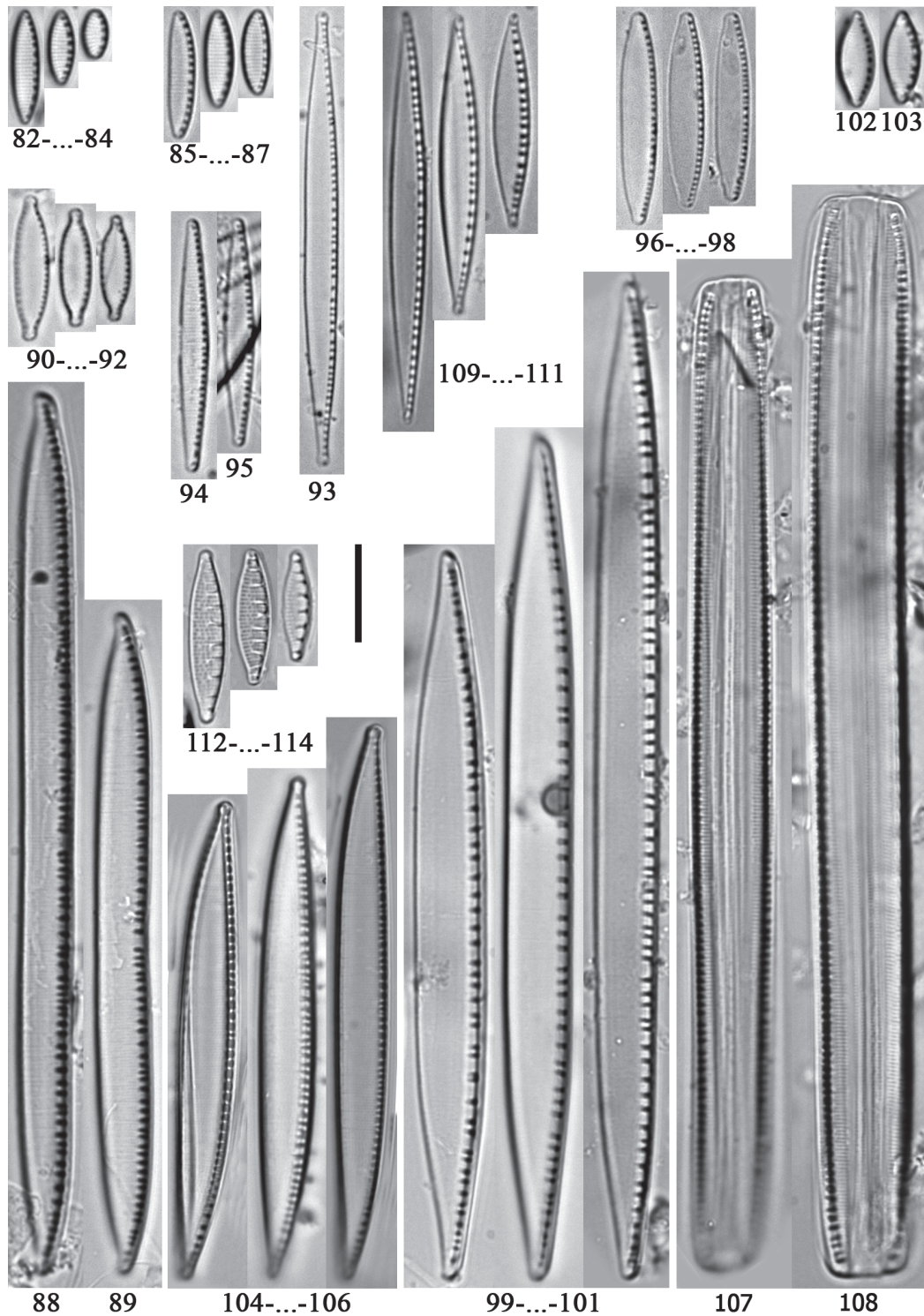
General distribution and ecology. The species is cosmopolitan, common in waters with moderate and high conductivity, up to the  $\alpha$ - $\beta$ -mesosaprobic zone (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobous, eutraphentic and brackish-freshwater species.

***Nitzschia leistikowii*** Lange-Bertalot; Fig. 5: 85–87

Ref. Krammer & Lange-Bertalot 1991 (pl. 68: 20–24).

Dimensions of the examined specimens. 8.6–13.2  $\mu\text{m}$  long; 2.5–3.1  $\mu\text{m}$  wide; 26–28 striae and 12–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K7, K9, K28, K36. The species was found in several samples characterized by moderate to high electrolyte content ( $118$ – $806 \mu\text{S cm}^{-1}$ ).



**Figure 5**

82–84 – *Nitzschia inconspicua* Grunow; 85–87 – *N. leistikowii* Lange-Bertalot; 88, 89 – *N. linearis* (C.Agardh) W.Smith; 90–92 – *N. microcephala* Grunow; 93 – *N. palea* (Kützing) W.Smith; 94, 95 – *N. paleacea* (Grunow) Grunow; 96–98 – *N. pusilla* Grunow; 99–101 – *N. recta* Hantzsch; 102, 103 – *N. rosenstockii* Lange-Bertalot; 104–106 – *N. sigma* (Kützing) W.Smith; 107, 108 – *N. sigmoidea* (Nitzsch) W.Smith; 109–111 – *N. sociabilis* Hustedt; 112–114 – *N. solgensis* A.Cleve-Euler. Scale bar: 10  $\mu$ m

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia linearis*** (C.Agardh) W.Smith; Fig. 5: 88, 89

Basionym: *Frustulia linearis* C.Agardh

Ref. Krammer & Lange-Bertalot 1991 (p.69, pl. 55: 1–4), Hofmann et al. 2011 (p. 452, pl. 106: 1–3).

Dimensions of the examined specimens. 58.8–105.4  $\mu\text{m}$  long; 5.4–6.0  $\mu\text{m}$  wide; 10–12 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K7, K33, K36. The species was found in a few samples characterized by moderate to high electrolyte content (515–834  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017).

General distribution and ecology. The species is one of the most frequently reported diatoms, with a wide ecological spectrum, neutrophilous (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, meso- to eutraphentic and fresh-brackish water species.

***Nitzschia microcephala*** Grunow; Fig. 5: 90–92

Ref. Krammer & Lange-Bertalot 1991 (p. 120, pl. 83: 10–18), Hofmann et al. 2011 (p. 452, pl. 111: 43–47).

Dimensions of the examined specimens. 9.0–13.8  $\mu\text{m}$  long; 3.3–3.4  $\mu\text{m}$  wide; 16 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K40, K45, K51. The species was found in a few samples characterized by moderate to very high electrolyte content (314–1502  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). Most of the data on the distribution of the species come from Turkish lakes (Solak et al. 2002).

***Nitzschia palea*** (Kützing) W.Smith; Fig. 5: 93

Basionym: *Synedra palea* Kützing

Ref. Krammer & Lange-Bertalot 1991 (p. 85, pl. 59: 1–10), Hofmann et al. 2011 (p. 454, pl. 111: 1–9).

Dimensions of the examined specimens. 34.7–46.3  $\mu\text{m}$  long; 3.5–4.1  $\mu\text{m}$  wide; 8–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K48. The species was found in one sample characterized by moderate electrolyte content (338  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in

Turkey (Solak & Wojtal 2012; Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan and common, especially in  $\alpha$ -mesosaprobic and polysaprobic waters (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous, polysaprobous, hypereutraphentic and fresh-brackish water species.

***Nitzschia paleacea*** (Grunow) Grunow; Fig. 5: 94, 95

Basionym: *Nitzschia subtilis* var. *paleacea* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 114, pl. 81: 1–7), Hofmann et al. 2011 (p. 455, pl. 111: 21–29).

Dimensions of the examined specimens. 23.1–25.7  $\mu\text{m}$  long; 2.9–3.0  $\mu\text{m}$  wide; 13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K44. The species was found in two samples characterized by high electrolyte content (515–745  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora. General distribution and ecology. The species is cosmopolitan and very common in eutrophic waters with moderate or high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobous, eutraphentic and fresh-brackish water species.

***Nitzschia pusilla*** Grunow; Fig. 5: 96–98

Ref. Hofmann et al. 2011 (p. 457, pl. 112: 10–15).

Dimensions of the examined specimens. 18.3–21.7  $\mu\text{m}$  long; 3.3–3.7  $\mu\text{m}$  wide; 15–19 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K32, K33, K34, K37, K40, K41, K51. The species was found in samples characterized by moderate to high electrolyte content (307–834  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. The species is cosmopolitan and common, characterized by a wide ecological tolerance, up to  $\alpha$ -mesosaprobic (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobous, eurytraphentic and fresh-brackish water species.

***Nitzschia recta*** Hantzsch; Fig. 5: 99–101

Ref. Krammer & Lange-Bertalot 1991 (p. 20, pl. 12: 1–11).

Dimensions of the examined specimens. 38.2–71.6



$\mu\text{m}$  long; 4.4–5.0  $\mu\text{m}$  wide; 6–7 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K6, K7, K9, K10, K14, K15, K49. The species was found in samples characterized by moderate to high electrolyte content (263–758  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). General distribution and ecology. According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, eurytraphentic, strictly aquatic and fresh-brackish water species.

***Nitzschia rosenstockii*** Lange-Bertalot; Fig. 5: 102, 103

Ref. Krammer & Lange-Bertalot 1991 (p. 116, pl. 81: 17–20).

Dimensions of the examined specimens. Valves 9.5–11.2  $\mu\text{m}$  long; 3.4–3.8  $\mu\text{m}$  wide; 13–15 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K11, K35, K41, K42, K49. The species was found in several samples characterized by moderate to high electrolyte content (130–609  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia sigma*** (Kützing) W.Smith; Fig. 5: 104–106

Basionym: *Synedra sigma* Kützing

Ref. Krammer & Lange-Bertalot 1991 (p. 32, pl. 23: 1–9).

Dimensions of the examined specimens. 48.7–56.7  $\mu\text{m}$  long; 5.5–5.9  $\mu\text{m}$  wide; 10–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K14, K19, K42. The species was found in a few samples characterized by high to very high electrolyte content (514–1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. According to Van Dam et al. (1994), it is an alkaliphilous,  $\alpha$ -mesosaprobous, eutraphentic and brackish water species.

***Nitzschia sigmoidea*** (Nitzsch) W.Smith; Fig. 5: 107, 108

Basionym: *Bacillaria sigmoidea* Nitzsch

Ref. Krammer & Lange-Bertalot (1991 p. 12, pl. 5: 1–5).

Dimensions of the examined specimens. 125.3  $\mu\text{m}$  long; 8.5  $\mu\text{m}$  wide; 7 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K14,

K15, K16. The species was found in a few samples characterized by high electrolyte content (405–514  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). General distribution and ecology. It is a cosmopolitan diatom, common in mesotrophic and eutrophic waters with moderate and high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, eutraphentic and fresh-brackish water species.

***Nitzschia sociabilis*** Hustedt; Fig. 5: 109–111

Ref. Krammer & Lange-Bertalot 1991 (p. 83, pl. 83: 1–9).

Dimensions of the examined specimens. 20.6–36.8  $\mu\text{m}$  long; 3.5–4.1  $\mu\text{m}$  wide; 8–10 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K6, K7, K8, K9, K10, K15, K21, K26, K28, K36, K49, K50. The species was commonly found in samples characterized by moderate to very high electrolyte content (118–1125  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

General distribution and ecology. It is probably a cosmopolitan diatom species, particularly common in waters with moderate to very high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobous, eutraphentic and fresh-brackish water species.

***Nitzschia solgensis*** A.Cleve-Euler; Fig. 5: 112–114

Ref. Hofmann et al. 2011 (p. 461, pl. 117: 21–25).

Dimensions of the examined specimens. 7.3–18.3  $\mu\text{m}$  long; 2.4–3.6  $\mu\text{m}$  wide; 23–25 striae and 4–5 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K13, K27, K37, K53. The species was found in several samples characterized by moderate to high electrolyte content (327–765  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the eastern Black Sea region (Kızılırmak River by Baytut & Gönüloğlu 2016).

General distribution and ecology. The species is cosmopolitan, particularly common in waters with moderate to very high conductivity,  $\beta$ - and  $\alpha$ -mesosaprobic (Krammer & Lange-Bertalot 1988). In Germany, classified as in regression (Lange-Bertalot 1996). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, aerophilous, meso- to

eutraphentic and fresh-brackish water species.

***Nitzschia solita*** Hustedt; Fig. 6: 115, 116

Ref. Krammer & Lange-Bertalot 1991 (p. 99, pl. 71: 1–12).

Dimensions of the examined specimens. 20.1–24.7  $\mu\text{m}$  long; 4.7–5.1  $\mu\text{m}$  wide; 27 striae and 12–13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K6, K8, K9. The species was found in several samples characterized by moderate to high electrolyte content (478–634  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in Inner Anatolia (Hafik & Tödürge Lakes by Sivacı et al. 2007) and the Mediterranean region (Andık Stream by Kalyoncu et al. 2014).

***Nitzschia soratensis*** Morales & Vis; Fig. 6: 117–119

Ref. Trobajo et al. 2013 (p. 47, figs 28–35).

Dimensions of the examined specimens. 5.5–7.5  $\mu\text{m}$  long; 2.6–3.1  $\mu\text{m}$  wide; 12–14 striae and 5–7 fibulae in 10  $\mu\text{m}$ .

Distribution in Kütahya waters. K9, K35. The species was found in two samples characterized by high electrolyte content (609–634  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia subacicularis*** Hustedt; Fig. 6: 120

Ref. Hofmann et al. 2011 (p. 462, pl. 107: 20–24).

Dimensions of the examined Turkish specimens. 39.9  $\mu\text{m}$  long; 2.9  $\mu\text{m}$  wide; 29 striae and 13 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5. The species was found in one sample characterized by high electrolyte content (515  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the western Black Sea region (Acarlar floodplain by Tunca et al. 2014).

***Nitzschia subtilis*** (Grunow) Hustedt; Fig. 6: 121

Basionym. *Synedra subtilis* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 70, pl. 55: 7–10).

Dimensions of the examined specimens. 44.4–56.9  $\mu\text{m}$  long; 2.5–3.5  $\mu\text{m}$  wide; 15–16 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K17.

The species was found in one sample characterized by high electrolyte content (751  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. This is the first record of the species for the Turkish freshwater diatom flora.

***Nitzschia supralitorea*** Lange-Bertalot; Fig. 6: 122–124

Ref. Krammer & Lange-Bertalot 1991 (p. 97, pl. 70: 14–21), Hofmann et al. 2011 (p. 464, pl. 112: 66–71).

Dimensions of the examined specimens. 12.4–20.2  $\mu\text{m}$  long; 2.7–3.9  $\mu\text{m}$  wide; 24–27 striae and 13–16 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K17, K29, K42, K45. The species was found in several samples characterized by high to very high electrolyte content (541–1502  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found in the Inner Anatolia region (Karagöl by Açıkgöz et al. 2005).

General distribution and ecology. The species is cosmopolitan, particularly common in eutrophic waters with moderate and high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\alpha$ -mesosaprobous, eutraphentic, aerophilous and fresh-brackish water species.

***Nitzschia tabellaria*** (Grunow) Grunow; Fig. 6: 125, 126

Basionym. *Denticula tabellaria* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 53, pl. 39: 10–13), Hofmann et al. 2011 (p. 464, pl. 117: 1–5), Bâk et al. 2012 (p. 260, pl. 76).

Dimensions of the examined specimens. 19.1–20.0  $\mu\text{m}$  long; 7.2–7.8  $\mu\text{m}$  wide; 21–23 striae and 6 fibulae in 10  $\mu\text{m}$ .

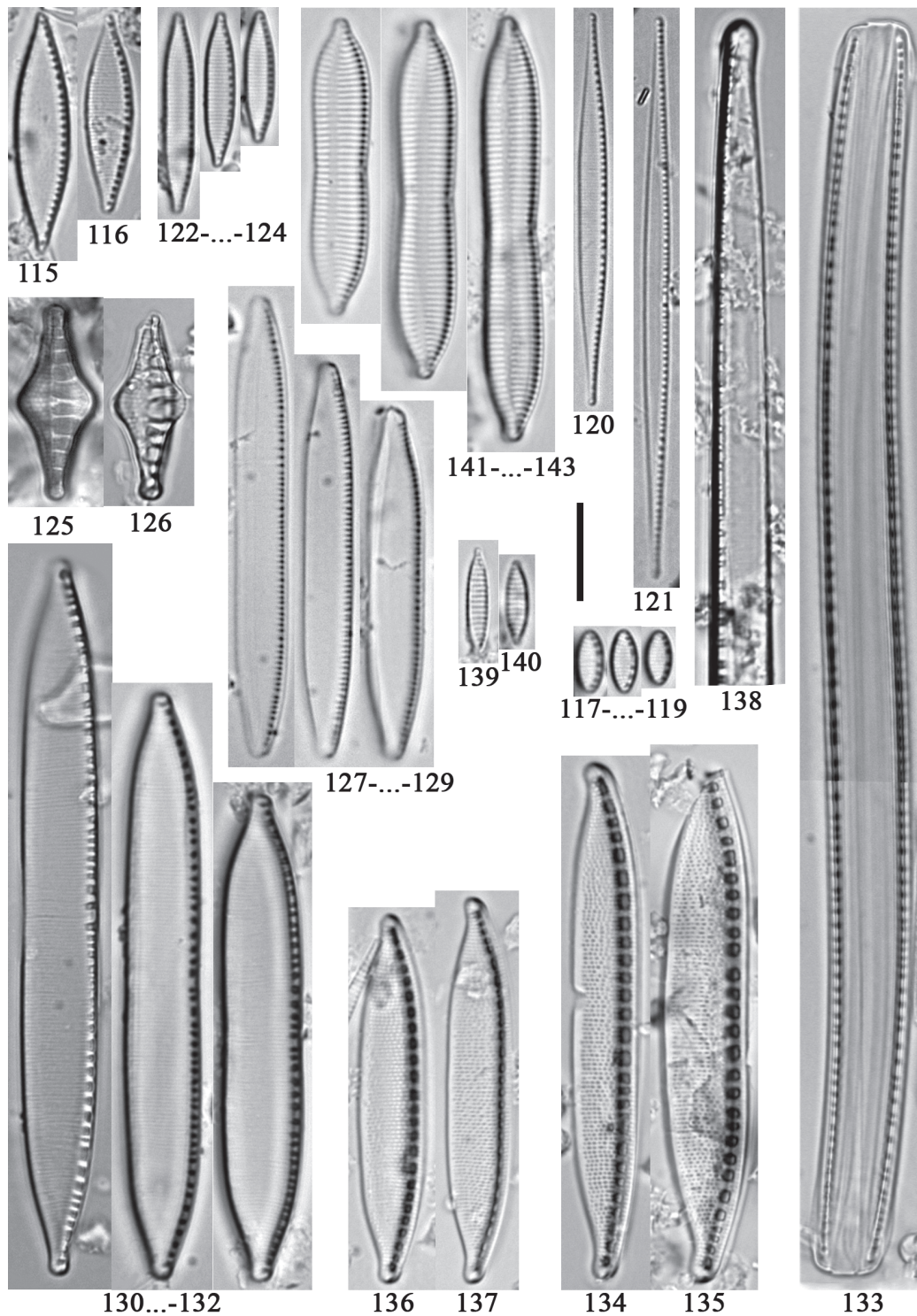
Distribution and ecology in Kütahya waters. K16. The species was found in one sample characterized by moderate electrolyte content (405  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönülol 2017). General distribution and ecology. The species is cosmopolitan (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is a neutrophilous,  $\beta$ -mesosaprobous, mesotraphentic and freshwater species.

***Nitzschia thermaloides*** Hustedt; Fig. 6: 127–129

Ref. Krammer & Lange-Bertalot 1991 (p. 59, pl. 44: 1–7).

Dimensions of the examined specimens. 15.3–48.9  $\mu\text{m}$  long; 3.4–5.8  $\mu\text{m}$  wide; 16–20 fibulae in 10  $\mu\text{m}$ .

**Figure 6**

115–116 – *Nitzschia solita* Hustedt; 117–119 – *N. soratensis* Morales & Vis; 120 – *N. subacicularis* Hustedt; 121 – *N. subtilis* (Grunow) Hustedt; 122–124 – *N. supralitorea* Lange-Bertalot; 125, 126 – *N. tabellaria* (Grunow) Grunow; 127–129 – *N. thermaloides* Hustedt; 130–132 – *N. umbonata* (Ehrenberg) Lange-Bertalot; 133 – *N. vermicularis* (Kützing) Hantzsch; 134, 135 – *N. vitrea* Norman; 136, 137 – *N. vitrea* var. *salinarum* Grunow; 138 – *N. wuellerstorffii* Grunow; 139, 140 – *Simonsenia delognei* (Grunow) Lange-Bertalot; 141–143 – *Tryblionella apiculata* W.Gregory. Scale bar: 10  $\mu\text{m}$

Distribution and ecology in Kütahya waters. K29, K42, K44, K45, K48. The species was found in several samples characterized by moderate to very high electrolyte content (338–1502  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Nitzschia umbonata*** (Ehrenberg) Lange-Bertalot; Fig. 6: 130–132

Basionym: *Navicula umbonata* Ehrenberg

Ref. Krammer & Lange-Bertalot 1991 (p. 65, pl. 51: 1–6A), Hofmann et al. 2011 (p. 467, pl. 105: 4–8).

Dimensions of the examined specimens. 58.1–71.5  $\mu\text{m}$  long; 8.0–8.2  $\mu\text{m}$  wide; 6–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K3, K4, K25, K26, K30, K31, K32, K33, K44. The species was commonly found in samples characterized by high to very high electrolyte content (539–1365  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Nitzschia vermicularis*** (Kützinger) Hantzsch; Fig. 6: 133

Basionym: *Frustulia vermicularis* Kützinger

Ref. Krammer & Lange-Bertalot 1991 (p. 14, pl. 4: 4, 5), Hofmann et al. 2011 (p. 468, pl. 115: 1–3).

Dimensions of the examined specimens. 132.2  $\mu\text{m}$  long; 5.2  $\mu\text{m}$  wide; 8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K9, K25. The species was found in two samples characterized by high electrolyte content (539–634  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017). Most of the data on the distribution of the species come from Turkish lakes (Solak et al. 2002).

General distribution and ecology. The species is cosmopolitan, occurring in oligotrophic and slightly eutrophic waters with moderate or high conductivity (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), it is an alkaliphilous,  $\beta$ -mesosaprobous, eurytraphentic and fresh-brackish water species.

***Nitzschia vitrea*** Norman; Fig. 6: 134, 135

Ref. Krammer & Lange-Bertalot 1991 (p. 72, pl. 56: 1, 2).

Dimensions of the examined specimens. 51.7–52.8

$\mu\text{m}$  long; 6.9–8.9  $\mu\text{m}$  wide; 23–24 striae and 5–6 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K48. The species was found in two samples characterized by moderate to high electrolyte content (338–541  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Nitzschia vitrea* var. *salinarum*** Grunow; Fig. 6: 136, 137

Ref. Krammer & Lange-Bertalot 1991 (p. 73, pl. 56: 3–5).

Dimensions of the examined specimens. 37.5–38.9  $\mu\text{m}$  long; 5.8–6.7  $\mu\text{m}$  wide; 24–26 striae and 7–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K48. The species was found in samples characterized by moderate electrolyte content (338  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the Aegean region (Kütahya lotic waters by Solak et al. 2016).

***Nitzschia wuellerstorffii*** Grunow; Fig. 6: 138

Ref. Krammer & Lange-Bertalot 1991 (p. 13, pl. 6: 1–6), Hofmann et al. 2011 (p. 468, pl. 114: 1–4).

Dimensions of the examined specimens. 6.7–7.7  $\mu\text{m}$  wide; 5.5–6.0 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K5, K24. The species was found in two samples characterized by moderate to high electrolyte content (435–515  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the western Black Sea region (Abant Lake by Çelekli & Külköylüoğlu 2006).

***Simonsenia delognei*** (Grunow) Lange-Bertalot; Fig. 6: 139, 140

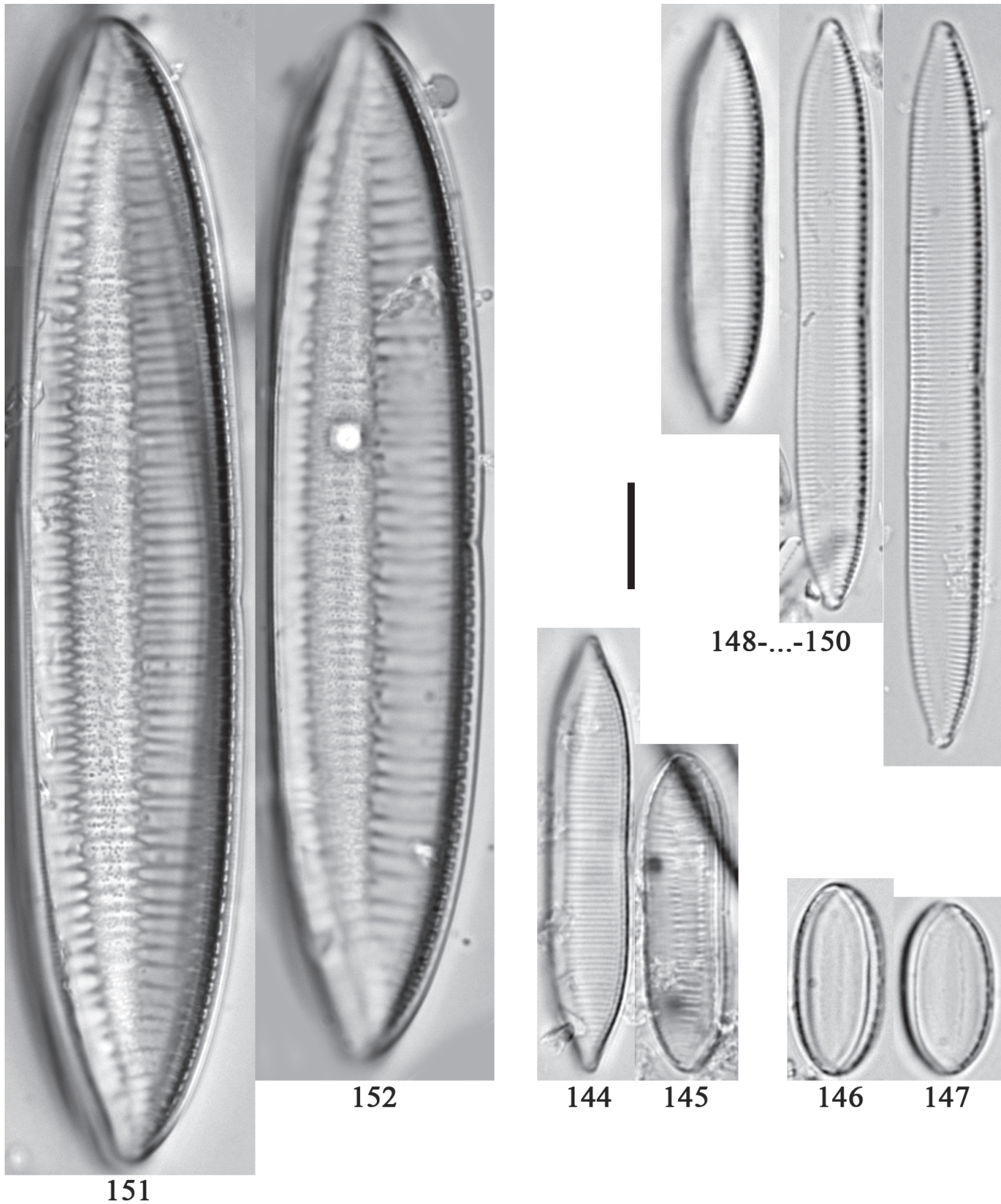
Basionym: *Nitzschia delognei* Grunow in Van Heurck

Ref. Krammer & Lange-Bertalot 1991 (p. 135, pl. 84: 13–19), Hofmann et al. 2011 (p. 540, pl. 47–50).

Dimensions of the examined specimens. 8.5–17.2  $\mu\text{m}$  long; 1.2–2.5  $\mu\text{m}$  wide; 17–21 striae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K17, K18, K50. The species was found in several samples characterized by moderate to high electrolyte content (362–751  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in

**Figure 7**

144, 145 – *Tryblionella calida* (Grunow) D.G.Mann; 146, 147 – *T. debilis* Arnott ex O'Meara; 148–150 – *T. hungarica* (Grunow) Frenguelli; 151, 152 – *Tryblionella* sp. Scale bar: 10  $\mu$ m

the Black Sea (Sarıkum Lagoon by Sivacı et al. 2008), Marmara and Aegean regions (Türkmen Mountain springs and Yalova lotic waters by Witkowski et al. 2016).

General distribution and ecology. According to Van Dam et al. (1994), it is an  $\alpha$ -mesosaprobous, eutrathentic and brackish-freshwater species.

***Tryblionella apiculata*** W.Gregory; Fig. 6: 141–143

Ref. Krammer & Lange-Bertalot 1991 (p. 43, pl. 35: 1–6).

Dimensions of the examined specimens. 27.3–46.6  $\mu\text{m}$  long; 5.3–6.5  $\mu\text{m}$  wide; 15–16 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K2, K5, K7, K9, K10, K15, K16, K19, K28, K31, K32, K33, K36, K43, K45, K51 The species was commonly found in samples characterized by moderate to very high electrolyte content (118–1502  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Tryblionella calida*** (Grunow) D.G.Mann; Fig. 7: 144, 145

Basionym: *Nitzschia calida* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 40, pl. 30: 1–5), Hofmann et al. 2011 (p. 437, pl. 103: 5–8).

Dimensions of the examined specimens. 37.3–47.9  $\mu\text{m}$  long; 7.8–8.2  $\mu\text{m}$  wide; 6–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K8, K9, K10, K14, K15, K33. The species was found in samples characterized by moderate to high electrolyte content (405–834  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon was found only in the western Black Sea region (Karagöl-Aksaz marsh by Sivacı 2013).

***Tryblionella debilis*** Arnott ex O'Meara; Fig. 7: 146, 147

Ref. Krammer & Lange-Bertalot 1991 (p. 39, pl. 27: 9–11), Hofmann et al. 2011 (p. 440, pl. 102: 12–17).

Dimensions of the examined specimens. 15.8–20.9  $\mu\text{m}$  long; 6.8–8.0  $\mu\text{m}$  wide; 8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K12, K20, K51. The species was found in several samples characterized by low to high electrolyte content (88–758  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Gönüloğlu 2017).

***Tryblionella hungarica*** (Grunow) Frenguelli; Fig. 7: 148–150

Basionym: *Nitzschia hungarica* Grunow

Ref. Krammer & Lange-Bertalot 1991 (p. 37, pl. 34: 1–3), Hofmann et al. 2011 (p. 449, pl. 104: 3–7).

Dimensions of the examined specimens. 32.3–62.0  $\mu\text{m}$  long; 7.7–8.5  $\mu\text{m}$  wide; 10–12 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K7, K9, K10, K17, K28, K30, K32, K33, K35, K36, K42. The species was commonly found in samples characterized by low to very high electrolyte content (118–1449  $\mu\text{S cm}^{-1}$ ).

Distribution in Turkey. The taxon is widespread in Turkey (Solak & Wojtal 2012; Gönüloğlu 2017). Most of the data on the distribution of the species come from Turkish lakes (Solak et al. 2002).

General distribution and ecology. The species is cosmopolitan, common in brackish water, up to  $\alpha$ -mesosaprobic (Krammer & Lange-Bertalot 1988). According to Van Dam et al. (1994), an alkaliphilous,  $\alpha$ -mesosaprobous, eutrathentic, strictly aquatic and brackish-freshwater species.

***Tryblionella sp.***; Fig. 8: 151, 152

Dimensions of the examined Turkish specimens. 72.3–115.0  $\mu\text{m}$  long; 18.9–21.7  $\mu\text{m}$  wide; 7–8 fibulae in 10  $\mu\text{m}$ .

Distribution and ecology in Kütahya waters. K42. The species was found in samples characterized by a very high electrolyte content (1449  $\mu\text{S cm}^{-1}$ ).

Remarks. The species is morphologically similar to *N. tryblionella*. The central area in *N. tryblionella* is straight, but appears as a visible “knob-like” shape in the central part of a hitherto unknown species. *Nitzschia tryblionella* has more visible ridges on the valve face. The taxon is also morphologically similar to *Nitzschia littoralis* Grunow. However, our unidentified taxon is larger in size and has visible ridges on the valve face.

## Discussion

This study reports a total of 65 taxa belonging to six genera of the order Bacillariaceae: *Cylindrotheca*, *Denticula*, *Hantzschia*, *Nitzschia*, *Simonsenia* and *Tryblionella*. Given the large number of described species in *Nitzschia* – DiatomBase reports over 2800 described names in this genus (Kociolek et al. 2018), which makes it by far the largest genus in the order, it is not surprising that 52 of the 65 taxa identified are

classified into *Nitzschia*. Krammer and Lange-Bertalot (1991) recognized about 15 subgroups within *Nitzschia*, eight of which are represented in the watersheds of the Kütahya region. Species representing the groups: Nitzschiellae (*N. acicularis*), Dissipatae (*N. dissipata*), Obtusae (*N. clausii*), Dubiae (*N. dubia*), Sigmoideae (*N. sigma*), Grunowiae (*N. tabellaria*), Lanceolatae (*N. palea*) and Lineares (*N. linearis*) were found in the study region.

Almost all taxa found during this study were characterized as benthic taxa (Hustedt 1930; Krammer & Lange-Bertalot 1991) and their presence in the collections from the Kütahya region reflects the slow current of most of its water bodies. In addition, several of these taxa were found in warm or hot waters, as some of the surveyed locations contained wastewater from health resorts (e.g. K42-Naşa thermal waters or K32-Eynal thermal waters). These locations were characterized by high species richness of Bacillariaceae. Members of this group are known to occur in thermal springs (Nikulina & Kociolek 2011).

Finally, we have recorded nearly 20% (15 out of a total of 65 taxa) of the species reported in the first reports for Turkey, even though they are well-known taxa. This demonstrates that our knowledge of the Turkish freshwaters is still in its infancy.

Future work on the freshwater diatom flora of Turkey should involve studies of specific characteristic features of species, such as striae patterns, areolae, the keel raphe system and others, of the new species and of the first records using a scanning electron microscope. Such research will certainly contribute to the identification of species groups based on morphology, the identification of keystone species from those previously described, some cryptic species (difficult to identify) such as *Nitzschia palea* or *N. amphibia*, and a more accurate assessment of the identity of taxa present in the Turkish flora. We expect to identify additional members of this taxonomically challenging group and to describe taxa that are new to science.

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