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Epiphytic diatoms (Diatomeae) from Piraquara II urban reservoir, Paraná state

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Abstract: We conducted a taxonomical study of epiphytic diatoms on the macrophytes *Polygonum hydropiperoides*, *Ludwigia peruviana* and *Alternanthera philoxeroides* collected in the mesotrophic reservoir Piraquara II flooded in 2009, located in the state of Paraná. A total of 135 infrageneric taxa were identified, among them five at generic level and other five are first records to the state. We provided illustration, valve metrics, meristics limits and taxonomic reference for each taxon. Also, life forms and species frequency are given. The most frequent diatoms totalized 15.3% of total identified taxa and sporadic species represented 54.7%. *Achnanthidium minutissimum* (Kützing) Czarnecki and *Brachysira neoexilis* Lange-Bertalot occurred in more than 90% of analyzed samples. Among the very frequent diatoms we found other species included in *Achnantidium, Fragilaria* and *Eunotia*. The solitary *Discotella stelligera* (Cleve & Grunow) Houk & Klee and the short chain *Aulacoseira tenella* (Nygaard) Simonsen are free living species that entangle among diatoms from the biofilm.

Keywords: *Bacillariophyta, freshwater, macrophytes, mesotrophic, periphyton, taxonomy.*

Diatomáceas epifíticas (Diatomeae) no reservatório urbano Piraquara II, estado do Paraná

Resumo: Realizamos um estudo taxonômico das diatomáceas epifíticas nas macrófitas: *Polygonum hydropiperoides, Ludwigia peruviana* e *Alternanthera philoxeroides*, coletadas no reservatório Piraquara II, uma represa urbana mesotrófica inundada em 2009, localizado no estado do Paraná. Um total de 135 táxons infragenéricos foi determinado, entre os quais cinco foram citações pioneiras para o Estado. Ilustrações, limites métricos, merísticos e referências taxonômicas para cada táxon foram providenciadas. Também, dados sobre formas de vida e frequência das espécies foram adicionados. As diatomáceas mais frequentes totalizaram 15,3% dos táxons determinados e as espécies esporádicas representaram 54%. *Achnanthidium minutissimum* (Kützing) Czarnecki and *Brachysira neoexilis* Lange-Bertalot ocorreram em mais de 90% das amostras analisadas. Dentre as diatomáceas muito frequentes encontram-se outras espécies de *Achnanthidium, Fragilaria* e *Eunotia. Discostella stelligera* (Cleve & Grunow) Houk & Klee, uma diatomácea solitária, e *Aulacoseira tenella* (Nygaard) Simonsen, com cadeias curtas, são espécies livres que se emaranham entre as diatomáceas do biofilme.

Palavras-chave: *Bacillariophyta, água doce, macrófitas, perifíton, taxonomia.*

Introduction

Stems of emergent macrophytes are suitable colonizable surfaces to epiphyton communities and are particularly able to transfer a small amount of nutrients to their epiphytes (Cattaneo & Kalff, 1979). As periphytic diatoms are sensitive to eutrophication, it is important to record the species that occured at present for comparision to the future assemblies, helping to understand the relationship between the species and the trophic level of aquatic system. Informations about biodiversity represent a useful tool for ecological and applied studies, but an accurate taxonomy is fundamental. Identification to species level is time consuming and sometimes difficult, but useful and necessary to future ecological studies (Kociolek 2005) in this urban reservoir.

Cetto et al. (2004), Silva et al. (2010), Bertolli et al. (2010) and Faria et al. (2010) provided recent diatom inventories from eutrophic and mesotrophic urbans reservoirs: Iraí, Passaúna and Itaqui. Also, Faria et al. (2013) selected tolerant diatom species from Itaqui reservoir. There are no related studies in the recently flooded Piraquara II urban reservoir. Bittencourt & Gobbi (2006) evaluated phosphorous total maximum daily load in the drainage area of Piraquara II reservoir before flooding. The study demonstrated the reservoir present high potencial to eutrophication due to the intense agricultural use of soil and shallow water. The urban reservoirs have been suffering severe anthropogenic nutrients inputs and consequently eutrophication is accelerated (Calisto et al., 2014) and periphyton may respond by changes in abundance and taxonomic composition (Stoermer & Smol 2004).

We conducted a taxonomical study of epiphytic diatoms in Piraquara II reservoir. For each taxon, we provided illustration, valve metrics and meristics limits, occurence, and literature to species taxonomic determination. The taxa first registered to state of Paraná were also described and commented.

Materials and Methods

Piraquara II reservoir (25º30' S and 49º00' W) is located in a preservation area and was built in 2008 by the dam of Piraquara river, inserted in the Iguaçu watershed, Paraná state, south Brazil (Figure 1). This shallow reservoir with 75 days of water retention time is used for public supply (depth 3.7 m, area 5.64 km^2, drainage area 58 km^2), and is mesotrophic most part of the year (Table 1, SANEPAR, 2013, unpublished data) with Trophic State Index (TSI) around 54 from 55 TSI (SANEPAR, 2010-2014, unpublished data). The main economic activities in the vicinity are the livestock and corn culture (Bittencourt & Gobbi 2006).

Epiphytic diatoms were sampled in June and November 2013 from stems of the emergent macrophytes *Polygnum hydropiperoides* Michaux (Polygonaceae), *Ludwigia peruviana* (L.) H. Hara (Onagraceae) and the amphibious *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae). The macrophytes were collected according to the local availability in six sampling sites (1-6) along the reservoir (Table 2, Figure 1), three stems (a,b,c) from each core were collected. Diatoms were scrapped off the substrates surfaces with an aluminium spatule, and the samples were cleaned with $KMnO_4$ and HCl (Simonsen 1974 modified by Moreira-Filho & Valente-Moreira 1981). Light microcopy-slides were mounted with Naphrax® and analyzed under Olympus BX40 microscope. Illustrations were captured by DP71 digital equipment. Cleaned samples were prepared and analised at JEOL JSM 6360LV scanning electron microscope (Eletronic Microscopy Center - Federal University of Paraná). Valve terminology followed Barber & Haworth (1981) and Round et al. (1990). Frequencies of occurrence were stablished based on Mateucci & Colma (1982): species as high frequent ($F \geq 70\%$), frequent ($40\% \leq F < 70\%$), low frequent ($10\% \leq F < 40\%$) and sporadic ($F < 10\%$).

The examined slides and samples were housed at the herbarium of the Universidade Federal do Paraná (UPCB) (Table 2). First recorded taxa to the state of Paraná and those identified to the generic level were described and commented. Diatoms were identified to the lowest taxonomical level according to current taxonomic literature. The references used to identify each taxon even as metrics and meristics limits are listed on Table 3.

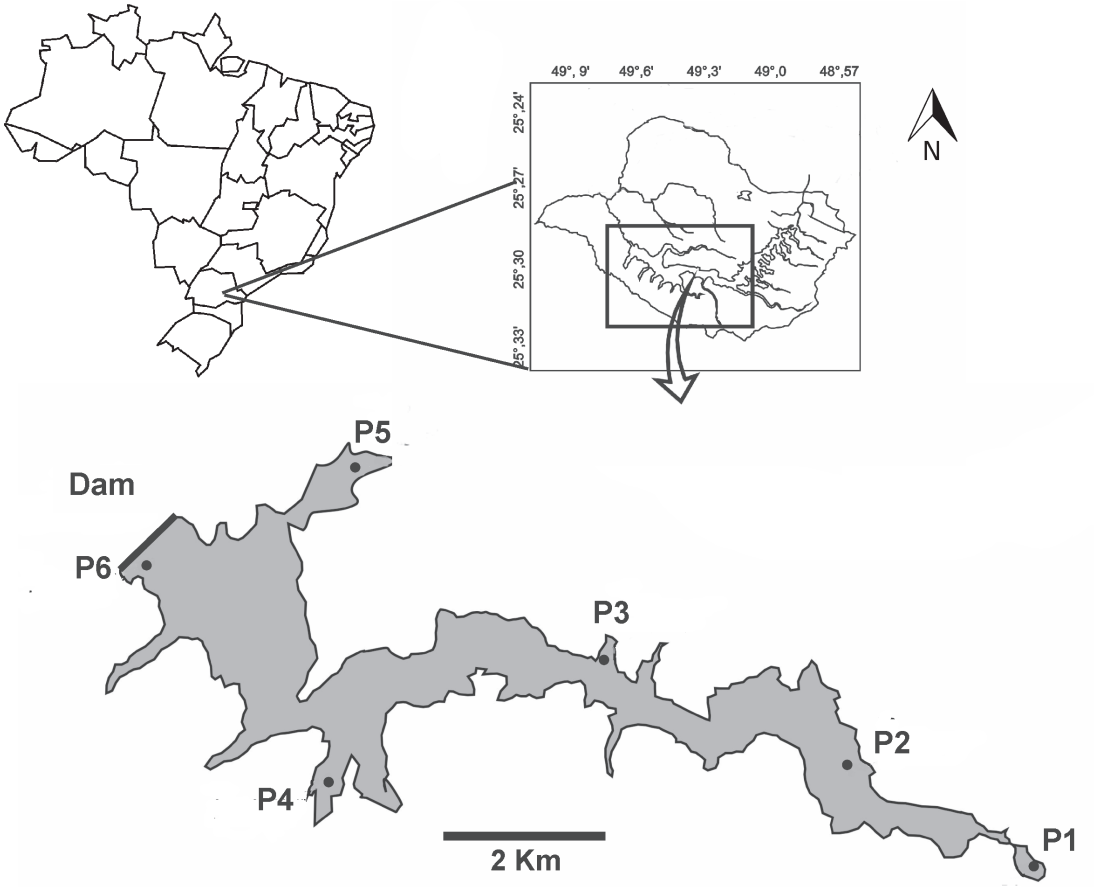

Figure 1. Localization of sampling sites in Piraquara II reservoir. Piraquara municipality, Paraná state, Brazil (modified from Google Earth 2013)

Table 1. Average set of abiotic data in the months of sampling epiphyton

Date	DO (mg/L)	Secchi (m)	pH	COD (mg/L)	TN (mg/L)	TP (mg/L)	TDS (mg/L)	Turbidity (NTU)	IQA
Jun/2013	6.7	2.7	6.8	12.8	1.4	0.025	46.0	3.0	84.5
SD	±0.3	±1.3	±0.3	±8.1	±0.3	±0	±7.0	±0.3	±5.2
Nov/2013	7.24	1.4	6.95	12.66	0.5	0.025	35.0	3.55	84,33
SD	±0.07	±0	±0.25	±5.43	±0	±0	±0	±0.75	±5.31

*DO: dissolved oxygen; COD: Chemical oxygen demand; TN: Total Nitrogen dissolved; TP: Total phosphorus dissolved; TDS: Total dissolved solids; IQA: Index Water Quality; SD: standard deviation.

SANEPAR (2013), unpublished data

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Table 2. Piraquara II reservoir informations. Collected species of macrophytes, sampling sites and sample register number at Universidade Federal do Paraná Herbarium (UPCB).

Sampling sites	Coordinates	Sampled macrophytes	UPCB	
1	S 25º30'38.2" W 49º1'38.2"	*Polygnum hydropiperoides*	78032	78044
2	S 25º30'23.2" W 49º2'12.6"	*Ludwigia peruviana*	78033	78045
3	S 25º29'42.9" W 49º3'28.4"	*Althernanthera philoxeroides* *Polygnum hydropiperoides*	78034	78046
4	S 25º30'18.4" W 49º2'44.1"	*Althernanthera philoxeroides* *Polygnum hydropiperoides*	78035	78047
5	S 25º28'47.3" W 49º4'42.1"	*Polygnum hydropiperoides*	78036	78048
6	S 25º29'30.1" W 49º5'38.9"	*Polygnum hydropiperoides*	78037	78049

Table 3. List of diatom taxa identified from Piraquara II reservoir. Morphometric & meristics limits, occurrence in samples & consulted literature. D: diameter (µm); L: length (µm); W: width (µm); SH: semi cell height (µm); S: striae in 10 µm; A: areolae in 10 µm; F: fibulae in 10 µm; AC: aliform chanells in 10 µm.

Species Name (Figure)	Metric (µm) & meristic (in 10 µm) limits	Month of occurrence at sampling sites		Consulted literature
		June	November	
Stephanodiscaceae				
Cyclotella meneghiniana Kützing (Figure 2)	D:9.9-15; S:10-12	4b, 6b		Krammer & Lange-Bertalot (1991a)
Discostella stelligera (Cleve & Grunow) Houk & Klee (Figures 3-4)	D:7.4-13.9; S:8-13	1a, 2abc, 3abc 4abc, 5abc, 6abc	2ab, 3ab, 4ac, 5ab, 6ab	Houk et al. (2010)
Aulacoseiraceae				
Aulacoseira ambigua (Grunow) Simonsen var. *ambigua* f. *ambigua* (Figures 15-16)	SH:7.1-12.2; D:6-7.5; S:8	1ab, 2abc, 3abc, 4abc, 5abc, 6abc	2b, 3ac, 4b, 5b, 6b	Krammer & Lange-Bertalot (1991a)
A. ambigua var. *ambigua* f. *spiralis* (Skuja) Ludwig & Valente-Moreira (Figure 10)	SH:10.9; D:3.9; S:14	3c		Ludwig & Valente-Moreira (1990)
A. brasiliensis Tremarin, Torgan & T. Ludwig (Figure 11)	SH:3.8-6.5; D:8.4-9.8; S:13-14; A:6-8	1b, 2abc, 3ac, 5a, 6a, 6b	1b	Tremarin et al. (2012)
A. granulata var. *angustissima* (O. Müller) Simonsen (Figures 17-18)	SH:11.5-14.8; D:2.7-2.8; S:3; A:14-15	2abc, 3ab, 4ac, 5a, 6abc	4c, 6c	Krammer & Lange-Bertalot (1991a)
A. granulata (Ehrenberg) Simonsen var. *granulata* (Figure 25)	SH:13.7-13.8; D:5.1-5.2; S:5-6; A:16-17	2abc, 3abc, 4abc, 5abc, 6abc	2c,3ab, 4c, 5b, 6abc	Krammer & Lange-Bertalot (1991a)
A. herzogii (Lemmermann) Simonsen var. *herzogii* (Figures 12-14)	SH: 3.7-7.1; D: 3.3-5.9	2bc, 4b, 5b, 6bc		Hickel & Häkansson (1991)
A. tenella (Nygaard) Simonsen (Figures 8-9)	SH:0.7-1.7; D: 5.6-6	1bc, 2bc, 3abc, 4abc, 5abc, 6c	2a, 3abc, 5bc, 6ac	Siver & Kling (1997), Camburn & Charles (2000)
Aulacoseira sp. (Figures 5-7)	SH:1-1.8; D:4.5-4.9	2bc, 3ab, 4ac, 5abc	6c	
Fragilariaceae				
Fragilaria mesolepta Rabenhorst (Figure 19)	L:21.8; W:2.8; S:16		5a	Tuji & Williams (2008b)
F. crotonensis Kitton (Figures 31-34)	L:60.8-76; W:2-2.6; S:17	4c, 6b, 2abc, 3b, 4ab, 5abc, 6abc	1ac	Patrick & Reimer (1966)
F. gracilis Ostrup (Figures 26-28)	L:40.2; W:2.2; S:22	4b	2c, 3a, 4bc, 5c, 6ac	Krammer & Lange-Bertalot (1991a)
F. parva (Grunow) Tuji & Williams (Figures 40-43)	L:26.6-51.6; W:2.5-2.6; S:15-16	1b, 2abc, 3ab, 4ac, 6abc	1b, 2abc, 3b, 4c, 5abc, 6abc	Tuji & Williams (2008c)
F. pectinallis (Müll) Lyngbye (Figures 21-24, 220-222)	L:20.8-28.0; W:3.5-3.1; S:16-18	1a, 2ac, 3abc, 4abc, 5a, 6abc	1c, 2b, 4bc, 5bc, 6abc	Tuji & Williams (2008a) as *F. capitellata* (Grun.) Pet., Wetzel & Ector (2015)
F. tenera (W. Smith) Lange-Bertalot (Figures 35-37)	L:34.6-49.4; W:1.9-3.0; S:20	1abc, 2c, 3abc, 4abc, 5abc, 6abc	1a, 2ab, 3b, 4bc, 5b, 6a	Zelazna-Wieczorek (2011)
F. microvaucheriae Wetzel & Ector (Figures 29-30)	L:10.7-11.4; W:4.1-4.4; S:9-10	2abc, 3b, 4abc, 6b	2abc, 3c, 4bc, 6ab	Tuji & Williams (2006)
Fragilariforma javanica (Hustedt) Wetzel, Morales & Ector (Figure 20)	L:27.9-69.8; W:5.5-6.1; S:19	2c	2b	Wetzel et al. (2013a)
Ulnaria acus (Kützing) Aboal (Figure 38)	L:114.9-140.7; W:3.2-3.4; S:16		1a	Levkov et al. (2007)
U. ulna (Nitzsch) Compère (Figure 39)	L:91.2; W:4.9; S:11	1b, 2b, 3b, 4c, 5a, 6ac	2abc, 6ab	Levkov et al. (2007)
Eunotiaceae				
Actinella leontopithecus-rosalia Costa (Figure 52)	L:25.1; W:3.2; S:18		1c, 5b	Costa (1995), Tremarin et al. (2016)

Table 3. Continued...

Species Name (Figure)	Metric (µm) & meristic (in 10 µm) limits	Month of occurrence at sampling sites		Consulted literature
		June	November	
Desmogonium ossiculum Metzeltin & Lange-Bertalot (Figure 73)	L:114.1-186.9; W:8.7; S:14-15	2c, 3a	2a	Metzeltin & Lange Bertalot (2007)
D. transfugum (Metzeltin & Lange-Bertalot) Metzeltin & Lange-Bertalot (Figure 74)	L:139.5-198.7; W:4.4-6.1; S:14-16	1a		Metzeltin & Lange-Bertalot (1998,)
*Eunotia bilunaris (*Ehrenberg) Mills (Figure 48)	L:22-43.7; W:3.1-3.4; S:17	1abc, 2bc, 3a, 4a, 5a, 6bc	1ab, 2ab, 3a, 4ac, 5bc, 6c	Lange-Bertalot & Metzeltin (1996)
E. camelus Ehrenberg (Figures 54-55)	L:23.2-44.2; W:5.4-8.5; S:11-14	1ab, 2a	1bc, 5b	Reichardt (1995), Metzeltin et al. (2005)
Eunotia cf. formicina Lange-Bertalot (Figure 53)	L:46.2-49.8; W:6-6.4; S:13-15	2c		Lange-Bertalot et al. (2011)
E. desmogonioides Metzeltin & Lange-Bertalot (Figure 72)	L:109.3-125.5; W:5.8-6.7; S:15	1a, 3ab, 5ab	2b	Metzeltin & Lange-Bertalot (2002)
E. intermedia (Krasske) Nörpel-Schempp & Lange-Bertalot (Figures 49-50)	L:9.7-17.8; W:2.9-3.1; S:14-15	1ac, 2abc, 3bc, 4ab, 5abc, 6abc	1abc, 2abc, 3abc, 5b, 6bc	Lange-Bertalot et al. (2011)
E. luna var. *trapezica* Hustedt (Figure 59)	L:28.7; W:11; S:12	6b		Frenguelli (1941), Simonsen (1987)
E. meridiana Metzeltin & Lange-Bertalot (Figure 56-58)	L:17.2-26.9; W:4-5; S:12-13	2a, 4b, 6b	1abc, 3ab,4b, 5c, 6bc	Metzeltin & Lange-Bertalot (1998)
E. monodon Ehrenberg (Figure 45)	L:69.2; W:9.5; S:10	4a		Hofmann et al. (2013)
E. minor (Kützing) Grunow (Figure 44)	L: 19.9-31.8; W:4.1-5.1; S: 14-17	3c, 6b	2ab, 3ab, 4bc, 6a	Lange-Bertalot et al. (2011)
E. naegelii Migulla (Figures 46-47)	L:61.1-106.6; W:2.5-2.9; S:16-20	1ab, 3c	3a	Krammer & Lange-Bertalot (1991a)
E. neocompacta Mayama (Figure 51)	L:18.4; W:2.7; S:20		6a	Lange-Bertalot et al. (2011)
E. paratridentula Lange-Bertalot & Kulikovskiy (Figure 61)	L:13.6-15.4; W:3-3.3; S:22	2abc		Kulikovskiy et al. (2010)
E. pseudosudetica Metzeltin, Lange-Bertalot & García-Rodríguez (Figure 63-64)	L:29.1-59.9; W:4.1-5.2; S:12	1abc, 2abc, 3b, 4ab, 5abc, 6abc	1abc, 2abc,3abc,4abc, 5b, 6abc	Metzeltin et al. (2005)
E. pyramidata Hustedt var. *pyramidata* (Figure 60)	L:19.5-33.4; W:5.9-8.8; S:13-15		5b	Frenguelli (1941)
E. rabenhorstii var. *monodon* Cleve & Grunow (Figure 62)	L:17.6; W:6.5; S:13	1a		Patrick & Reimer (1966)
E. yanomami Metzeltin & Lange-Bertalot (Figures 65-67)	L: -89 -152.7; W: 17.2-18.7; S:10-13	6b,c		Metzeltin & Lange-Bertalot (1998)
Cymbellaceae				
Cymbella aspera (Ehrenberg) Cleve (Figure 91)	L:108.4-158.3; W:20.6-25.2; S:9-10; A:10-11	2c, 5bc, 6ac	5a	Patrick & Reimer (1975), Krammer (2002)
Cymbopleura naviculiformis var. *naviculiformis* (Auerswald) Krammer (Figure 71)	L:27.5-31.9; W:7.1-7.9; S:14	2bc, 4c, 5bc, 6abc	5b,6c	Krammer (2003)
Encyonema incurvatum Krammer (Figures 68-70)	L:27.2-32.2; W:7.5-8.1; S:10-11	1a, 2abc, 3a, 4abc, 6ab	5b, 6c	Krammer (1997a)
E. neogracile Krammer (Figure 80)	L:26.4-47.4; W:5.5-7.6; S:12-14	1abc, 2abc, 3bc, 4bc, 5abc, 6abc	1c, 2abc, 3b, 4c, 5b, 6c	Krammer (1997a)
E. silesiacum (Bleisch) Mann (Figures 75-77)	L:20.5-24.7; W:6.5-8.1; S:10-13	2a, 6b	2b	Krammer (1997a)
E. vulgare var. *vulgare* Krammer (Figure 78)	L:31.4; W:8.6; S:10	4c		Krammer (1997a)
Encyonopsis frequentiformis Metzeltin & Krammer (Figure 79)	L:38.4-39.7; W:9.3-9.5; S:15-16		3a, 3b,4b,5b	Metzeltin & Lange-Bertalot (1998)
E. microcephala (Grunow) Krammer (Figures 95-96)	L:17.6-23.1; W:4.0; S:23-24	2abc, 3ab, 4c, 5bc, 6abc	3a, 5b	Krammer (1997b)
Geissleria lateropunctata (Wallace) Potapova & Winter (Figure 89)	L:20.5-21.8; W: 7.1-7.7; S: 18-19	2a, 4c, 5b, 6c.	6b	Kulikovskiy et al. (2014)
G. punctifera (Hustedt) Metzeltin, Lange-Bertalot **&** García-Rodríguez (Figure 88)	L:20.8-25.5; W:6.3-6.6; S:17	2b, 6a		Kulikovskiy et al. (2014), Torgan & Oliveira (2001)
Placoneis elginensis (Gregory) Cox (Figures 81-82)	L:30.2-34.8; W:9.9-10.1; S:13	4a		Hustedt (1961-1966), Hofmann et al. (2013)

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Table 3. Continued...

Species Name (Figure)	Metric (µm) & meristic (in 10 µm) limits	Month of occurrence at sampling sites		Consulted literature
		June	November	
Placoneis symmetrica (Hustedt) Lange-Bertalot (Figure 83)	L:31.8; W:9.6; S:12	4b		Cox (2003), Hofmann et al. (2013)
Gomphonemataceae				
Gomphonema guaraniarum Metzeltin & Lange-Bertalot (Figures 84-87)	L:68.6-54.7; W:11.1-11.5; S:10-11	1abc, 2ab, 3ac, 4bc, 5bc, 6abc	1ab, 2ab, 3ac, 4bc, 5bc	Metzeltin & Lange-Bertalot (2007)
G. hawaiiensis Reichardt (Figure 103)	L:35.2; W:7.3; S:16.	6b		Reichardt (2005)
G. lagenula Kützing (Figure 104)	L:15.6-21.1; W:5.4-6.1; S:16	1abc, 2abc, 3abc, 4abc, 5abc, 6ab	1a,c, 3ab, 6c	Krammer & Lange-Bertalot (1991b)
G. graciloides Hustedt (Figures 97-101, 214-216)	L:25.4-47.9; W:7.8-8.5; S:11-14	1c		Reichardt (2015)
G. naviculoides W. Smith (Figures 116-117, 213)	L:29.1-56.3; W:6.6-9.3; S:14-16	1abc, 2ab, 3ac, 4bc, 5bc, 6abc	2b, 3a, 4c, 5b,6bc	Reichardt (2015)
G. parvulum (Kützing) Van Heurck var. *parvulum* (Figure 121-122)	L:13.9-17.6; W:3.9-4.4; S:15	1bc, 2a, 3a, 5a	1bc,3a, 6c	Krammer & Lange-Bertalot (1991b)
G. parvulum f. *saprophilum* Lange-Bertalot & Reichardt (Figure 120)	L:11.8-16.4; W:4.6-6.4; S:17	1abc, 2ab, 3ac, 4bc, 5bc, 6a	1abc, 3ac, 5bc, 6a	Krammer & Lange-Bertalot (1991b)
G. parvulum var. *subcapitata* Grunow (Figure 90)	L:12.7-26.1; W:3.7-4.8; S:12-15	1abc, 2ab	1abc	Van Heurck (1880), Krammer & Lange-Bertalot (1986)
G. pseudoaugur Lange-Bertalot (Figures 92-94)	L:27.5-31.8; W:7.2-8.3; S:15	3a	6c	Krammer & Lange-Bertalot (1986)
G. subtile Ehrenberg (Figure 102)	L:48.2; W:7.83; S:9	4b		Krammer & Lange-Bertalot (1986) Patrick & Reimer (1975)
Gomphonema sp. (Figures 118-119)	L:23.6-33.2; W:3.8-4.1; S:14	1abc, 2c		
Achnanthidiaceae				
Achnanthidium caledonicum (Lange-Bertalot) Lange-Bertalot (Figures 105-107)	L:17.4-24.8; W:2.5-2.7	1abc, 2abc, 3abc, 4ac, 5abc, 6abc	1abc, 2b,3ab, 4bc,5b, 6ab	Wojtal et al. (2011)
A. catenatum (Bily & Marvan) Lange-Bertalot (Figures 110-112)	L: 13.6-18.7; W:2.9	1abc, 2ab, 3abc, 4abc, 5abc, 6abc	1b, 2b, 3a, 5b, 6c	Krammer & Lange-Bertalot (1991b)
A. eutrophilum (Lange-Bertalot) Lange-Bertalot (Figures 125-126)	L:8.3-10.7; W:3-3.1	1ab, 2bc, 3ab, 4ac, 5bc, 6a	1abc, 5a	Hlúbiková et al. (2011)
A. exiguum (Grunow) Czarnecki (Figures 123-124)	L:10.6-13.8; W:4.4-4.9	4c		Krammer & Lange-Bertalot (1991b)
A. macrocephalum (Hustedt) Round & Bukhtiyarova (Figures 114-115, 219)	L:9.1-11.6; W:2.6-2.7	1ab, 2abc, 3abc, 4abc, 5abc, 6abc	1abc, 2b, 3bc, 5b, 6bc	Ponader & Potapova (2007), Taylor et al. (2007)
A. minutissimum (Kützing) Czarnecki (Figure 113)	L:7.9-16.4; W:2.5-3.1	1abc, 2abc, 3abc, 4abc, 5abc, 6bc	1abc, 2b, 3abc, 4abc, 5ab, 6abc	Potapova (2009), Siver & Hamilton (2011)
Lemnicola hungarica (Grunow) Round & Basson (Figure 129)	L:23.1; W:7.1; S:20		1b	Round & Basson (1997)
Planothidium biporomum (Hohn et Hellerman) Lange-Bertalot (Figure 130)	L:21.7; W:6.8; S:13	2b		Wetzel et al. (2013b)
P. heteromorphum (Grunow) Lange-Bertalot (Figures 131-132)	L:34.5; W:13.1; S:10	4b		Metzeltin & Lange-Bertalot (1998)
P. rostratum (Oestrup) Lange-Bertalot (Figures 108-109)	L:12.6; W:5; S:14	3a		Krammer & Lange-Bertalot (1991b), Levkov et al. (2007)
Diadesmidaceae				
Humidophila contenta (Grunow) Lowe *et al.* (Figure 128)	L:7.5; W:2.2	1a, 2a, 2b		Metzeltin & Lange-Bertalot (2007), Lowe et al. (2014)
H. implicata (Moser, Lange-Bertalot & Metzeltin) Lowe *et al.* (Figure 127)	L:10.4; W:2.9	5a		Lowe et al. (2014)
Amphipleuraceae				
Frustulia acidophilissima Wydrzycka & Lange-Bertalot (Figure 156)	L:31.8; W:10.8	2a, 4b	6a	Metzeltin & Lange-Bertalot (2007)
F. crassinervia (Brébisson) Costa (Figures 133-134)	L:32.7-34.2; W:7.9-8.8	1ab, 2abc; 6ab	5b	Metzeltin & Lange-Bertalot (1998)
F. guayanensis Metzeltin & Lange Bertalot (Figure 137)	L:34.5-34.4; W:7.8-7.6	2a, 6c		Metzeltin & Lange-Bertalot (1998)
F. quadrisinuata Lange-Bertalot (Figure 157)	L:58.9; W:14.5	6b		Metzeltin & Lange-Bertalot (1998)
F. undosa Metzeltin & Lange-Beratlot (Figures 135-136)	L:32.7-39.1;W:8.4-9.2	2abc, 6b		Metzeltin & Lange-Bertalot (1998) Metzeltin & Lange-Bertalot (2007)

Table 3. Continued...

Species Name (Figure)	Metric (µm) & meristic (in 10 µm) limits	Month of occurrence at sampling sites		Consulted literature
		June	November	
Brachysiraceae				
Brachysira brebissonii Ross (Figure 140)	L:16.9-24.3;W:4.5-6.9	1abc, 2ac	2b	Lange-Bertalot & Moser (1994)
B. neoexilis Lange-Bertalot (Figure 141)	L:26.3-13.9; W:5.4-4.3	1abc, 2abc, 3bc, 4abc, 5abc, 6abc	1ab, 2abc,3abc, 4c, 5ab, 6ab	Lange-Bertalot & Moser (1994)
Neidiaceae				
Neidium affine (Ehrenberg) Pfitzer (Figure 139)	L: 43.3; W: 10.7; S:24	6a		Patrick & Reimer (1966), Krammer & Lange-Bertalot (1986)
N. iridis (Ehrenberg) Cleve (Figure 138)	L:76.6; W:30.3; S:17; A:9	6a		Krammer & Lange-Bertalot (1986)
Sellaphoraceae				
Sellaphora nigri (De Notaris) Wetzel & Ector (Figures 151-152)	L:8.7; W:3.6	4c		Wetzel et al. (2015)
S. pupula (Kützing) Mereschkowsky (Figures 146-147)	L:21.8-25.7; W:6.6-7.4; S:21-25	4b		Mann et al. (2004)
S. sardiniensis Lange-Bertalot, Cavacini, Tagliaventi & Alfinito (Figures 149-150, 218)	L:9.2-12.8; W:4.2-4.5; S:24	4b		Lange-Bertalot et al. (2003)
S. sassiana (Metzeltin & Lange-Bertalot) Wetzel (Figures 144-145, 217)	L:15; W:4.4; S:24	5ac, 6c		Metzeltin & Lange-Bertalot (1998)
S. saugerresii (Desm.) Wetzel & Mann (Figures 142-143)	L:5.4-18.8; W:3.3-5; S:17-22	2abc, 3ab, 4bc, 5ab, 6abc	3ab, 4a, 6bc	Wetzel et al. (2015)
S. ventraloconfusa (Lange-Bertalot) Metzeltin & Lange-Bertalot (Figure 153)	L:15.5-23.3; W:4.6-5.8; S:22	1ab, 2c, 4a		Krammer & Lange-Bertalot (1986)
Sellaphora sp. (Figure 148)	L:15.9; W:5.6; S:23		2a	
Pinnulariaceae				
Chamaepinnularia brasilianopsis Metzeltin & Lange-Bertalot (Figures 171-172)	L:15; W:3.9; S:23	4b		Metzeltin & Lange-Bertalot (1998)
Chamaepinnularia mediocris (Krasske) Lange-Bertalot (Figures 154-155)	L:11.0; W:3.8; S:21	2ac		Lange-Bertalot & Metzeltin (1996)
Pinnularia acrosphaeria (Brébisson) Smith (Figure 158)	L:79.24; W:13.54; S:10	1a		Krammer (2000)
P. brauniana (Gunow) Mills (Figure 160)	L: 49.75; W: 9.6; S:11	1a		Krammer (1992)
P. butantanum (Krasske) Meltzeltin (Figure 166)	L:87.8; W:12.7; S:15	1a		Metzeltin & Lange-Bertalot (1998)
P. divergentissima var. *minor* Krammer (Figure 168)	L:23.7-27.7; W:4.8-5.1; S:15	6b		Krammer (2000)
P. gibba Ehrenberg (Figures 164-165)	L:57.5-74.2; W:10.7-11.7; S:9	1a		Krammer (2000)
P. latarea Krammer (Figure 159)	L:61.7; W:10.1; S:10	1a		Krammer (2000)
P. latevittata Cleve (Figure 162)	L:216.1; W:33.7; S:5	2a		Reichardt (1995)
P. similiformis Krammer (Figure 167)	L:38.9; W:5; S:13		6b	Krammer (2000)
P. subbrevistriata Krammer (Figure 170)	L:48.4; W:9.2; S: 11		6b	Krammer (2000)
P. subcapitata Gregory (Figure 169)	L:28.9; W:4.8; S:14	4b		Krammer (2000)
P. subgibba var. *undulata* Krammer (Figure 163)	L:84.2; W:8.8: S:12	1a		Krammer (1992)
P. stoermeri Metzeltin & Lange-Bertalot (Figure 161)	L:157.6; W:26.6; S:8	4a		Metzeltin & Lange-Bertalot (2007)
Naviculaceae				
Capartogramma crucicula (Grunow) Ross (Figure 173)	L:32.5; W:9.7; S:23	4b		Patrick & Reimer (1966)
Hippodonta capitata ssp. *iberoamericana* Metzeltin, Lange-Bertalot & García-Rodríguez (Figure 174)	L:20.6; W:4.9; S:10	2b		Metzeltin et al. (2005)
Mayamaea permitis (Hustedt) Bruder & Medlin (Figure 187)	L:9.2; W:3.1	4c	3a	Lange-Bertalot et al. (2003)
Navicula angusta Grunow (Figures 175-176)	L:40.5-45.0; W:6.1-6.4; S:12	2bc, 3a, 4bc, 6abc	3a, 4b, 5ab, 6ab	Krammer & Lange-Bertalot (1986)
N. cryptotenella Lange-Bertalot (Figure 179)	L:23.5-26.2; W:5.3-5.3; S:16	1ab, 2bc, 4c, 5abc, 6ac	5b, 6bc	Lange-Bertalot & Metzeltin (1996)
N. notha Wallace (Figure 178)	L:23.7-26.6; W:4.4-4.7; S:16	3c, 5bc		Rumrich et al. (2000)

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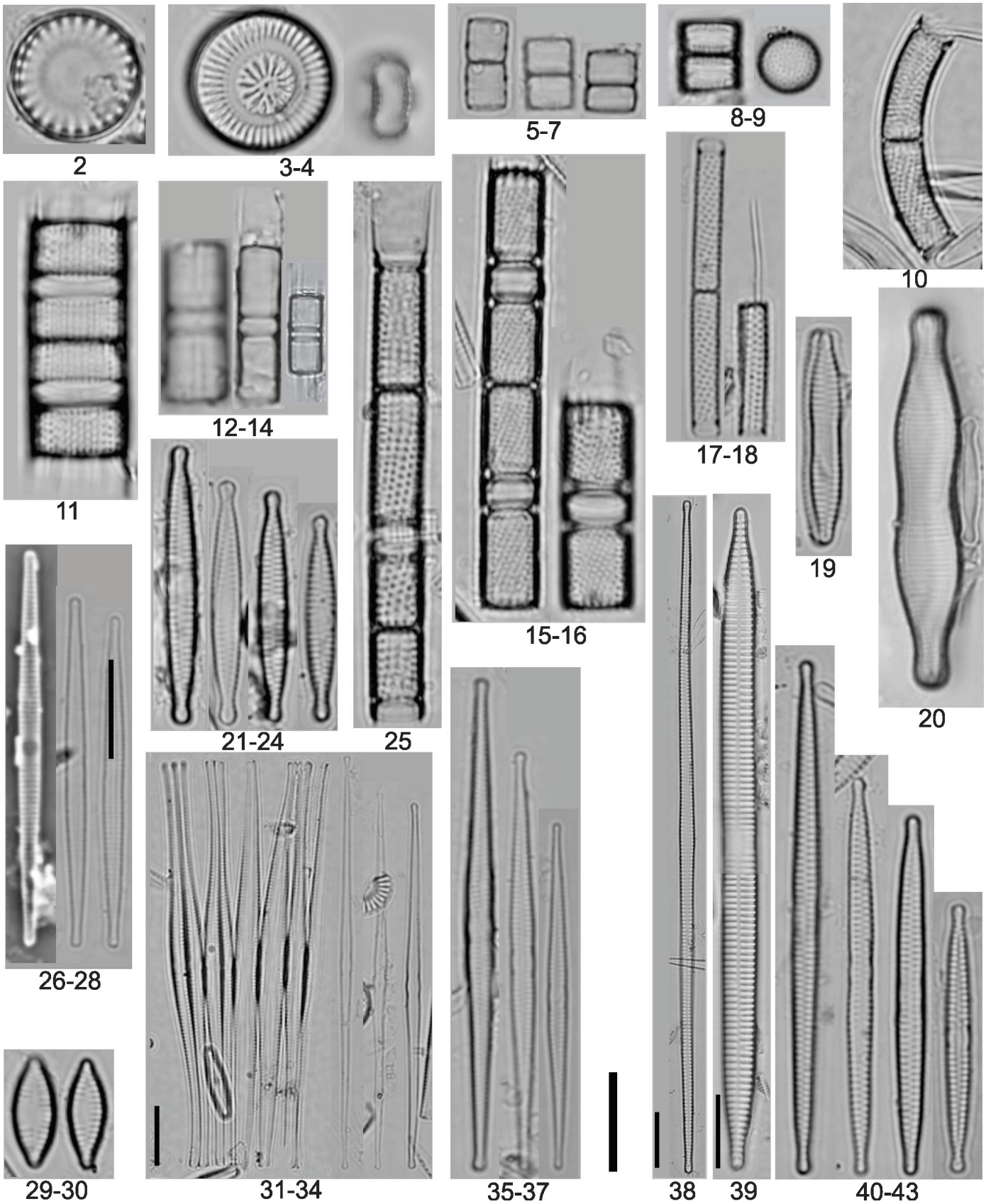
Table 3. Continued...

Species Name (Figure)	Metric (µm) & meristic (in 10 µm) limits	Month of occurrence at sampling sites		Consulted literature
		June	November	
N. tridentula Krasske (Figures 181-182)	L:17.5; W:3.7	5b		Krammer & Lange-Bertalot (1986)
N. veneta Kützing (Figure 180)	L:18.8; W:5.4; S:17	2b		Rumrich et al. (2000)
N. viridulacalcis Lange-Bertalot & Rumrich (Figure 177)	L:44.2-75.6; W:10.5-11.3; S:9	4abc, 5b, 6c	3a, 5a	Rumrich et al. (2000)
N. ventraloconfusa var. *chilensis* (Krasske) Lange-Bertalot (Figures 188-189)	L:15.9-19.2; W:5.2-5.4; S:21	4a, 5b		Krammer & Lange-Bertalot (1986), Lange-Bertalot & Metzeltin (1996)
Nupela torganie Tremarin & Ludwig (Figures 183- 184)	L:10.9-13.7; W: 4.1-5	1ab, 2ab, 3ab, 4ab, 5b, 6c	6c	Tremarin et al. (2015)
Stauroneidaceae				
Craticula riparia (Hustedt) Lange-Bertalot (Figures 192-193)	L:37.6-38.4; W:7.2-8.1; S:22	2ab, 3a, 4b		Krammer & Lange-Bertalot (1986)
C. submolesta (Hustedt) Lange-Bertalot (Figures 185-186)	L:17.0; W:3.8; S:23	4a, 6abc	6c	Krammer & Lange-Bertalot (1986)
Stauroneis anceps Ehrenberg (Figure 200)	L:56.5-59.2; W:9.9-10.7; S:20	5c		Krammer & Lange-Bertalot (1986)
S. gracilis Ehrenberg (Figure 201)	L:88.7; W:15.9; S:19	1b		Reichardt (1995)
Bacillariaceae				
Nitzschia clausii Hantzsch (Figure 203)	L:28.2-41.2; W:4.9-5.3; F:13	3a		Krammer & Lange-Bertalot (1988)
N. gracilis Hantzsch (Figures 196-197)	L:43.1-62.9; W:2.6-3.6; F:14	1bc		Krammer & Lange-Bertalot (1988)
N. intermedia Hantzsch ex Cleve & Grunow (Figures 198-199)	L:42.7-64.7; W:4-4.3; F:11-12	1b, 2b, 3a, 5c, 6c		Krammer & Lange-Bertalot (1988)
N. palea (Kützing) W. Smith var. *palea* (Figures 194-195)	L: 16.1-41.0; W: 2.4-4.7; F: 9-14	1bc, 2abc, 3ab, 4abc, 5bc, 6abc	1b, 3b, 5b, 6c	Rumrich et al. (2000) Levkov et al. (2007)
N. perminuta (Grunow) Peragallo (Figures 190-191)	L:11.2-22.1; W:2.4-2.8; F:10-13	3ab, 4b, 5bc, 6b		Krammer & Lange-Bertalot (1988), Levkov et al. (2007)
N. vermicularis (Kützing) Hantzsch (Figure 202)	L:106.3; W:4.9; F:10	4b		Krammer & Lange-Bertalot (1988), Rumrich et al. (2000)
Rhopalodiaceae				
Rhopalodia gibberula (Ehrenberg) O. Muller (Figure 210)	L:36.1; W:8.6; S:19; A:9	6b		Krammer & Lange-Bertalot (1988)
Surirellaceae				
Stenopterobia curvula (W. Smith) Krammer (Figure 206)	L:127.7-156.4; W:5.2; AC:7	1b		Metzeltin & Lange-Bertalot (1998)
S. delicatissima (Lewis) Brébissoni (Figure 207)	L:60.4-75.6; W:5.3-6.0; AC:7	4b, 6b	6c	Metzeltin & Lange-Bertalot (1998)
Surirella angusta Kutzing (Figure 204)	L:26.1; W:6.8; AC:7	1a		Krammer & Lange-Bertalot (1988)
S. biseriata var. *constricta* Hustedt (Figure 212)	L:190.4; W:17.6; AC:2	1a		Huber-Pestalozii (1942)
S. lineares var. *helvetica* (Ehrenberg) Kützing (Figure 208)	L:49.9; W:14.5; AC:3	4b		Metzeltin & Lange-Bertalot (1998)
S. splendida (Ehrenberg) Kutzing (Figure 211)	L: 113; W: 40.3: AC:2	1a		Krammer & Lange-Bertalot (1988)
S. tenuissima Hustedt (Figure 205)	L:25.3; W:8.5; AC:4	1a		Simonsen (1987), Krammer & Lange-Bertalot (1988)
Surirella sp. (Figure 209)	L:57.2; W:9.5; AC:4	6c		

Results and Discussion

A total of 135 infrageneric diatoms taxa were identified (Table 3, Figures 2-222), representing eighteen families (Round et al. 1990, Kulikovskiy et al., 2014). The species richness from Piraquara II reservoir was higher than the diatom floras found in the nearby urban reservoirs Iraí (96 taxa), Passaúna (106 taxa) and Itaqui (124 taxa) (Silva et al. 2010, Bertolli et al. 2010, Faria 2010). In June, (127 taxa) it was found higher richness than in November (66 taxa).

The diatoms occuring highly frequent were (10 taxa): *Achnanthidium caledonicum* (Lange-Bertalot) Lange-Bertalot, *Achnanthidium macrocephalum* (Hustedt) Round & Bukhtiyarova, *Achnanthidium minutissimum* (Kützing) Czarnecki, *Aulacoseira tenella* (Nygaard) Simonsen, *Brackysira neoexilis* Lange-Bertalot, *Discostella stelligera* (Cleve & Grunow) Houk & Klee, *Eunotia pseudosudetica* Metzeltin, Lange-Bertalot & García-Rodríguez, *Eunotia intermedia* (Krasske) Nörpel-Schempp & Lange-Bertalot, *Fragilaria recapitellata* Lange-Bertalot & Metzeltin and *Fragilaria parva* (Grunow) Tuji & Williams. Diatoms registered as frequent were (11 taxa): *Achnanthidium catenatum* (Bily & Marvan) Lange-Bertalot, *Achnanthidium eutrophilum* (Lange-Bertalot) Lange-Bertalot, *Aulacoseira ambigua* (Grunow) Simonsen f. *ambigua, Aulacoseira granulata* (Ehrenberg) Simonsen var. *granulata, Eunotia bilunaris* (Ehrenberg) Mills, *Encyonema neogracile* Krammer,



Figures 2-43. Diatoms from Piraquara II reservoir. 2. *Cyclotella meneguiniana.* 3-4. *Discostella stelligera.* 5-7. *Aulacoseira* sp. 8-9. *A. tenella.* 10. *A. ambigua* var. *ambigua* f. *spiralis.* 11. *A. brasiliensis.* 12-14. *A. herzogii* var. *herzogii.* 15-16. *A. ambigua* var. *ambigua* f. *ambigua.* 17-18. *A. granulata* var. *angustissima.* 19. *Fragilaria mesolepta.* 20. *Fragilariforma javanica.* 21-24. *Fragilaria pectinalis.* 25. *Aulacoseira granulata* var. *granulata.* 26-28. *Fragilaria gracilis.* 29-30. *F. microvaucheriae.* 31-34. *F. crotonensis.* 35-37. *F. tenera.* 38. *Ulnaria acus.* 39. *U. ulna.* 40-43. *Fragilaria parva.* Scales: 10 µm.

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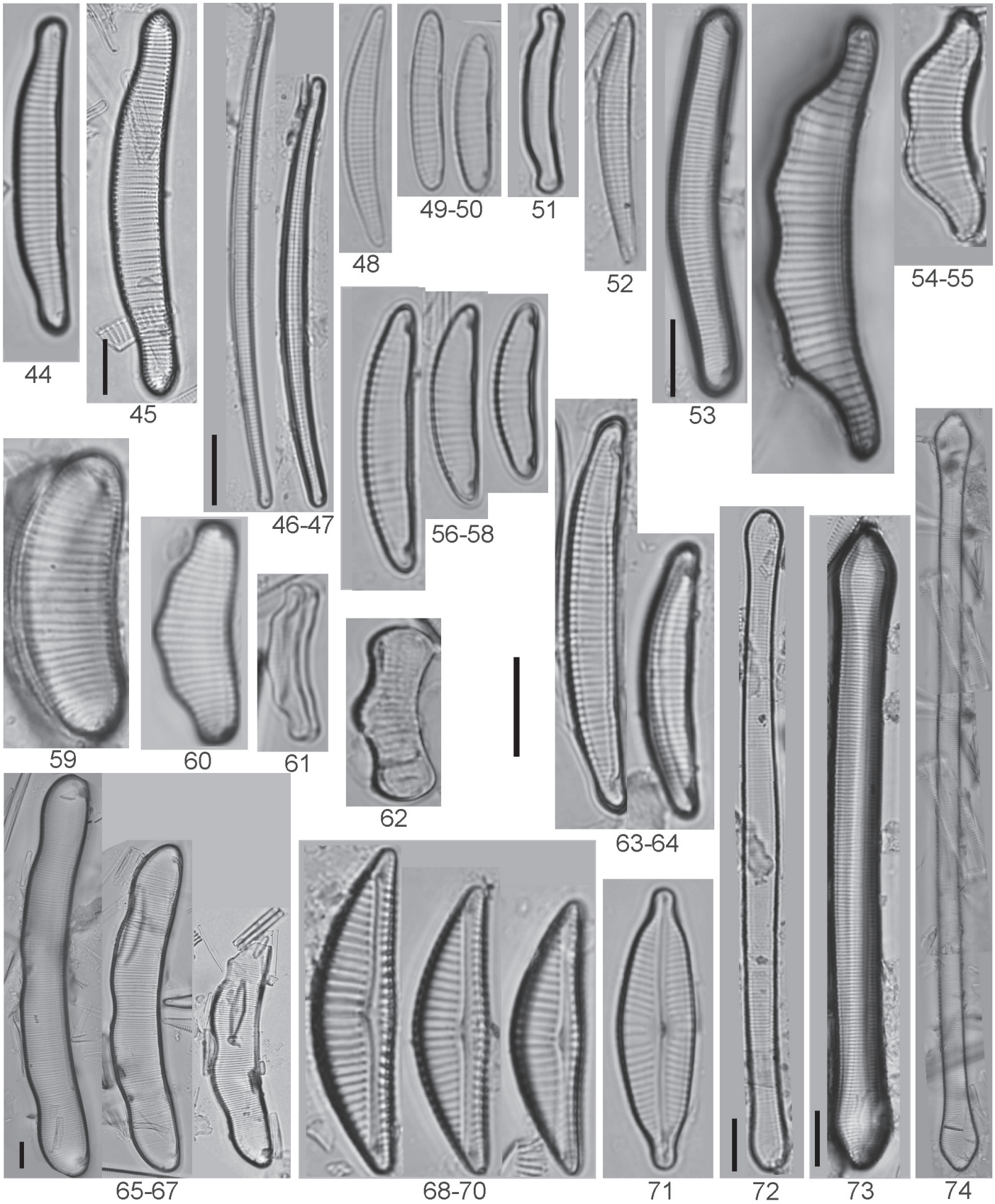
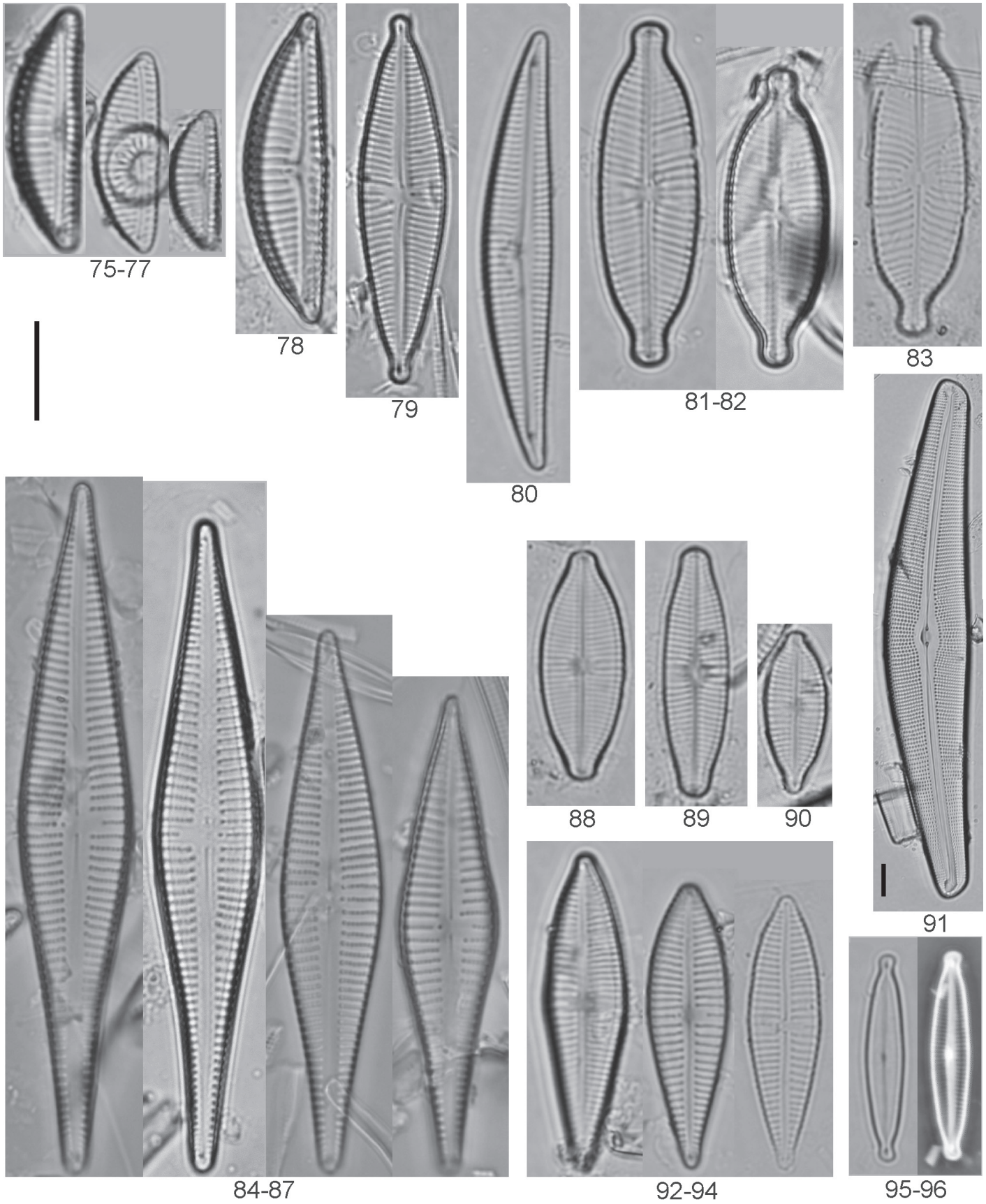


Figures 44-74. Diatoms from Piraquara II reservoir. 44. *Eunotia minor.* 45. *E. monodon.* 46-47. *E. naegelli.* 48. *E. bilunaris.* 49-50. *E. intermedia.* 51. *E. neocompacta.* 52. *Actinella leontopithecus-rosalia.* 53. *Eunotia cf. formicina.* 54-55. *E. camelus.* 56-58. *E. meridiana.* 59. *E. luna* var. *trapezica.* 60. *E. pyramidata* var. *pyramidata.* 61. *E. paratridentula.* 62. *E. rabenhorstii* var. *monodon.* 63-64. *E. pseudosudetica.* 65-67. *E. yanomami.* 68-70. *Encyonema incurvatum.* 71. *Cymbopleura naviculiformis.*72. *Eunotia desmogonioides.* 73. *D. ossiculum.* 74. *D. transfugum.* Scales: 10 µm.



Figures 75-96. Diatoms from Piraquara II reservoir. 75-77. *Encyonema silesiacum.* 78. *E. vulgare* var. *vulgare.* 79. *Encyonopsis frequentiformis.* 80. *Encyonema neogracile.* 81-82. *Placoneis elginensis.* 83. *P. symmetrica.* 84-87. *Gomphonema guaraniarum.* 88. *Geissleria punctifera.* 89. *G.lateropunctata.* 90. *Gomphonema parvulum* var. *subcapitata.* 91. *Cymbella aspera.* 92-94. *Gomphonema pseudoargur.* 95-96. *Encyonopsis microcephala.* Scales: 10 µm.

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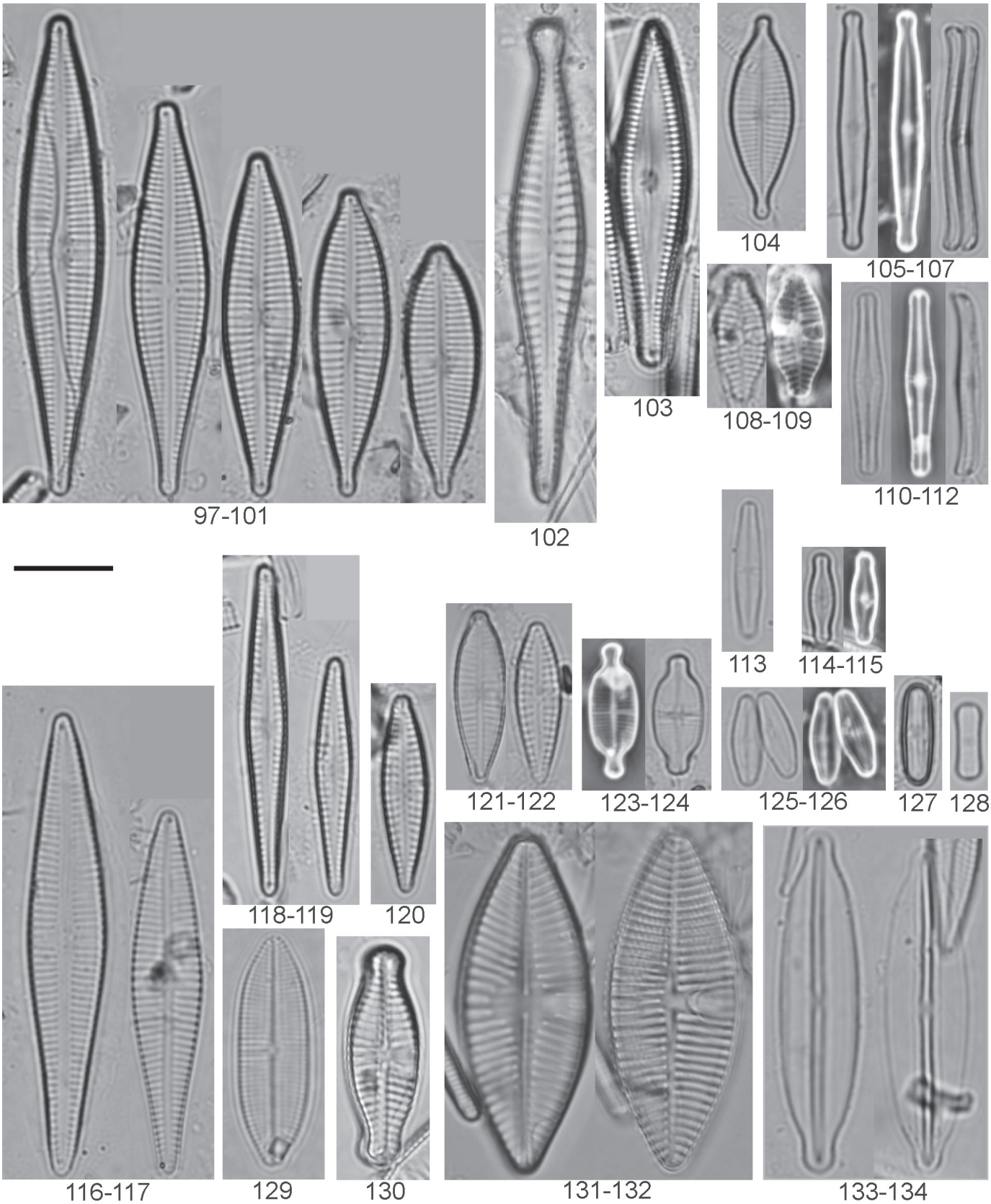
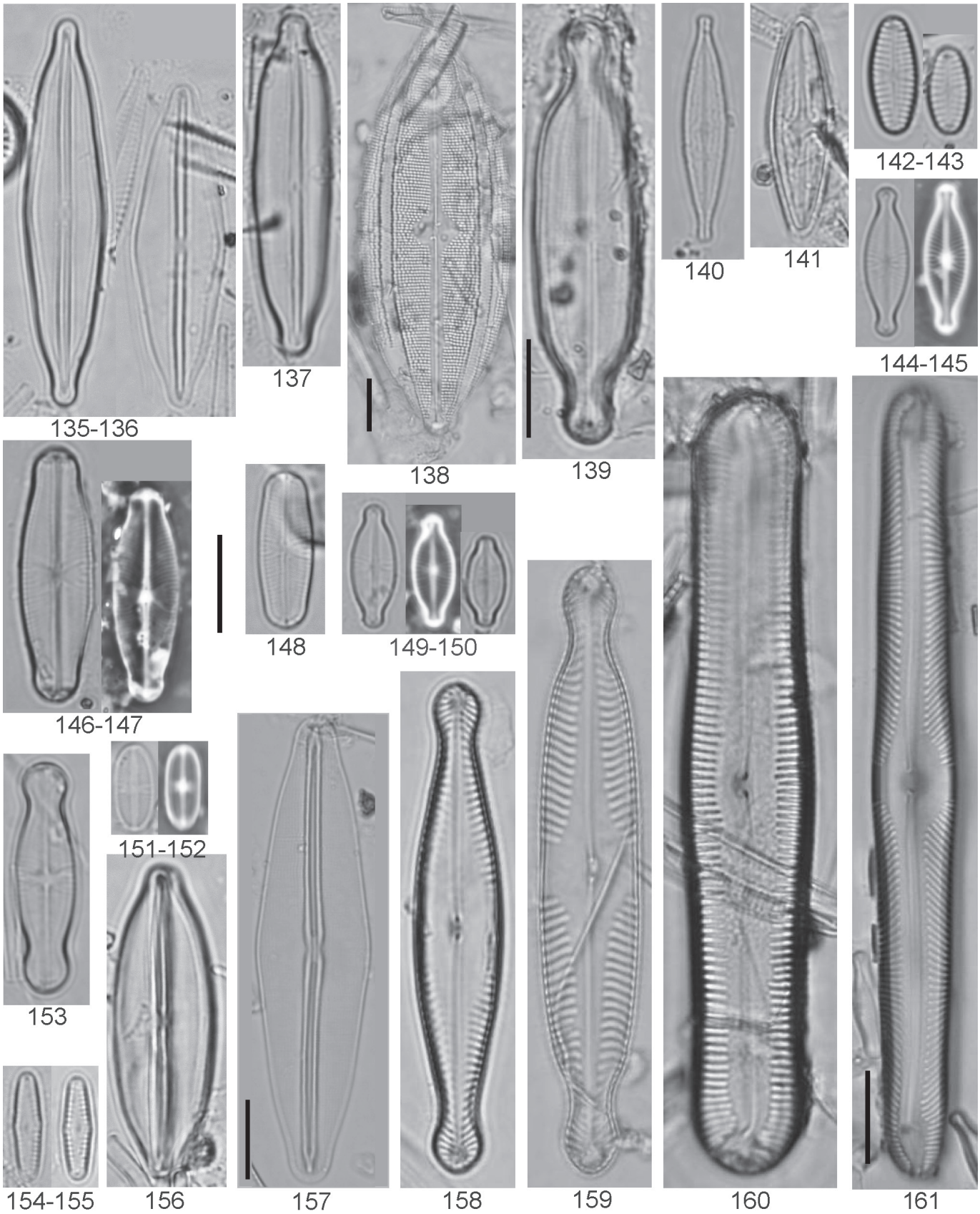


Figures 97-134. Diatoms from Piraquara II reservoir. 97-101. *Gomphonema graciloides.* 102. *G. subtile.* 103. *G. hawaiiensis.* 104. *G. lagenula.* 105-107. *Achnanthidium caledonicum.* 108-109. *Planothidium rostratum.* 110-112. *Achnanthidium catenatum.* 113. *A. minutissimum.* 114-115 *A. macrocephalum.* 116-117. *Gomphonema naviculoides.* 118-119. *Gomphonema* sp. 120. *G. parvulum* f. *saprophilum.* 121-122. *G. parvulum* var. *parvulum* 123-124 *Achnanthidium exiguum.* 125-126 *Achnanthidium eutrophilum.* 127. *Humidophila implicata.* 128. *Humidophila contenta.* 129. *Lemnicola hungarica.* 130. *Planothidium biporomum.* 131-132. *P. heteromorphum.* 133-134. *Frustulia crassinervia.* Scales: 10 µm.



Figures 135-161. Diatoms from Piraquara II reservoir. 135-136. *Frustulia undosa*. 137. *F. guayanensis*. 138. *Neidium iridis*. 139. *N. affine*. 140. *B. brebissoni*. 141. *Brackysira neoexilis*. 142-143 *Sellaphora saugerresii*. 144-145. *S. sassiana*. 146-147. *S. pupula*. 148. *Sellaphora* sp. 149-150. *S. sardiniensis*. 151-152. *S. nigri*. 153. *S. ventraloconfusa*. 154-155. *Chamaepinnularia mediocris*. 156. *Frustulia acidophilissima*. 157. *F. quadrisinuata*. 158. *Pinnularia acrosphaeria*. 159. *P. latarea*. 160. *P. brauniana*. 161. *P. stoermeri*. Scales: 10 µm.

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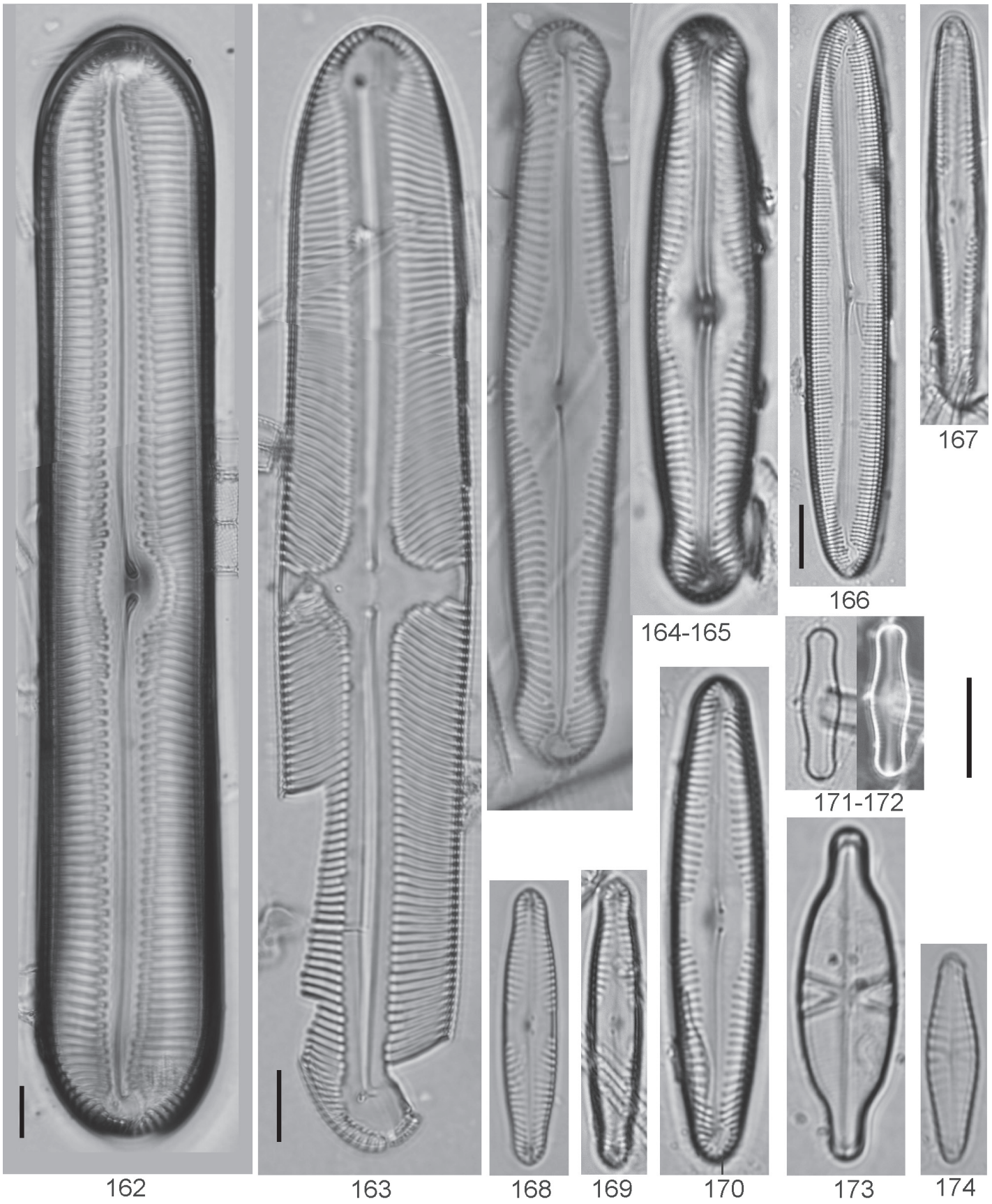
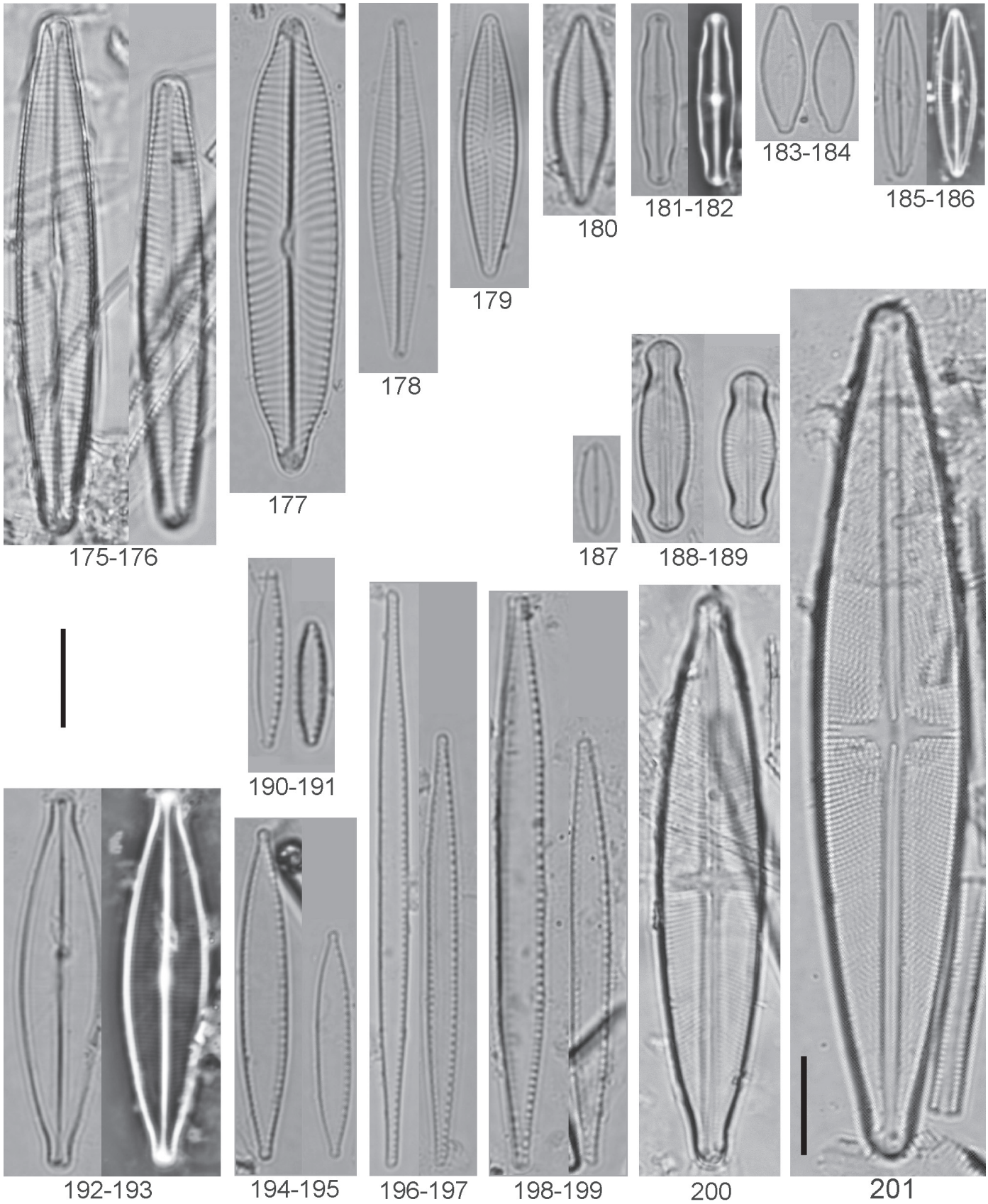


Figures 162-174. Diatoms from Piraquara II reservoir. 162. *Pinnularia latevitatta.* 163. *P. subgibba* var. *undulata.* 164-165. *P. gibba.* 166. *P. butantanum.* 167. *P. similiformis.* 168. *P. divergentissima* var. *minor.* 169. *P. subcapitata.* 170. *P. subbrevistriatta.* 171-172 *Chamaepinnularia brasilianopsis.* 173. *Capartogramma crucicola.* 174. *Hippodonta capitatta* ssp. *iberoamericana.* Scales: 10 µm.



Figures 175-201. Diatoms from Piraquara II reservoir. 175-176. *Navicula angusta.* 177. *N. viridulacalcis.* 178. *N. notha.* 179. *N. cryptotenella.* 180. *N. veneta.* 181-182. *N. tridentula.* 183-184. *Nupela torganiae.* 185-186. *Craticula submolesta.* 187. *Mayamaea permitis.* 188-189. *Naviculadicta ventraloconfusa* var. *chilensis.* 190-191. *Nitzschia perminuta.* 192-193. *Craticula riparia.* 194-195. *Nitzschia palea.* 196-197. *N. gracilis.* 198-199. *N. intermedia.* 200. *Stauroneis anceps.* 201. *S. gracilis.* Scales: 10 μm.

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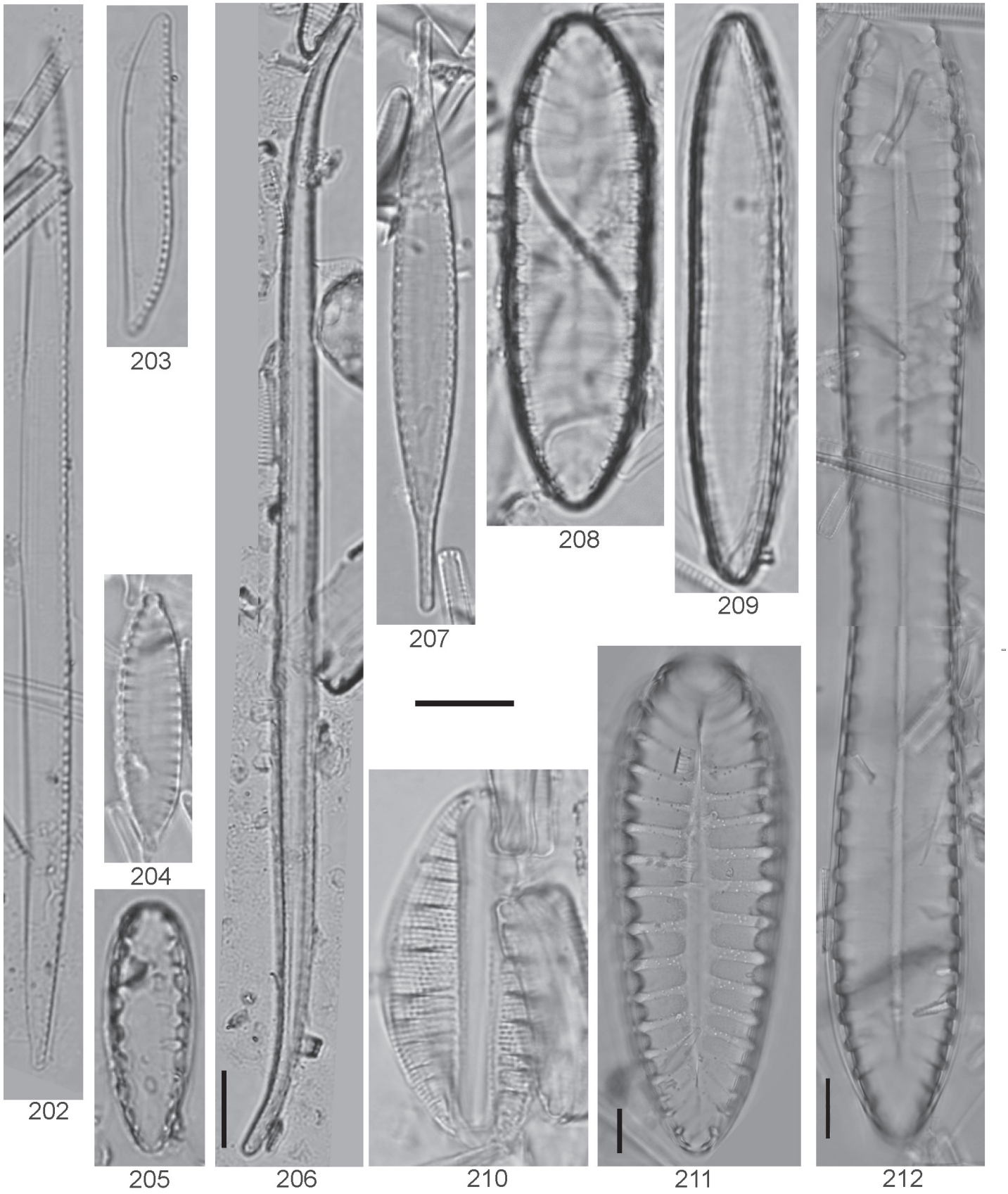
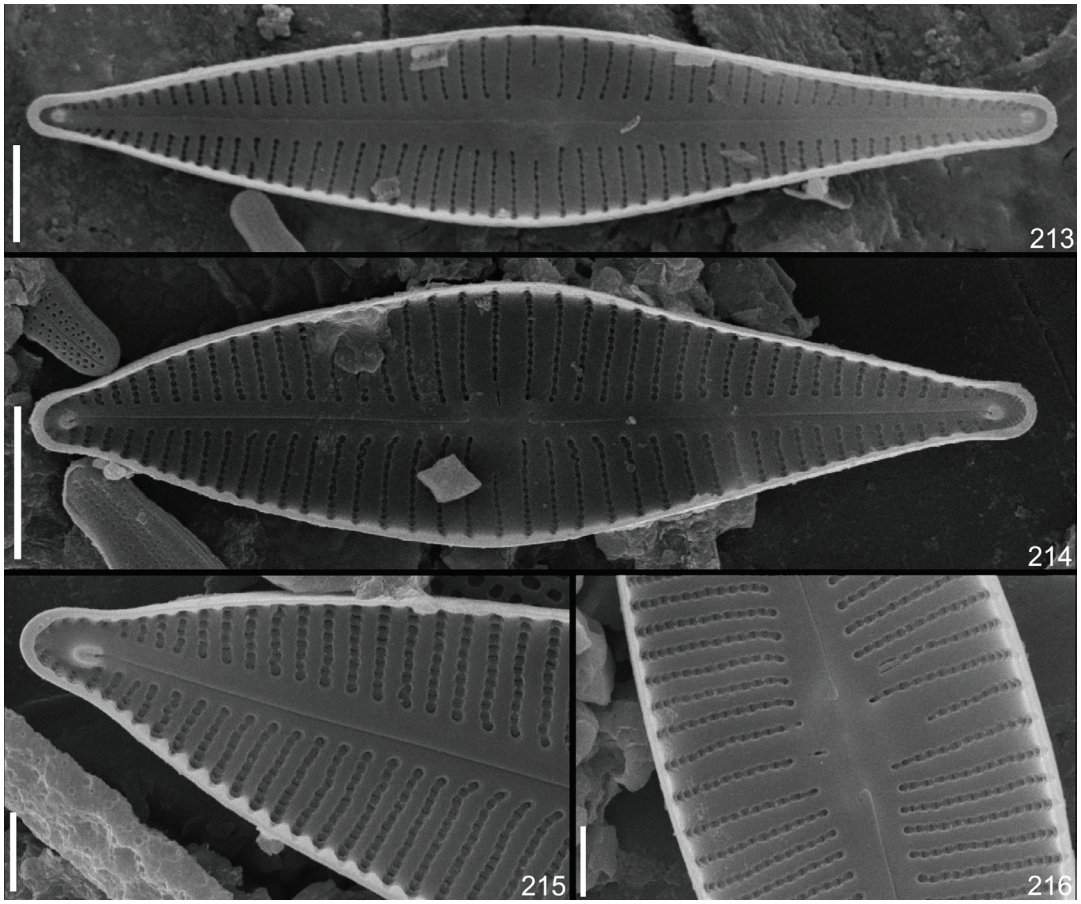


Figures 202-212. Diatoms from Piraquara II reservoir. 202. *Nitzschia vermicularis*. 203. *N. clausii*. 204. *Surirella angusta*. 205. *S. tenuissima*. 206. *Stenopterobia curvula*. 207. *S. delicatissima*. 208. *Surirella lineares* var. *helvetica*. 209. *Surirella* sp. 210. *Rophalodia gibberula*. 211. *Surirella splendida*. 212. *S. biseriata* var. *constricta*. Scales: 10 µm.



Figures 213-216. Diatoms from Piraquara II reservoir (SEM). 213. Internal view of *Gomphonema naviculoides,* scale: 5 µm. 214. Internal view of *G. graciloides,* scale: 5 µm. 215. Headpole of *G. graciloides* in internal view, scale: 1 µm. 216. Median region of *G. graciloides* showing the proximal raphe ends and the stigma opening in internal view, scale: 2 µm.

Fragilaria tenera (W. Smith) Lange-Bertalot, *Fragilaria microvaucheriae* Wetzel & Ector, *Gomphonema graciloides* Hustedt, *Gomphonema lagenula* Kützing and *Nitzschia palea* (Kützing) W. Smith. Altogether the more frequent diatoms totalized 15.3% of 135 taxa identified and 54.7% were sporadic in the reservoir.

Achnanthidium minutissimum and *Brachysira neoexilis* were the most frequent taxa present in 90% of the samples. Among the very frequent diatoms we found other species included in *Achnantidium, Fragilaria* and *Eunotia*. The solitary *Discotella stelligera* and the short chain *Aulacoseira tenella* are free living species that entangled among diatoms from the biofilm.

Description and comments of specimens not identified and first registered to the state of Paraná are bellow.

Aulacoseiraceae

Aulacoseira sp.

Figs 5, 7

Frustules solitary or in short chains. Valves circular, shallow ringleist; inconspicuous striae, areolae and spines.

Aulacoseira sp. resembles *A. simoniae* Tremarin, Torgan & Ludwig and *A. tenella*, differing by the conspicuous ornamentation of the latter species (Tremarin et al. 2014). Specimens were rare in samples, making detailed analysis impracticable.

Eunotiaceae

Eunotia cf. formicina Lange-Bertalot *in* Lange-Bertalot et al., Diatoms of Europe 6: 105; pl. 222, figs 1-7, pl. 223, 2011.

Fig. 53

Valves with dorsal margin convex, ventral margin concave, ends rounded, not detached from the valve, striae parallel to radiate near the apices.

Eunotia formicina was recently proposed (Lange-Bertalot et al. 2011) to nominate morphotypes of *E. formica* Ehrenberg distinguished by rounded ends, narrower valve (6-8 µm) and denser areolae (25-28 in 10 µm) in the striae (8-12 in 10 µm). *Eunotia formica* shows cuneate poles, wider valves (7-14 µm) and less denser striae (6-12 in 10 µm). Central delicate gibbosity at ventral margin of *E. formicina* was not observed in our specimens and the striae are originally less dense.

Gomphonemataceae

Gomphonema guaraniarum Metzeltin & Lange-Bertalot in Lange-Bertalot, Iconogr. Diatomol. 18: 147, pl. 212, figs 9-14, 2007.

Figs 84-87

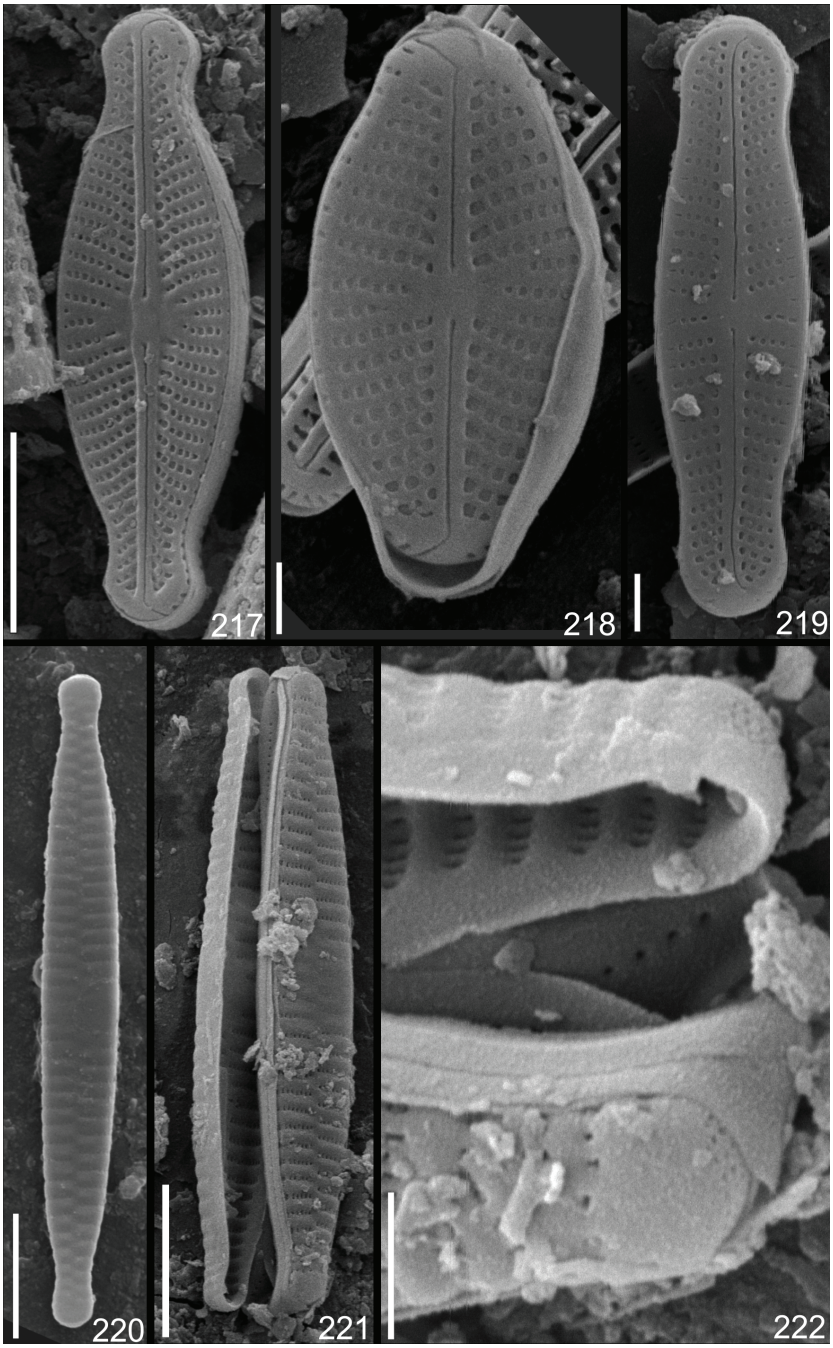
Valves rhombic-lanceolate, slightly heteropolar, ends acute, raphe-sternum linear and straight, central area unilaterally expanded with a stigma at the opposite side, striae distintly punctuate, parallel to radiate toward the ends.

Gomphonema sp.

Figs 118-119

Valves narrowly lanceolate, heteropolar, ends acute, raphe-sternum linear and straight, central area with a stigma at the end of a stria, striae radiate, areolae inconspicuous.

Gomphonema sp. is similar to *G. geisslerae* Reichardt & Lange-Bertalot in outline (lenght 18-27.5 µm, width 2.6-3.8 µm), but is wider (Reichardt 1997).



Figures 217-222. Diatoms from Piraquara II reservoir (SEM). 217. External view of *Sellaphora sassiana* showing the striation pattern, proximal and distal raphe ends, scale: 5 µm. 218. *Sellaphora sardinensis* in external view showing the shape of areolae, proximal and distal raphe ends, scale: 1 µm. 219. Raphe valve of *Achnanthidium macrocephalum* in external view, scale: 1 µm. 220-221. *Fragilaria pectinalis* in external view, scales: 5 µm. 222. Detail of apical pore field of *Fragilaria pectinalis*, scale: 1 µm.

Achnanthidiaceae

Achnanthidium macrocephalum (Hustedt) Round & Bukhtiyarova, Diatom Res. 11: 349, 1996.

Figs. 114-115, 219

Valves lanceolate, ends capitate, sternum narrow and linear, central area round, slightly expanded, raphe straight, striae inconspicuous.

The measurements of analysed specimens agree with the limits given by Krammer & Lange-Bertalot (1991b) of species *Achnanthes minutissima* var. *macrocephala* Hustedt (lenght 6-14 µm, width 2.5-3 µm). *Achnanthidium reimeri* (Camburn) Ponader & Potapova present similar outline, but the valve is wider (9.4-13.5 µm long, 2.9-3.2 µm wide) and the apices are more rounded. Also, *A. latecephalum* Kobayasi has similar outline, but the capitate ends and parallel striae distinguish the species from *A. macrocephalum* (Ponader & Potapova 2007).

Amphipleuraceae

Frustulia quadrisinuata Lange-Bertalot in Lange-Bertalot & Metzeltin, Iconogr. Diatomol. 2: 59-60, pl. 38, figs 10-12, pl. 119, figs 1-1, 1996.

Fig. 157

Valves lanceolate with margins slightly triondulate, ends rostrate, raphe-sternum narrow and linear, with longitudinal costa constricted at the central area, raphe straight, striae inconspicuous.

Sellaphoraceae

Sellaphora sardiniensis Lange-Bertalot, Cavacini, Tagliaventi & Alfinito in Lange-Bertalot, Iconogr. Diatomol. 12: 122; pl. 19, fig. 1-9, pl. 20, fig. 1-5, 2003.

Figs. 149-150, 218

Valves elliptic, ends subcapitate, raphe-sternum narrow and linear, central area elliptic, limited by irregular shortening striae, raphe straight, striae radiate.

Sellaphora sardiniensis resembles *S. subpupula* Levkov & Nakov, but the latter taxon have central area laterally expanded and denser striae (27-30 in 10 µm) (Lange-Bertalot et al. 2003; Levkov et al. 2007).

Sellaphora sp.

Fig. 148

Valves linear-lanceolate, ends subcapitate, raphe-sternum narrow and linear, elliptic central area limited by irregular shortening striae; raphe straight with proximal ends curved to the same side, striae radiate.

Sellaphora sp. is similar to *S. rhombicarea* Metzeltin, Lange-Bertalot & García-Rodriguez in outline, but differs in the dimensions (lenght 24-50 µm, width 9.5-11 µm, 17-19 striae in 10 µm) (Metzeltin et al. 2005). *Sellaphora laevissima* (Kützing) Mann is larger and striae less dense (lenght 6-9.3 µm and 15-19 striae in 10 µm) (Zimmerman et al. 2010).

Surirellaceae

Surirella sp.

Fig. 209

Valves isopolar, linear to lanceolate, slightly constricted in the middle, ends cuneate-rounded. Aliform chanells parallel, straight to slightly radiated near the ends, striae inconspicuous.

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