DATA ON DIATOMS (BACILLARIOPHYCEAE) AND THE BIOLOGICAL QUALITY OF RIVERS (OSUMI, DEVOLLI AND SEMANI) IN BERATI AREA (SOUTH-CENTRAL ALBANIA)

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ABSTRACT

Periphyton data on siliceous algae (diatoms) are reported here. The sampling was carried out in 5 river stations in the Berati area, with 3 in Osumi (Fushe Peshtani, Gorica Bridge, Dimali), one in Devolli (Vlashuk), and one in Semani (Kuçi Bridge). Samples were collected in July 2020 and May 2021. Additionally, two samples were from springs in Tomorri National Park, Berati, collected in July 2013 and 2016, respectively. The samples were collected, processed, examined, and counted following EU standards (EN 14407:2004; EN13946:2003). Based on the percentage of each species in the periphyton community, the Index of Pollution Sensitivity (IPS; Coste in Cemagref, 1982) was calculated. The data are discussed in comparison to similar assessments carried out previously in the Osumi River in the years 2003-2004 (Kupe, 2006) and 2006 (Jaupaj, 2007). Approximately 145 species of diatoms were found by Salca (2022); only 5 were centric, while the others were pennate. With previous data, 195 diatom taxa (9 centrics & 186 pennate) have been found in total in the waters of Berati. A checklist and illustrations with microscopic photos are reported here. The IPS in the Berati rivers (July 2020 & May 2021) ranged from 13.08 to 16.01 (average 14.9), corresponding to the 'Good' class quality, in accordance with WFD (2000) criteria. In Tomorri springs, IPS was 19.2 and 19.32, corresponding to the 'High' class quality. In two stations in Osumi (Uznova & Dimali) assessed during 2003-2004, IPS varied from 5.14 to 15.05 (average

11.2), indicating 'Moderate' class quality. **A significant improvement in the ecological quality of Osumi waters is observed between the two periods.** It is likely due to restoration measures and better management of urban wastewater and solid waste by local authorities. Regular monitoring of surface waters is advised, including biological monitoring, to obtain better information on water quality and to prevent potential risks to biota and human health.

Keywords**:** Freshwater ecology, Berati rivers, algal diversity, IPS, water quality.

1. INTRODUCTION

Diatoms (Bacillariophyceae) are unicellular or colonial eukaryotic photosynthetic organisms. Their cells, measuring 2-400 µm, are covered by two silicon caps (frustula: epitheca and hypotheca), firmly fixed together. The frustule is very hard but transparent, exhibiting centric or pennate symmetry. It forms many decorations (ridges, pores, cracks) characteristic of each species, which aids in their determination under optical and electron microscopes. Diatoms are the most diverse algae on Earth, annually producing a significant portion of the Earth's biomass and generating up to 50% of the oxygen (Spaulding *et al*., 2021; Diatoms of North America, 2020). The group is the primary producer of organic matter and serves as the main, and sometimes only, food source for aquatic organisms such as radiolarians, crustaceans, and even fish. Moreover, diatoms exhibit ranges and tolerances for environmental factors, including nutrients (N & P), suspended sediment, flow regime, elevation, and various types of human disturbance (Diatoms of North America, 2020).

Therefore, the diatoms are largely used as indicators of surface water quality (WFD, 2000; etc.). Several indexes have been developed for the assessment and classification of fresh water quality based on diatom community in periphyton. Vidaković *et al*. (2020) have shown that the Index of Pollution Sensitivity (IPS) may be a more promising tool for bioindication of lakes in Albania according to the demands of the WFD (2000). It wasoriginally developed at the Cemagref institute by Coste (1982), using the formula of Zelinka & Marvan (1961), and further elaborated by Eloranta & Kwandrans (1996). IPS combines the impact of inorganic and organic nutrient loads. Over the years we have also calculated IPS. The ecological values (S_i and V_i) were obtained from the OMNIDIA database (Lecointe *et al*., 1993). The water quality is categorized into 5 classes: High, $17 \leq IPS \leq 20$ (color *blue*); Good, $13 \leq IPS \leq 17$ (*green*); Moderate, $9 \leq IPS \leq 13$ (*yellow*); Poor, $5 \leq IPS \leq 9$ (*orange*); Bad, $IPS < 5$ (*red*).

The present work is part of the ongoing efforts by the Group of Botany, University of Tirana, to assess algal diversity and evaluate the bioquality of Albanian surface waters using diatoms. This study focuses on the data obtained from riverine waters in the Berati region (Osumi, Devolli, and Semani) and two aquatic habitats within the Tomorri National Park, Berati. These findings were derived from Salca's master's thesis (2022), where complete data and microscopic photos can be found. The data were compared with previous assessments primarily conducted by Kupe (2006) as part of the joint Swiss project for Albanian rivers (Miho *et al*., 2005; Cullaj *et al*., 2005), and by Jaupaj (2007) within the framework of the StEMA project (Miho *et al.*, 2008).

2. MATERIAL END METHODS

The area is located within Berati County, South-Central Albania, encompassing several significant urban areas: Berati (with 99,793 inhabitants as of 2021, source: http://bashkiaberat.gov.al/demografia/), Kuçova (with 31,262 inhabitants as of 2011, source: https://portavendore.al/bashkia-kucove/pasaporta-e-bashkise-kucove/), and Dimali (Ura Vajgurore) (with 27,295 inhabitants as of 2011, source: https://sq.wikipedia.org/wiki/Bashkia_Dimal). The Osumi River (with a flow rate of 32.5 m^3/s) traverses through the urban areas of Berati and Dimali, while the Devolli River (with a flow rate of 49.5 m^3/s) flows northwest of Kuçova and converges with the Osumi River in the Arrezi village (approximately three kilometers above the Kuçi Bridge) (Fig. 1). Both confluence forms the Semani River (with a flow rate of 95.7 m^3/s), which continues its course through the Fieri area before reaching the Adriatic Sea (Miho *et al*., 2005; Cullaj *et al*., 2005).

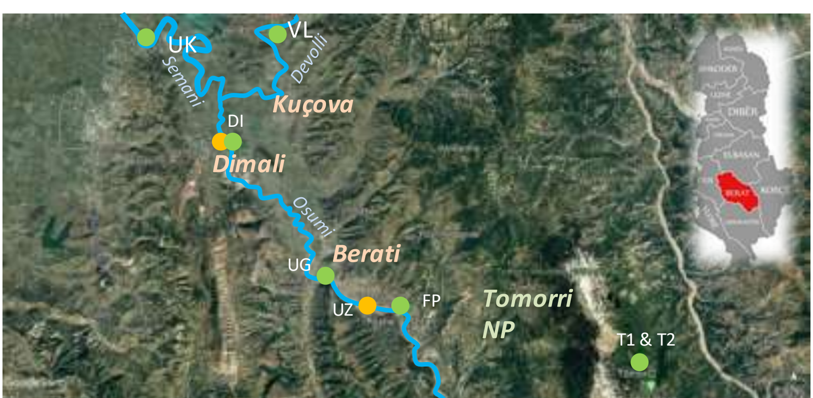

Figure 1. Satellite map of Berati area showing the stations sampled by Salca (2022) (*green*) and by Kupe (2006) and Jaupaj (2007) (*orange*) (*elaborated* from Google Earth 2023).

The sampling was conducted at 5 river stations in the Berati area, including 3 in Osumi (Fushe Peshtani, Gorica Bridge, Dimali, denoted as FP, UG, DI, respectively), one in Devolli (Vlashuk, VL), and one in Semani (Kuçi Bridge, UK) (*refer* to Fig. 1). Samples were collected in July 2020 and May 2021. Additionally, two samples were obtained from two small springs in Tomorri National Park, Berati, collected in July 2013 and 2016, respectively (denoted as T1 & T2). These springs serve as drinking water sources near the Abaz Ali mosque, situated at approximately 1400 m above sea level on the northeastern slopes of Tomorri Mount. The samples were collected, processed, and counted following EU standards (EN 14407:2004; EN13946:2003). The Index of Pollution Sensitivity (IPS) was calculated based on the percentage of each species in the periphyton community (Coste in Cemagref, 1982). The data are discussed in comparison to similar assessments conducted previously in the Osumi River during the years 2003-2004 (Uznova & Dimali; May, November 2002, May, July, September, November 2003, March 2004) (Kupe, 2006) and in September 2006 (Dimali) (Jaupaj, 2007).

The diatom frustules were cleaned by boiling the material in H_2O_2cc (according to EN13946:2003). Microscopic slides were prepared using Naphrax (1.71). Diatom keys from the 'Süßwasserflora von Mitteleuropa' (Krammer & Lange-Bertalot, 1986-2000) were primarily used for species identification. Examinations were conducted using an optical microscope, specifically the Motic BA310, with a 100x objective and a Motic digital camera. Taxonomic nomenclature and distribution were referenced using AlgaeBase, available at **https://www.algaebase.org/**. More than 400 frustules were counted at a magnification of 1000x (with a confidence level of 95%, ±10%). The Index of Pollution Sensitivity (IPS) was calculated, and the quality class was determined and discussed.

3. RESULTS AND DISCUSSION

Approximately 145 diatom taxa (6 centrics & 139 pennate) were identified by Salca (2022). The number of species ranged from 29 in Dimali (May 2021) to 58 at Gorica Bridge (July 2020) (Tab. 1), with an average of 37 species. When considering the taxa found by Kupe (2006) and Jaupaj (2007), a total of 194 diatom taxa (9 centrics & 186 pennate) have been recorded in the waters of Berati. A complete checklist is provided in ANNEX 1, representing the first published contribution to the algal diversity of Berati surface waters. Eight taxa are reported at the genus level (noted with *sp*.), and 14 species are denoted as *cf*., indicating *compared* with the most similar species. These are mostly rare individuals or species that are challenging to identify due to limited experience or available literature (e.g., *Navicula* sp1-sp4, *Fallacia* sp., etc.). The most represented genera include *Navicula* with approximately 30 species and *Nitzschia* with 28 species. Additionally, 135 microscopic photos representing 107 diatom species are included in Plates I-XI at the end of this report.

The average values of species number between two periods differ: 35.5 in the assessment made in Osumi by Kupe (2006) and Jaupaj (2007), and 43.8 in the assessment made by Salca (2022) (data reported in Tables 1 and 2). Despite the apparently higher species number during the most recent period, the difference is considered not statistically significant ($t = 1.7854$; $df = 22$) according to GraphPad Software (2023). Approximately 54 diatom species (2 centrics & 52 pennate) are found relatively widespread in the Berati area, with a frequency of more than 40%, as listed in table 3. Differences between the two periods are highlighted in red. The quality and abundance of the periphyton community condition the observed differences in water quality. The most abundant species are listed separately below.

In Salca (2022), ***Acnanthidium minutissimum*** was highly abundant in Tomorri, comprising up to 79.2% (T1) and 75.4% (T2), as well as in all rivers, with proportions ranging from 29.9% to 53.9% at Fushe Peshtani (FP), 30.4% to 43.9% at Gorica Bridge (GO), 43.8% to 36% at Dimali (DI), 16.6% to 29.8% at Kuçi Bridge (UK), and 23.1% to 21.6% at Vlashuk (VL). ***Encyonema ventricosum*** was scarcely present in rivers, with proportions up to 9.9% in T2. ***Encyonopsis microcephala*** was present in all samples, relatively abundant in rivers in May 2021, with proportions reaching up to 18.1% at Vlashuk (VL), 10.3% at Fushe Peshtani (FP), 10.8% at Gorica Bridge (UG), and 8.6% at Kuçi Bridge (UK). ***Amphora pediculus*** was consistently present, reaching up to 14.8% at Dimali (DI) in May 2021. Other species were exclusively found in rivers, including ***Cocconeis pediculus***, with proportions reaching up to 49.6% at Fushe Peshtani (FP), 26% and 17.8% at Gorica Bridge (UG), and 9.4% at Kuçi Bridge (UK); ***Gomphonella olivacea***, with proportions reaching up to 11.1% at Dimali (DI) in July 2020; ***Diatoma moniliformis***, with proportions reaching up to 44.3% at Vlashuk (VL) in May 2021; ***Gomphonema tergestinum***, with proportions reaching up to 10.5% at Fushe Peshtani (FP) in July 2020; ***Nitzschia incospicua***, with proportions reaching up to 8.2% at Gorica Bridge (UG), 10% and 27.5% at Dimali (DI), and 39.7% at Kuçi Bridge (UK); ***Fragilaria crotonensis***, with proportions reaching up to 10.4% at Vlashuk (VL) in July 2020; and ***Adlafia minuscula***, comprising 14.3% at Kuçi Bridge (UK) in July 2020.

As a result, the Index of Pollution Sensitivity (IPS) in rivers ranged from 13.08 to 16.01 (with an average of 14.9), corresponding to the 'Good' class quality, in accordance with the requirements of the Water Framework Directive (WFD, 2000). In Tomorri springs, the IPS was high, with values of 19.2 and 19.32, corresponding to the 'High' class quality (*refer* to Tab. 1).

Table 1. Overview data of periphyton community found by Salca (2022). N, species number; IPS, Index of Pollution Sensitivity (Coste in Cemagref, 1982), and related quality classes; colors after WFD (2000). T1 & T2, Tomorri NP; DI, Dimali; VL, Vlashuku, UK, Kuçi Bridge; UG, Gorica Bridge; FP, Fushe Peshtani (Fig. 1).

Habitat	**Tomorri NP**		**Osumi**			**Semani**	**Devolli**
Stations code	**T1**	**T2**	**FP**	**UG**	**DI**	**UK**	**VL**
Date	*17 July 2013*	*23 July 2016*	*08 July 2020*				
N	44	29	52	57	45	51	41
IPS	19.2	19.32	15.69	14.38	14.26	13.08	15.34
IPS class	**High**		**Good**			**Moderate**	**Good**
Date	-	-	*16 May 2021*				
N	-	-	38	34	29	49	42
IPS	-	-	15.83	15.17	15.1	14.5	16.01
IPS class	-	-	**Good**				

The two representative stations in the Osumi River (Uznova & Dimali) were regularly assessed during 2003-2004 (Kupe, 2006) and once by Jaupaj (2007) (Tab. 2). Uznova (UZ) is upstream Berati town, and relativley close to the Osumi river flow in Fushe Peshtani. The Index of Pollution Sensitivity (IPS) varied from 5.14 (in Dimali, November 2003) to 15.05 (in Dimali March 2004), with an average of 11.2, corresponding to 'Moderate' class quality. **It is generally worse than what was observed recently by Salca (2022) in the two respective stations of Osumi River crossing Berati area, Fushi Peshtani and Dimali (Ura Vajgurore)** (Tab. 1).

The most significant periphyton community was dominated by the following species: ***Achnanthidium minutissimum***, present but not abundant, with proportions up to 22.2% (UZ) and 13.1% (DI) in May 2003. ***Cocconeis pediculus***, present with proportions up to 52% (UZ, May 2003), 8.8% (UZ, July 2003), and 43.4% (DI, July 2003). ***C. placentula***, present in summer and autumn, with proportions up to 23.8% (UZ, July 2003) and 26.7% (DI, September 2006). ***Craticula accomoda***, present in November 2003 and March 2004, with proportions up to 13.8% (UZ, March 2004). ***Diatoma ehrenbergii***, almost present, with proportions up to 38.3% (DI, March 2004). ***Encyonopsis microcephala***, relatively abundant, with proportions up to 10.6% (UZ, July 2003). ***Gomphonella olivacea***, also relatively abundant, with proportions up to 42.9% (DI, March 2004). ***Gomphonema minutum***, present only at 10.8% (UZ, July 2003). ***G. parvulum***, relatively abundant at

13.1% (DI, May 2003), 8.0% (UZ), and 20.9% (DI) in July 2003. ***Mayamaea atomus***, with proportions of 6.8% (DI, May 2003) and 20.3% (DI, May & September 2003). ***Nitzschia dissipata***, always present and relatively abundant, with proportions up to 18.2% (UZ, March 2004). ***N. incospicua***, also present, with proportions up to 12.6% (UZ, May 2002) and 14.6% (DI, September 2006). ***N. palea***, always abundantly present, with proportions up to 18.2% (DI, May 2003), 8.4% (UZ) & 8.9% (DI) in July 2003, 21.6% (UZ) & 30.0% (DI) in September 2003, 42.9% (UZ), & 46.7% (DI) in November 2003, and 12.0% (UZ, March 2004). ***N. pusilla***, present only in Dimali, with proportions of 11.2% (May 2003). ***Surirella brebissoni***, always present, with proportions up to 13.2% (DI, November 2003). ***Tryblionella apiculata***, relatively present, with proportions up to 10.7% (UZ, November 2003).

Table 2. Overview data of periphyton community found by Kupe (2006) and Jaupaj 2007. N, species number; IPS, Index of Pollution Sensitivity (Coste in Cemagref, 1982), and related quality classes; colors after WFD (2000) for water quality. UZ, Uznova (upstream Berati town, close to Fushe Peshtani); DI, Dimali (Ura Vajgurore) (Fig. 1).

Station code	**UZ**	**DI**	**UZ**	**DI**	**UZ**	**DI**	**UZ**	**DI**
Date	*May 2002*		*November 2002*		*May 2003*		*July 2003*	
N	42	36	37	52	31	60	30	33
IPS	14.85	14.95	14.58	14.18	16.47	7.62	11.10	10.75
IPS class	**Good**					**Poor**	**Moderate**	
Station code	**UZ**	**DI**	**UZ**	**DI**	**UZ**	**DI**	**-**	**DI**
Date	*September 2003*		*November 2003*		*March 2004*		*September 2006*	
N	34	29	38	36	27	24	-	23
IPS	7.96	7.24	6.59	5.14	10.29	15.05	-	8.71
IPS class	**Poor**				**Moderate**	**Good**	-	**Poor**

Table 3. The most frequent species of diatoms (with more than 40% frequency) in periphyton community of Berati area. First value is the frequency during 2003-2004 (Kupe, 2006), and the second value correspond to the most recent period (Salca, 2022). Species that made the difference are labeled in red.

Centricae
Cyclotella meneghiniana (40% & 25%)
Melosira varians (33% & 50%)
Pantocsekiella comensis (47% & 8%)
Pennatae
Achnanthidium minutissimum (87% & 100%)
Amphipleura pellucida (13 & 42%)
Amphora pediculus (47% & 100%)
Caloneis aequatorialis (47% & 0%)
Cocconeis lineata (0% & 67%)
C. pediculus (80% & 83%)
C. placentula (47% & 0%)
Craticula accomoda (53% & 17%)
Cymbella affinis (47% & 100%)
C. helvetica (40% & 67%)
C. lacustris (0% & 50%)
C. lanceolata (0% & 42%)
Cymbopleura amphicephala (27% & 67%)
Diatoma moniliformis (80% & 75%)
D. vulgaris (33% & 59%)
Encyonema silesiacum (60% &17%)
E. ventricosum (27% & 75%)
Encyonopsis cesatii (0% & 42%)
E. microcephala (73% & 100%)
Fistulifera saprophila (47% & 0%)
Fragilaria capucina (73% & 33%)
F. crotonensis (0% & 42%)
F. gracilis (0% & 42%)
Frustulia vulgaris (27% & 42%)
Gomphonella olivacea (73% & 83%)
Gomphonema parvulum (87% & 50%)
G. pumilum (47% & 58%)
G. tergestinum (53% & 75%)
Gyrosigma acuminatum (13% & 50%)
G. scalproides (53% & 42%)
Mayamaea atomus (60% & 8%),
Navicula antonii (20% & 50%)
N. capitatoradiata (80% & 75%),
N. caterva (33% & 75%)
N. cryptotenella (87% & 83%)
N. cryptotenelloides (40% & 83%)
N. metareichardtiana (40% & 0%)
N. schroeteri (73% & 25%)
N. tripunctata (47% & 75%)
Nitzschia dissipata (100% & 92%)
N. incospicua (47% & 75%)
N. linearis (40% & 59%)
N. palea (100% & 83%),
Reimeria sinuata (40% & 58%)
Rhoicosphenia abbreviata (7% & 42%)
Surirella angusta (67% & 33%)
S. brebissoni(80% & 58%)
Tryblionella apiculata (60% & 50%)
Ulnaria ulna (93% & 92%)

Regular monitoring of surface waters is advised, including the biological monitoring, in order to get better information on water quality, preventing in time eventual risks to the biota and human health. **A management plan dealing with water quality** would help the Berati County to preserve and restore the riverine habitats, protect the quality life for the biota, and humans, as well as the recreational and tourist features this area offers.

The significant difference observed in the ecological quality of Osumi waters (t = 2.6; df = 19; after GraphPad 2023) suggests **improvement**, likely attributed to restoration measures and enhanced management of urban wastewater and solid waste (https://qarkuberat.gov.al/projekte/waste-rreact/). Pollution sources affecting surface waters in the Berati area include untreated wastewater from urban centers such as Berati, Dimali, and Kuçova (Fig. 1), as well as agro-industrial processing, quarries, hydrocarbons, and leaching from agricultural and livestock farms (Leshi, 2017).

Regular monitoring of surface waters, including biological monitoring, is strongly recommended to obtain better insights into water quality. This proactive approach can help prevent potential risks to both the biota and human health. **Implementing a comprehensive management plan** focusing on water quality would be beneficial for Berati County, enabling the preservation and restoration of riverine habitats. Such efforts would contribute to maintaining the quality of life for both the local ecosystem and human inhabitants, as well as safeguarding the recreational and tourist attractions offered by the area.

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ANNEX I: Checklist of diatoms found in surface waters from Berati region. *Cf*., compare with...

Name of the species	**Contributors**
Centricae	
Aulacoseira sp.	Salca, 2022
Conticribra weissflogii (Grunow) Stachura-Suchoples & D.M.Williams	Kupe, 2006
Cycllotella distinguenda Hustedt	Kupe, 2006
Cyclotella meneghiniana Kützing	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Lindavia radiosa (Grunow) De Toni & Forti	Kupe, 2006

Name of the species	**Contributors**
Melosira varians Agardh	Salca, 2022; Kupe, 2006
Pantocsekiella comensis (Grunow) K.T.Kiss & E.Ács	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Pantocsekiella ocellata (Pantocsek) K.T.Kiss & Ács	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Stephanodiscus medius Håkansson	Salca, 2022
Stephanodiscus parvus Stoermer & Håkansson	Kupe, 2006
Pennatae	
Achnanthidium biasolettianum (Grunow) Lange-Bertalot, *nom. illeg.*	Salca, 2022
Achnanthidium minutissimum (Kützing) Czarnecki	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Adlafia minuscula (Grunow) Lange-Bertalot (=*Navicula minuscula Grunow*)	Salca, 2022; Jaupaj, 2007
Amphipleura pellucida (Kützing) Kützing	Salca, 2022; Kupe, 2006
Amphora inariensis Krammer	Kupe, 2006
Amphora lybica Ehrenberg	Kupe, 2006
Amphora ovalis (Kützing) Kützing	Salca, 2022
Amphora pediculus (Kützing) Grunow	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Asterionella formosa Hassall	Salca, 2022
Brachysira aponina Kützing	Kupe, 2006
Brachysira neoexilis Lange-Bertalot	Salca, 2022; Kupe, 2006
Brachysira vitrea (Grunow) R.Ross	Jaupaj, 2007; Kupe, 2006
Caloneis aequatorialis Hustedt	Jaupaj, 2007; Kupe, 2006
Caloneis alpestris (Grunow) Cleve	Salca, 2022
Caloneis bacillum (Grunow) Cleve	Salca, 2022
Caloneis cf. branderi (Hustedt) Krammer	Kupe, 2006
Caloneis hendeyi Lange-Bertalot	Kupe, 2006
Caloneis cf. lancettula (Schulz-Danzig) Lange-Bertalot & Witkowski	Salca, 2022
Caloneis silicula (Ehrenberg) Cleve	Salca, 2022
Caloneis sp.	Salca, 2022; Kupe, 2006
Caloneis tenuis (W.Gregory) Krammer	Salca, 2022
Caloneis cf. thermalis (Grunow) Krammer	Salca, 2022
Cocconeis lineata Ehrenberg	Salca, 2022; Kupe, 2006
Cocconeis neodiminuta Krammer	Salca, 2022; Kupe, 2006
Cocconeis pediculus Ehrenberg	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Cocconeis placentula Ehrenberg var. *placentula*	Salca, 2022; Jaupaj, 2007; Kupe, 2006

Name of the species	**Contributors**
Cocconeis scutellum Ehrenberg	Salca, 2022
Craticula accomoda (Hustedt) D.G.Mann	Salca, 2022; Kupe, 2006
Craticula ambigua (Ehrenberg) D.G.Mann	Salca, 2022; Kupe, 2006
Craticula cuspidata (Kützing) D.G.Mann	Salca, 2022; Kupe, 2006
Craticula minusculoides (Hustedt) Lange-Bertalot	Salca, 2022
Craticula subminuscula (Manguin) C.E.Wetzel & Ector (=*Navicula subminuscula* Manguin)	Kupe, 2006
Cymbella affinis Kützing	Salca, 2022; Kupe, 2006
Cymbella cistula (Ehrenberg) Kirchner	Salca, 2022; Kupe, 2006
Cymbella helvetica Kützing	Salca, 2022; Kupe, 2006
Cymbella lanceolata (C.Agardh) Kirchner, *nom. illeg.*	Salca, 2022
Cymbella subhelvetica Kützing	Salca, 2022
Cymbella tumida (Brébisson) Van Heurck	Salca, 2022; Kupe, 2006
Cymbella cf. turgidula var. venezolana Krammer	Kupe, 2006
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	Salca, 2022; Kupe, 2006
Cymbopleura austriaca (Grunow) Krammer	Salca, 2022
Cymbopleura designata (Krammer) Bahls	Kupe, 2006
Cymbopleura incerta (Grunow) Krammer	Kupe, 2006
Cymbopleura naviculiformis (Auerswald ex Heiberg) Krammer	Kupe, 2006
Cymbopleura cf. subaequalis (Grunow) Krammer	Salca, 2022
Denticula tenuis Kützing	Salca, 2022
Diatoma ehrenbergii Kützing	Kupe, 2006
Diatoma moniliformis Kützing	Salca, 2022; Kupe, 2006
Diatoma tenuis C.Agardh	Salca, 2022
Diatoma vulgaris Bory	Salca, 2022; Kupe, 2006
Diploneis elliptica (Kützing) Cleve	Salca, 2022
Diploneis oblongella (Nägeli) Cleve-Euler	Salca, 2022
Diploneis ovalis (Hilse) Cleve	Salca, 2022
Dorofeyukea kotschyi (Grunow) Kulikovskiy, Kociolek, Tusset & T.Ludwig (=*Luticola kotschyi* (Grunow) J.C.Taylor, W.R.Harding & C.G.M.Archibald, *nom. inval.*)	Kupe, 2006
Encyonema cespitosum Kützing	Salca, 2022; Kupe, 2006
Encyonema lacustre (C.Agardh) Pantocsek (=*Cymbella lacustris* (C.Agardh) Cleve)	Salca, 2022

Name of the species	**Contributors**
Encyonema leibleinii (C.Agardh) W.J.Silva, R.Jahn, T.A.V.Ludwig, & M.Menezes (=*Cymbella prostratum* (Berkeley) Kützing)	Salca, 2022
Encyonema minutum (Hilse) D.G.Mann	Salca, 2022; Jaupaj, 2007
Encyonema silesiacum (Bleisch) D.G.Mann	Salca, 2022; Kupe, 2006
Encyonema subminutum Krammer & Lange-Bertalot	Kupe, 2006
Encyonema ventricosum (C.Agardh) Grunow	Salca, 2022; Kupe, 2006
Encyonema vulgare Krammer	Salca, 2022
Encyonopsis cesatii (Rabenhorst) Krammer	Salca, 2022; Kupe, 2006
Encyonopsis descripta (Hustedt) Krammer	Salca, 2022; Kupe, 2006
Encyonopsis microcephala (Grunow) Krammer	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Encyonopsis subminuta Krammer & Reichardt	Kupe, 2006
Epithemia adnata (Kützing) Brébisson	Salca, 2022; Jaupaj, 2007
Epithemia turgida var. granulata (Ehrenberg) Brun	Salca, 2022
Fallacia cf. helensis (Schulz) D.G.Mann	Salca, 2022
Fallacia pygmaea (Kützing) Stickle & D.G.Mann	Kupe, 2006
Fallacia sp.	Salca, 2022
Fistulifera saprophila (Lange-Bertalot & Bonik) Lange-Bertalot(=*Navicula saprophila* Lange-Bertalot)	Jaupaj, 2007; Kupe, 2006
Fragilaria capucina Desmazières	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Fragilaria capucina var. capitellata (Grunow) Lange-Bertalot	Salca, 2022
Fragilaria crotonensis Kitton	Salca, 2022
Fragilaria perminuta (Grunow) Lange-Bertalot	Salca, 2022
Fragilaria cf. radians (Kützing) D.M.Williams & Round(=*Fragilaria gracilis* Østrup)	Salca, 2022
Fragilaria rumpens (Kützing) G.W.F.Carlson	Salca, 2022
Fragilaria vaucheriae (Kützing) J.B.Petersen	Salca, 2022
Frustulia vulgaris (Thwaites) De Toni	Salca, 2022; Kupe, 2006
Gogorevia exilis (Kützing) Kulikovskiy & Kociolek (=*Achnanthes exigua* Grunow)	Salca, 2022
Gomphonella olivacea (Hornemann) Rabenhorst	Salca, 2022; Kupe, 2006
Gomphonema acuminatum Ehrenberg	Kupe, 2006
Gomphonema angustatum (Kuetzing) Rabenhorst	Salca, 2022; Kupe, 2006
Gomphonema clavatum Ehrenberg	Salca, 2022
Gomphonema exilissimum (Grunow) Lange-	Kupe, 2006

Name of the species	Contributors
Bertalot & E.Reichardt	
Gomphonema gracile Ehrenberg	Salca, 2022; Kupe, 2006
Gomphonema hebridense W.Gregory	Kupe, 2006
Gomphonema micropus Kützing	Salca, 2022; Kupe, 2006
Gomphonema minutiforme Lange-Bertalot & E.Reichardt	Salca, 2022
Gomphonema minutum (Agardh) Agardh	Salca, 2022; Kupe, 2006
Gomphonema cf. parallelistriatum Lange-Bertalot & E.Reichardt	Salca, 2022
Gomphonema parvulum Kützing	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Gomphonema tergestinum Fricke	Salca, 2022; Kupe, 2006
Gomphonema truncatum Ehrenberg	Kupe, 2006
Gomphonema vibrio Ehrenberg	Salca, 2022
Grunowia tabellaria (Grunow) Rabenhorst (=*Nitzschia sinuata var. tabellaria* (Grunow) Grunow)	Salca, 2022
Gyrosigma acuminatum (Kützing) Rabenhorst	Salca, 2022; Kupe, 2006
Gyrosigma attenuatum (Kützing) Rabenhorst	Salca, 2022
Gyrosigma cf. nodiferum (Grunow) Reimar	Salca, 2022
Gyrosigma scalproides (Rabenhorst) Cleve	Salca, 2022; Kupe, 2006
Halamphora montana (Krasske) Levkov	Salca, 2022; Kupe, 2006
Hannaea arcus (Ehrenberg) R.M.Patrick	Salca, 2022; Kupe, 2006
Hantzschia amphioxys (Ehrenberg) Grunow	Kupe, 2006
Haslea spicula (Hickie) Bukhtiyarova (=*Navicula spicula* (Hickie) Cleve)	Kupe, 2006
Iconella bifrons (Ehrenberg) Ruck & Nakov (= *Surirella bifrons* (Ehrenberg) Ehrenberg)	Salca, 2022
Iconella helvetica (Brun) Ruck & Nakov	Salca, 2022
Karayevia clevei (Grunow) Bukhtiyarova	Kupe, 2006
Luticola cohnii (Hilse) D.G.Mann	Kupe, 2006
Luticola goeppertiana (Bleisch) D.G.Mann ex J.Rarick, S.Wu, S.S.Lee and Edlund	Salca, 2022
Luticola mutica (Kützing) D.G.Mann	Salca, 2022; Kupe, 2006
Luticola nivalis (Ehrenberg) D.G.Mann	Kupe, 2006
Mayamaea asellus Lange-Bertalot, *nom. inval.*	Kupe, 2006

Name of the species	**Contributors**
Mayamaea atomus (Kützing) Lange-Bertalot(=*Navicula atomus* (Kützing) Grunow)	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Meridion circulare (Greville) C.Agardh	Salca, 2022; Kupe, 2006
Navicula angusta Grunow	Kupe, 2006
Navicula antonii Lange-Bertalot	Salca, 2022; Kupe, 2006
Navicula capitatoradiata Germain	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Navicula cari Ehrenberg	Salca, 2022
Navicula caterva Hohn & Hellerman	Salca, 2022; Kupe, 2006
Navicula cryptocephala Kützing	Salca, 2022; Kupe, 2006
Navicula cryptotenella Lange-Bertalot	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Navicula cryptotenelloides Lange-Bertalot	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Navicula cf. gottlandica Grunow	Salca, 2022
Navicula gregaria Donkin	Kupe, 2006
Navicula lanceolata Ehrenberg	Salca, 2022
Navicula leistikowii Lange-Bertalot	Kupe, 2006
Navicula menisculus Schumann	Salca, 2022
Navicula metareichardtiana Lange-Bertalot & Kusber	Kupe, 2006
Navicula novaesiberica Lange-Bertalot, *nom. inval*.	Kupe, 2006
Navicula oligotraphenta Lange-Bertalot & G.Hofmann	Salca, 2022; Kupe, 2006
Navicula radiosa Kützing	Salca, 2022
Navicula rostellata Kützing	Salca, 2022; Kupe, 2006
Navicula salinicola Hustedt	Kupe, 2006
Navicula schroeteri F.Meister	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Navicula tripunctata (O. F. Müller) Bory	Salca, 2022; Kupe, 2006
Navicula trivialis Lange-Bertalot	Kupe, 2006
Navicula veneta Kützing	Salca, 2022; Kupe, 2006
Navicula wildii Lange-Bertalot	Salca, 2022
Navicula sp1-sp4	Salca, 2022
Navigeia decussis (Østrup) Bukhtiyarova (=*Geissleria decussis* (Østrup) Lange-Bertalot & Metzeltin)	Salca, 2022; Kupe, 2006
Neidium dubium (Ehenberg) Cleve	Salca, 2022; Kupe, 2006
Nitzschia acicularis (Kützing) W.Smith	Salca, 2022; Kupe, 2006
Nitzschia amphibia Grunow	Salca, 2022; Kupe, 2006
Nitzschia clausii Hantzsch	Salca, 2022

Name of the species	**Contributors**
Nitzschia denticula Grunow (=*Denticula kuetzingii* Grunow)	Salca, 2022; Kupe, 2006
Nitzschia dissipata (Kützing) Grunow	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Nitzschia draveillensis Coste & Ricard	Salca, 2022
Nitzschia cf. gracilis Hantzsch	Salca, 2022
Nitzschia heufleriana Grunow	Kupe, 2006
Nitzschia incospicua Grunow	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Nitzschia lacuum Lange-Bertalot	Salca, 2022
Nitzschia ligowskii Witkowski, Lange-Bertalot, Kociolek & Brzezinska (=*N. subconstricta* Desikachary & Prema)	Kupe, 2006
Nitzschia linearis (Agarth) W. Smith var. *linearis*	Salca, 2022; Kupe, 2006
Nitzschia palea (Kützing) W. Smith var. *palea*	Salca, 2022; Jaupaj, 2007; Kupe, 2006
Nitzschia cf. paleacea (Grunow) Grunow	Salca, 2022
Nitzschia cf. pura Hustedt	Salca, 2022
Nitzschia recta Hantzsch ex Rabenhorst	Salca, 2022
Nitzschia sigmoidea (Nitzsch) W.Smith	Kupe, 2006
Nitzschia sinuata (Thwaites ex W.Smith) Grunow	Salca, 2022
Nitzschia cf. thermaloides Hustedt	Salca, 2022
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	Kupe, 2006
Nitzschia valdecostata Lange-Bertalot & Simonsen	Kupe, 2006
Nitzschia valdestriata Aleem & Hustedt	Kupe, 2006
Nitzschia pusilla Grunow	Kupe, 2006
Odontidium mesodon (Kützing) Kützing	Salca, 2022; Kupe, 2006
Pinnularia brebissonii (Kützing) Rabenhorst	Salca, 2022; Kupe, 2006
Pinnularia sp.	Kupe, 2006
Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot	Salca, 2022
Reimeria sinuata (W.Gregory) Kociolek & Stoermer	Salca, 2022; Kupe, 2006
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	Salca, 2022
Rhopalodia brebissonii Krammer	Salca, 2022
Rhopalodia gibba (Ehrenberg) O. Müller	Salca, 2022
Sellaphora bacillum (Ehrenberg) D.G.Mann	Salca, 2022
Sellaphora stroemii (Hustedt) H.Kobayasi	Salca, 2022
Surirella angusta Kützing	Salca, 2022; Kupe, 2006

Name of the species	**Contributors**
Surirella brebissoni Krammer & Lange-Bertalot	Salca, 2022; Kupe, 2006
Surirella librile (Ehrenberg) Ehrenberg(=*Cymatopleura solea* (Brébisson) W.Smith)	Salca, 2022; Kupe, 2006
Surirella minuta Brébisson ex Kützing, *nom. illeg.*	Salca, 2022
Tabellaria flocculosa (Roth) Kützing	Salca, 2022
Tryblionella angustatula (Lange-Bertalot) Cantonati & Lange-Bertalot	Salca, 2022
Tryblionella apiculata W.Gregory (=*Nitzschia constricta* (Kützing) Ralfs)	Salca, 2022; Kupe, 2006
Tryblionella hantzschiana Grunow (=*Nitzschia tryblionella* Hantzsch)	Salca, 2022
Tryblionella hungarica (Grunow) Frenguelli (=*Nitzschia hungarica* Grunow)	Kupe, 2006
Tryblionella littoralis (Grunow) D.G.Mann(=*Nitzschia littoralis* Grunow)	Kupe, 2006
Ulnaria acus (Kützing) Aboal	Salca, 2022; Kupe, 2006
Ulnaria biceps (Kützing) Compère	Kupe, 2006
Ulnaria ulna (Nitzsch) Compère	Salca, 2022; Kupe, 2006

PLATE I

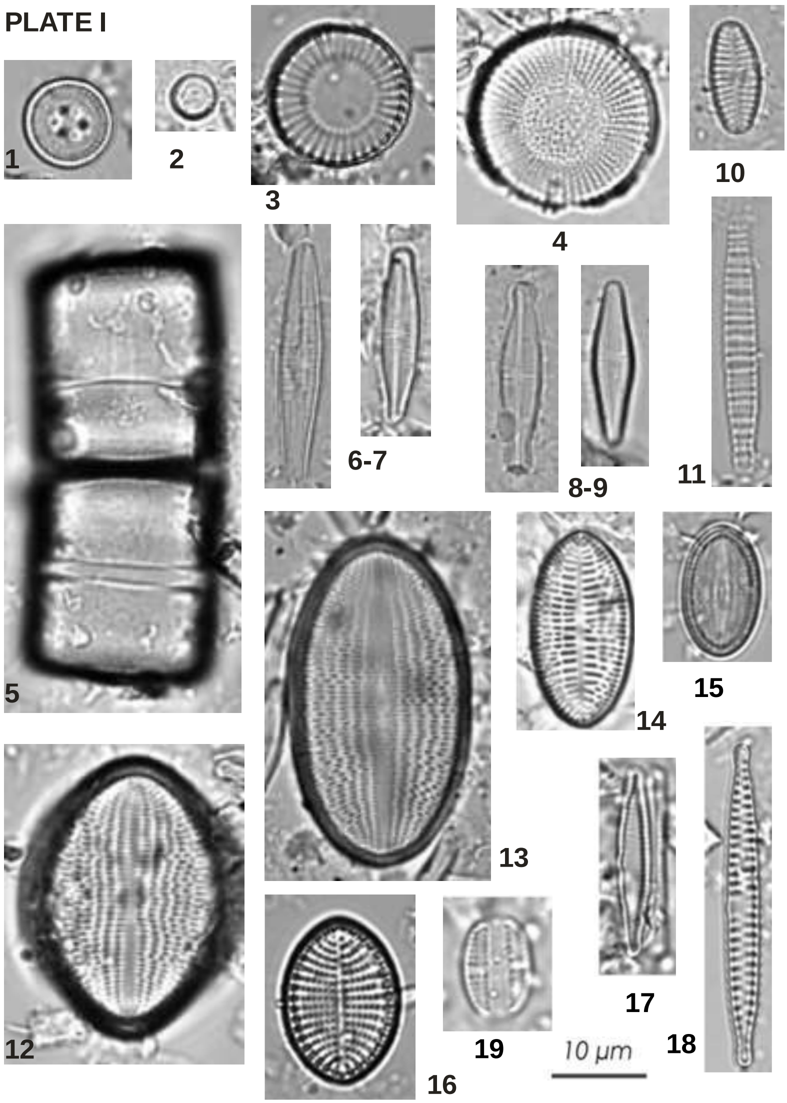


PLATE I: 1, *Pantocsekiella ocellata* (K1); **2,** *P. comensis* (UK); **3,** *Cyclotella meneghiniana* (UG); **4,** *Stephanodiscus medius* (DI); **5,** *Melosira varians* (UK); **6-7,** *Achnanthidium biasolettianum* (FP & UG); **8-9,** *A. minutissimum* (UK & FP); **10,** *Planothidium lanceolatum* (UG); **11**, *Diatoma moniliformis* (FP); **12,** *Cocconeis pediculus* (UG & FP); **13.** *C. lineata* (FP); **14**, *C. neodiminuta* (T); **15**, *C. placentula* (UG); **16**, *C scutellum* (UG); **17**, *Fragilaria perminuta* (FP); **18**, *Fragilaria vaucheriae* (FP); **19**, *Amphora pediculus* (FP) (1500x).

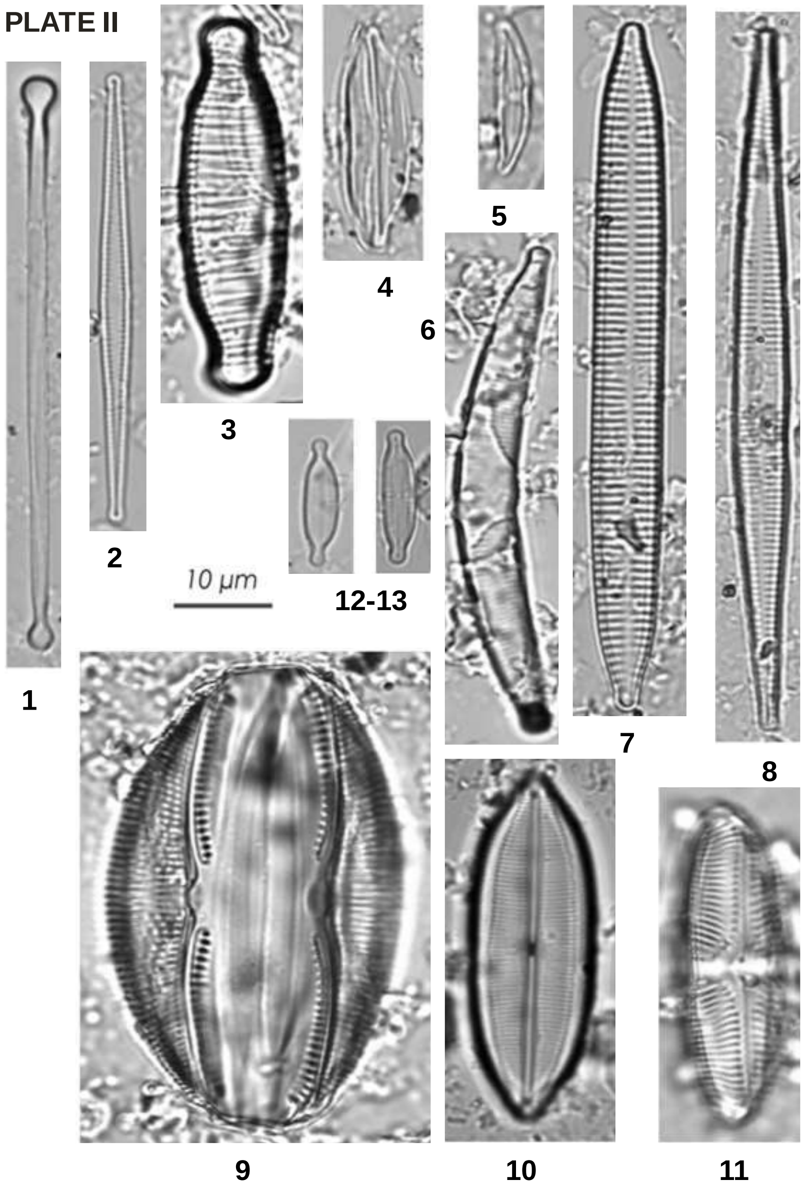
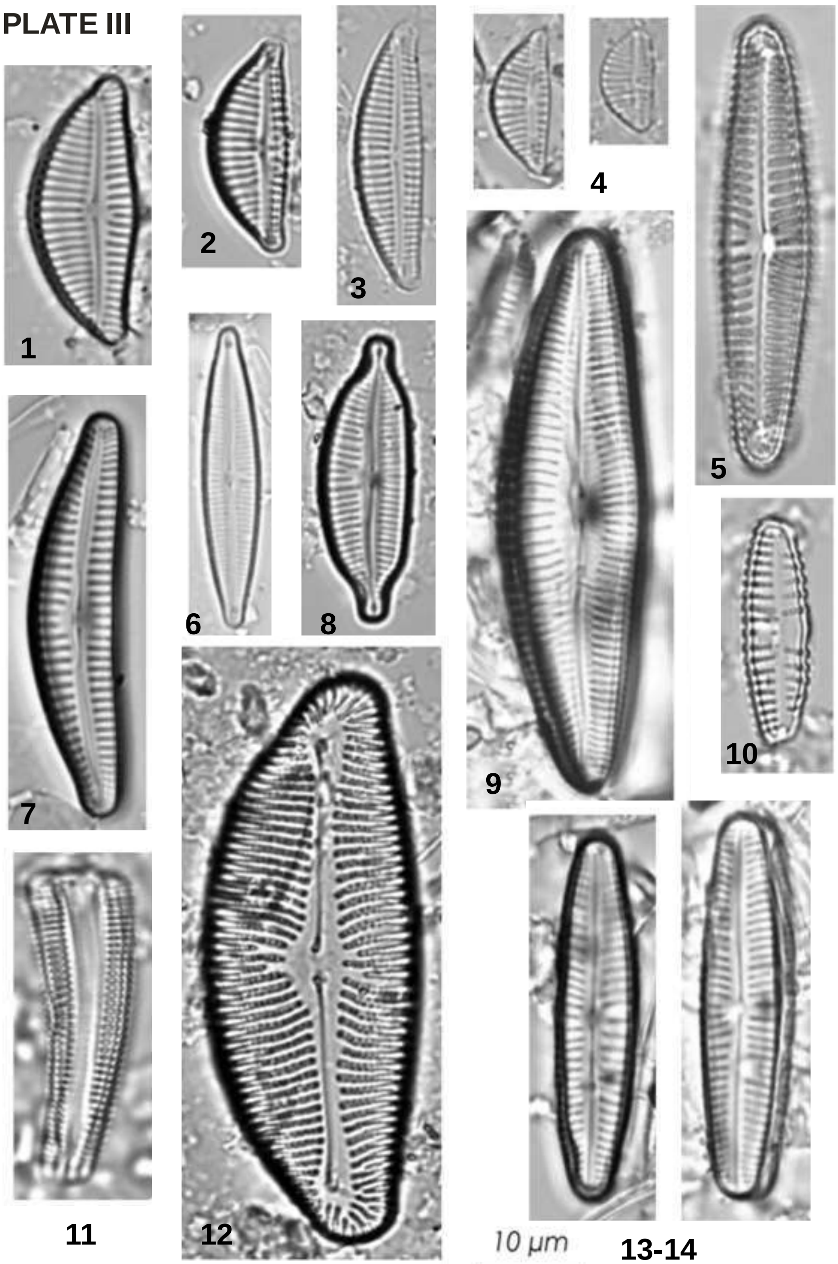


PLATE II: **1**, *Asterionella formosa* (UK); **2**, *Fragilaria crotonensis* (FP); **3**, *Diatoma vulgaris* (UG); **4**, *Halamphora oligotraphenta* (*cf.*) (DI); **5**, *Halamphora montana* (UG); **6,** *Hannaea arcus* (UG); **7**, *Ulnaria ulna* (FP); **8**, *U. acus* (DI); **9**, *Amphora ovalis* (UK); **10**, *Neidium dubium* (DI); **11**, *Pinnularia brebissonii* (DI); **12-13,** *Encyonopsis microcephala* (FP & UG) (1500x).

PLATE III



PASQYRA III: 1, *Encyonema cespitosum* (FP); **2,** *E. ventricosum* (UG); **3,** *E. Silesiacum* (FP); **4,** *E. minutum* **(**UK); **5,** *E. lacustre* (FP); **6,** *Encyonopsis cesatii* **(UG); 7,** *Cymbella affinis* (FP); **8,** *Cymbopleura amphicephala* (FP); **9,** *Cymbopleura austriaca* **(**T); **10,** *Reimeria sinuata* (UK); **11,** *Rhoicosphenia abbreviata* (UK); **12,** *Encyonema leibleinii* (UK); **13-14,** *Cymbopleura subaequalis* (*cf.*) (T) (1500x).

PLATE IV

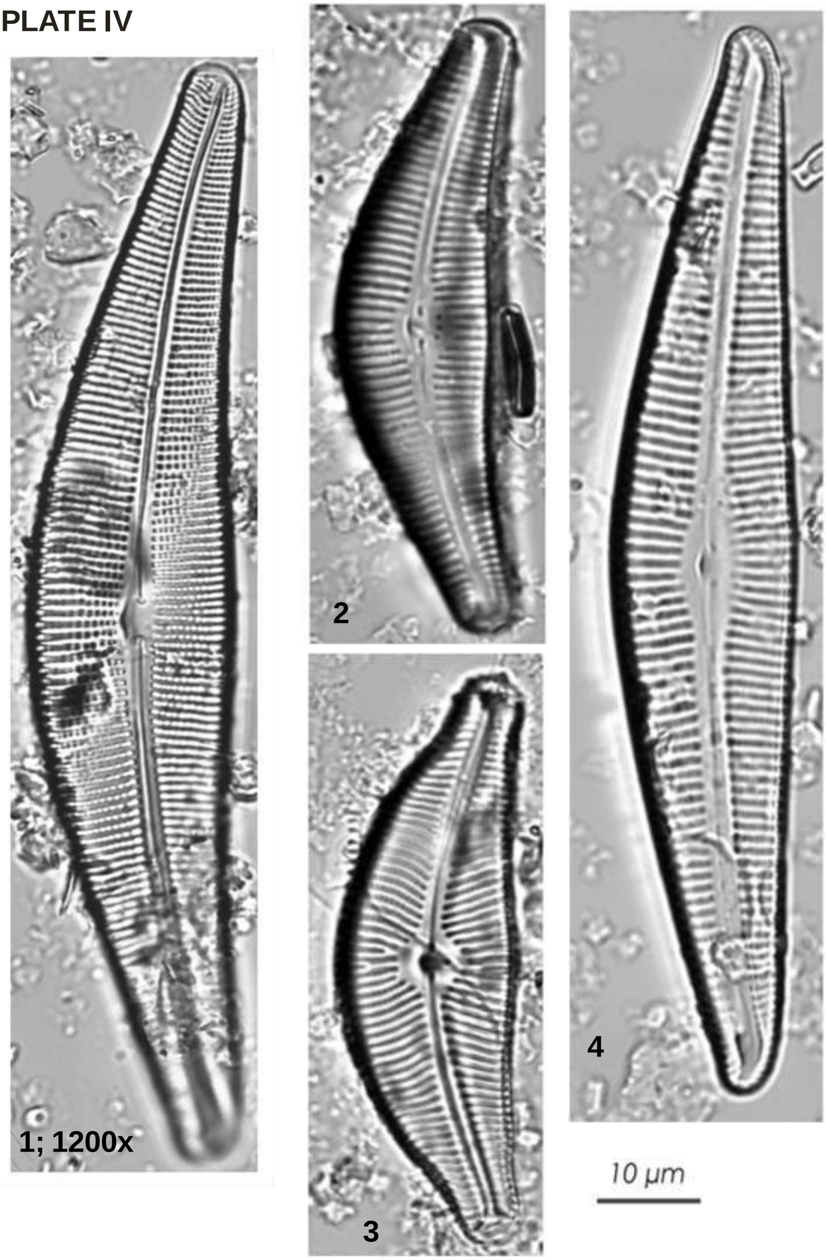


PLATE IV: **1**, *Cymbella lanceolata* C.Agardh (FP); **2**, *Cymbella helvetica* (FP); **3**, *C. tumida* (UK); **4**, *Cymbella helvetica* (UK) (1: 1200x; others 1500x).

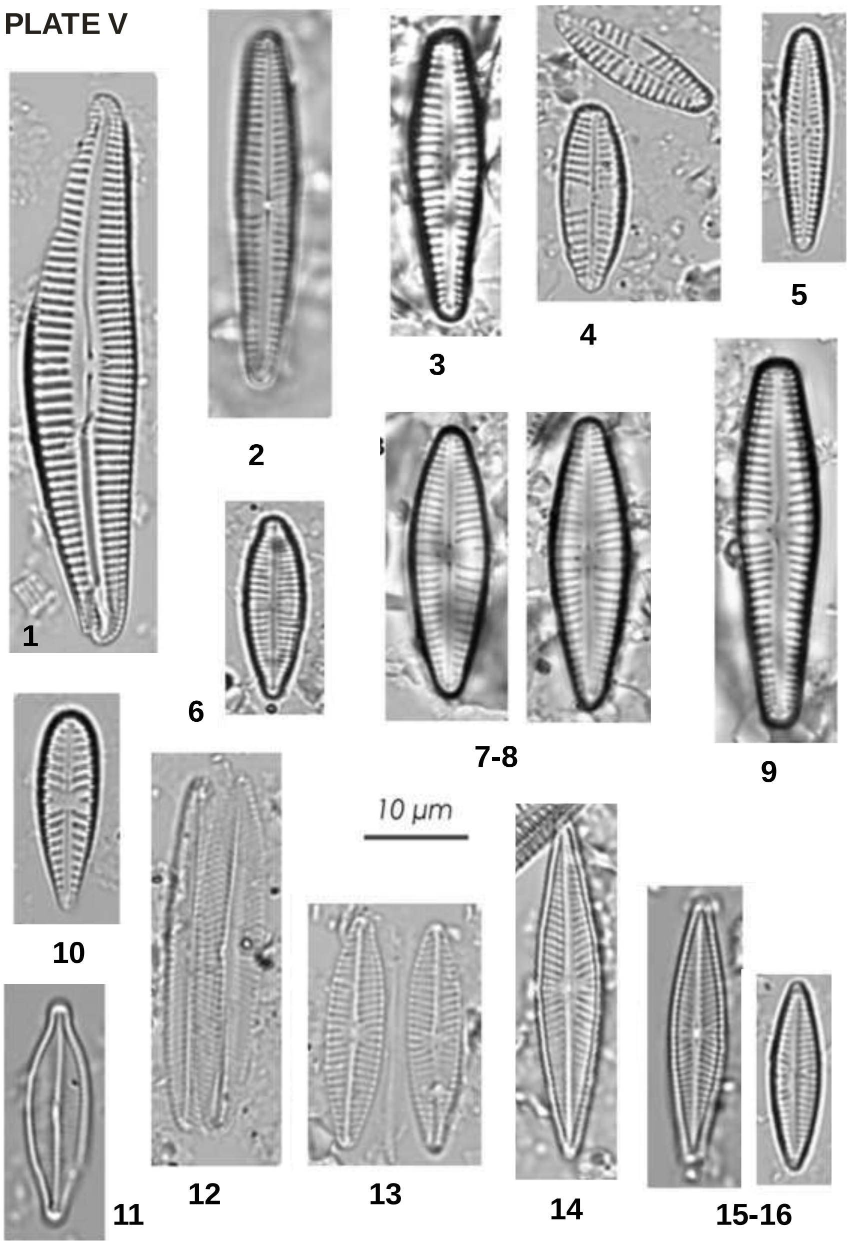


PLATE V: 1, *Cymbella subhelvetica* (FP); **2,** *Gomphonemaangustatum* **(T); 3,** *G. minutum* (*cf.*) (T); **4,** *G. tergestinum* (FP); **5,** *G. pumilum* (FP); **6,** *G. parvulum* (UG); **7-8,** *G. parallelistriatum* (*cf.*) (T & UK); **9,** *G. clavatum***; 10,** *Gomphonella olivacea* (FP); **11,** *Craticula accomoda* (UG); **12,** *Navicula schroeteri* (UG); **13,** *N. veneta* (DI); **14,** *N. cryptotenella* (FP, UG); **15-16,** *N. Cryptotenelloides* (DI) **(1500x).**

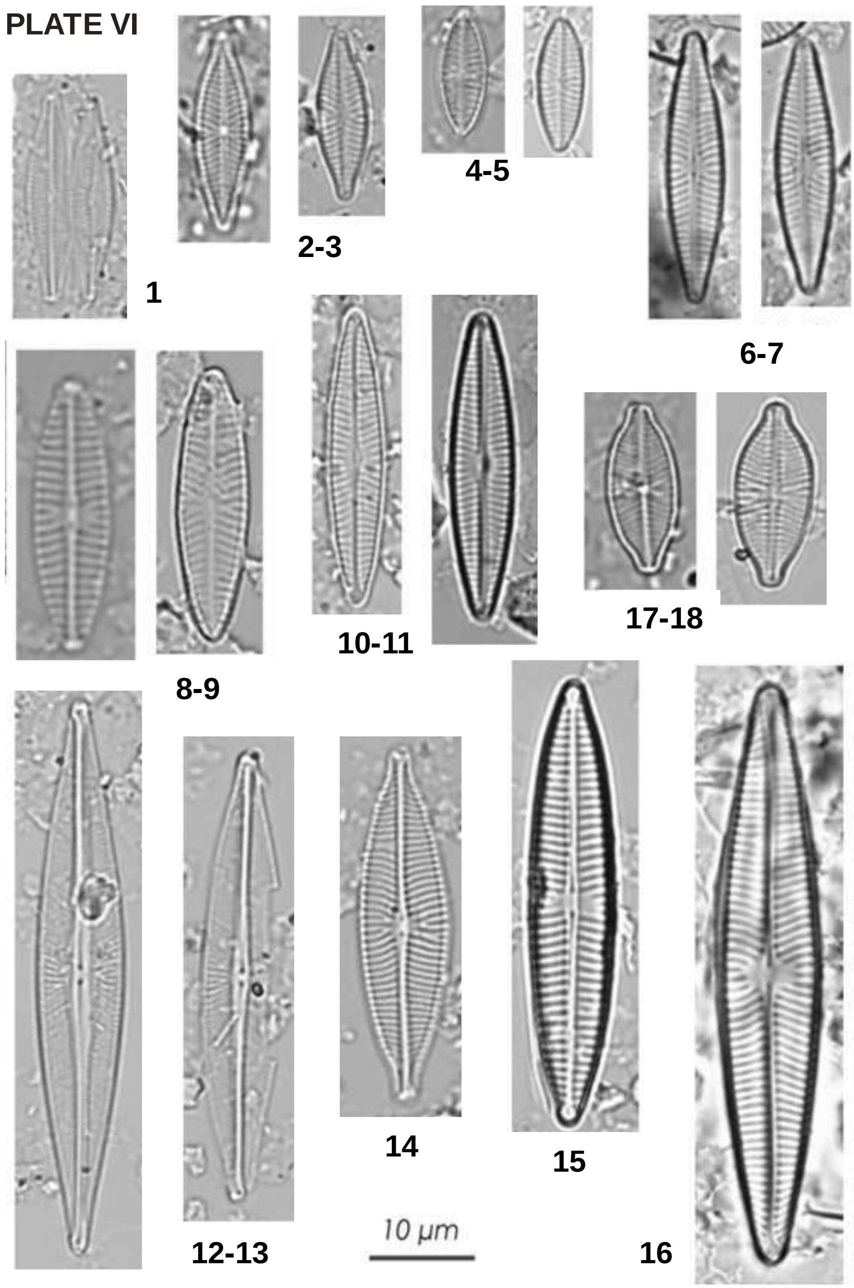


PLATE VI: **1**, *Navicula cryptocephala* (UK); **2-3,** *N. caterva* (DI & UG); **4-5,** *N. antonii* (FP & UG); **6-7,** *Navicula sp*.1 (T); **8-9,** *Navicula sp*.2 (UG); **10-11,** *Navicula sp*.3 (UG); **12-13,** *N.gottlandica* (*cf.*) (UK); **14,** *N. capitatoradiata* (FP); **15,** *N. tripunctata* (FP); **16,** *N. radiosa* (T); **17-18,** *Navigeia decussis* (=*Geissleria decussis*) (UG & UK) (1500x).

PLATE VII

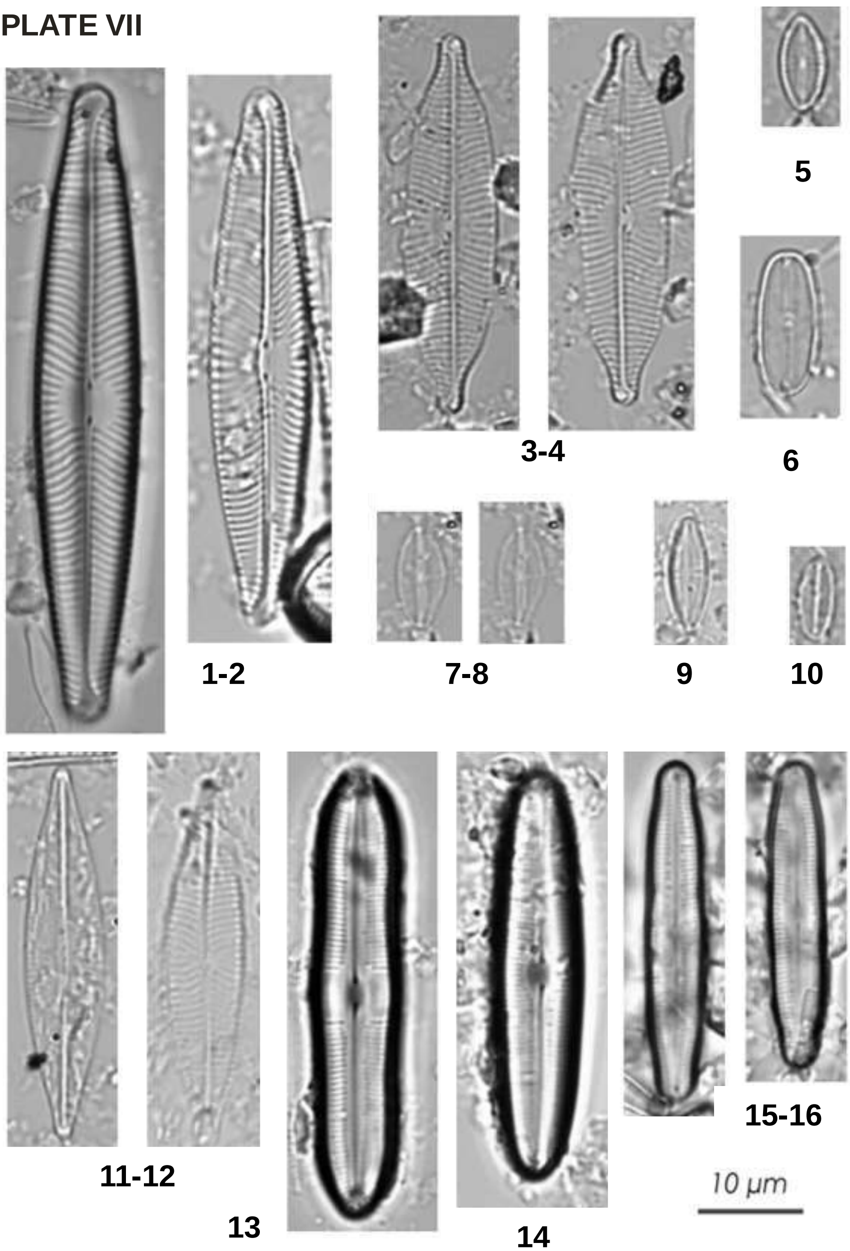


PLATE VII: **1-2**, *Navicula lanceolata* (UK); **3-4**, *Navicula rostellata* (UG); **5**, *Mayamaea atomus* (UK); **6**, *Fallacia helensis* (*cf.*) (UK); **7-8**, *Craticula minusculoides* (UG); **9**, *Navicula sp.4* (UK); **10**, *Fallacia sp.* (UK); **11-12,** *Navicula menisculus* (*cf.*) (UG & UK); **13**, *Caloneis silicula* (UK); **14**, *Caloneis thermalis* cf. (FP); **15-16,** *Caloneis tenuis* (T) (1500x).

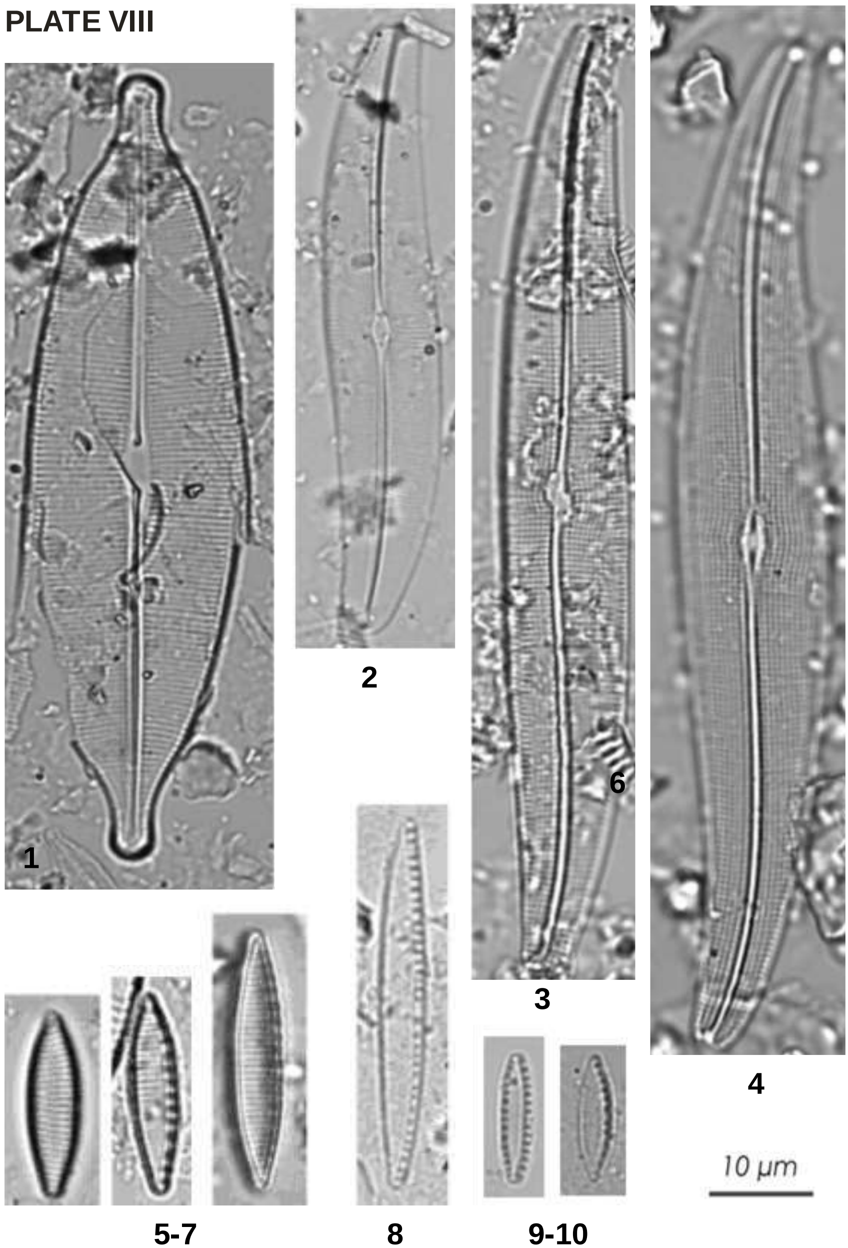


PLATE VIII: **1,** *Craticula cuspidata* (DI); **2,** *Gyrosigma scalproides* (FP); **3,** *G. attenuatum* (UK); **4,** *G, acuminatum* (UG); **5-7,** *Nitzschia amphibia* (UK); **8,** *N. clausii* (UK); **9-10,** *N. incospicua* (UK& UG) (1500x).

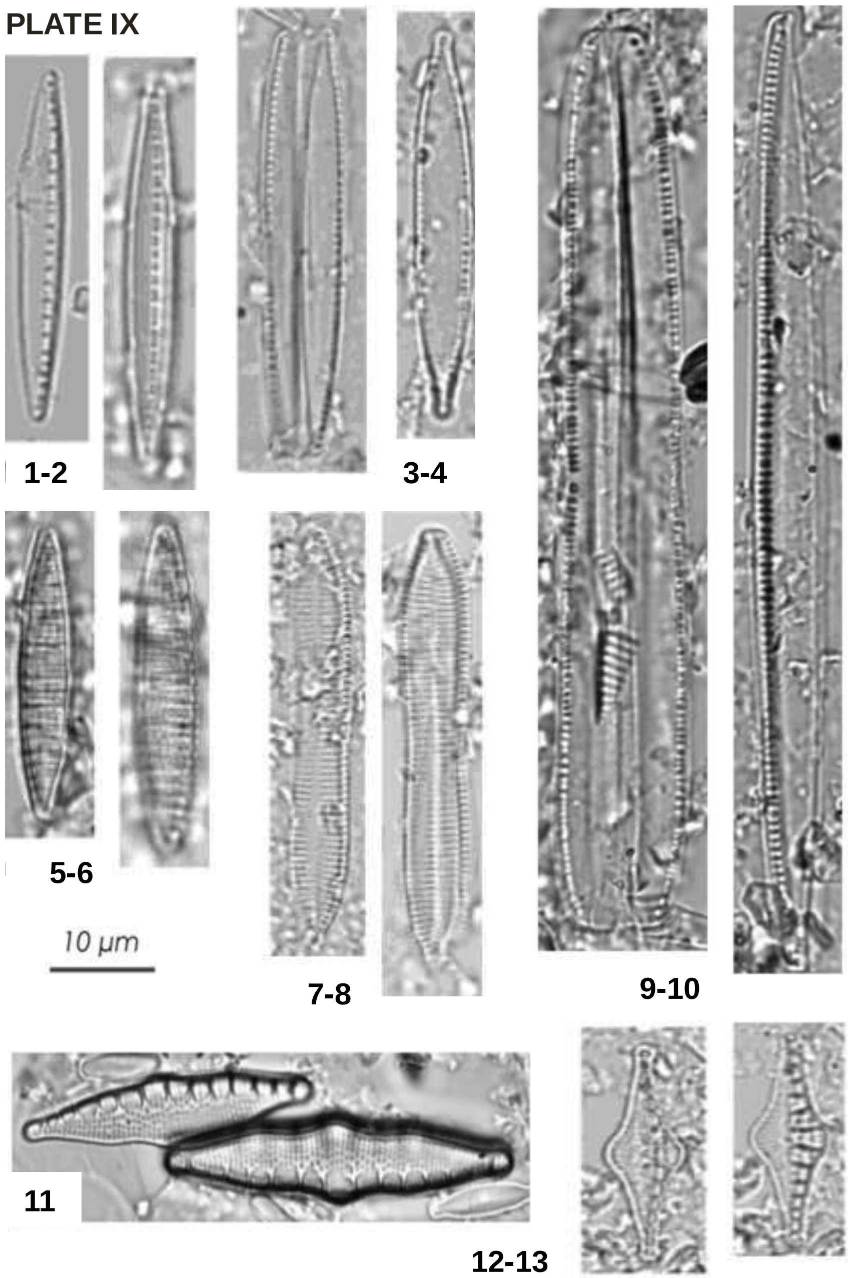


PLATE IX: **1-2,** *Nitzschia dissipata* (FP & UK); **3-4,** *N. palea* (FP, UG); **5-6,** *N. denticula* (UK); **7-8,** *Tryblionella apiculata* (=*Nitzschia constricta*) (UG); **9-10,** *Nitzschia linearis* (DI); **11**, *Nitzschia sinuata var. sinuata* (T); **12-13,** *Grunowia tabellaria* (UK) (1500x).

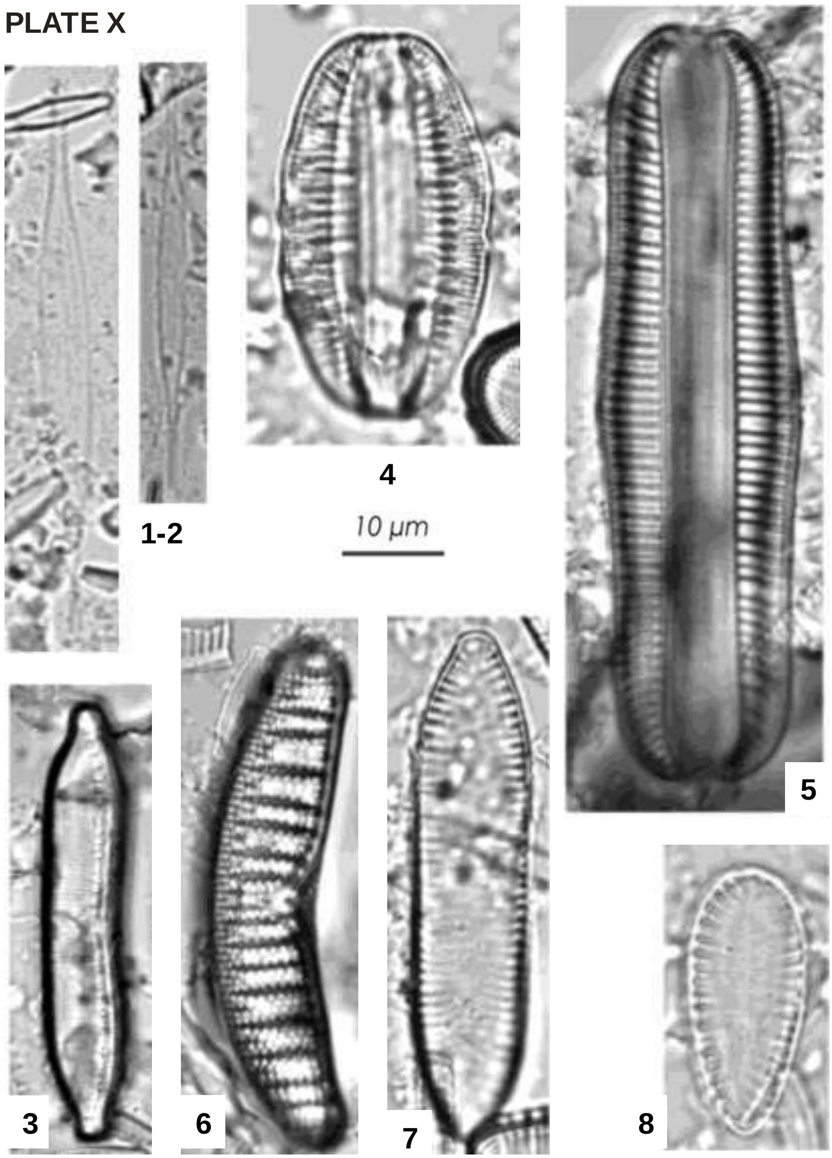


PLATE X: **1-2,** *Nitzschia draveillensis* (FP); **3,** *Hantzschia amphioxys* (T); **4,** *Rhopalodia brebissonii* (FP); **5,** *R. gibba* (T); **6,** *Epithemia adnata* (T); **7**, *Surirella angusta* (FP); **8,** *S. brebissonii* (FP) (1500x).

PLATE XI

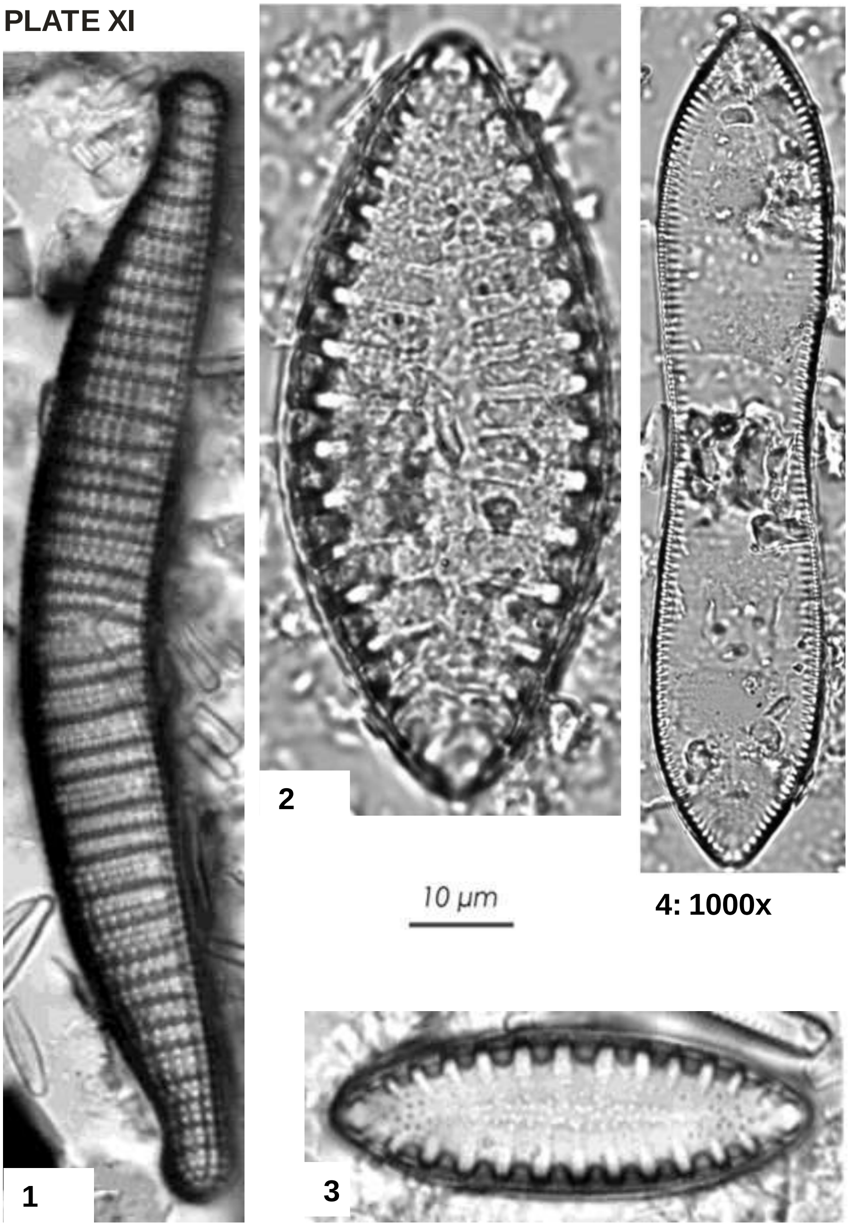


PLATE XI: **1,** *Epithemia turgida* var. *granulata* (T); **2,** *Iconella bifrons* (UK); **3,** *I. helvetica* (T); **4,** *Surirella librile* (=*Cymatopleura solea*) (UG) (4: 1000x; others 1500x).