Taxonomic composition of the epilithic diatom flora from rivers Vit and Osum, Bulgaria

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Dedicated to Assoc. Prof. Dr Stefan Draganov in honour of his 75th anniversary

Abstract. This paper presents the epilithic diatom flora from rivers Vit and Osum. Twenty-eight sampling sites were chosen along the river catchments, from the springs to the inflows (the Danube River). A total of 114 diatom taxa (103 species and 11 varieties) from 36 genera were identified in the epilithon of the studied rivers. The epilithic diatom floras from rivers Vit and Osum had high floristic similarity, Cs = 0.737 (with 66 common spesies).

To characterize the diatom distributional patterns, nonmetric multidimensional scaling was used Two types of diatom assemblages were found throughout the studied rivers. The diatom assemblages from the upper reaches of the studied rivers were dominated by *Achnanthidium pyrenaicum*, *A. minutissimum*, *Encyonema minutum*, *E. silesiacum*, *Gomphonema olivaceum*, *G. pumilum*, *Reimeria sinuata*, *Amphora pediculus,* and *Cocconeis pediculus.* The diatom assemblages found in the lower reaches of the studied rivers were dominated by *Navicula cryptotenella*, *N. lanceolata*, *Eolimna subminuscula*, *Mayamaea atomus*, *M. atomus* var. *permitis*, *Amphora pediculus, Cocconeis placentula* and varieties, *Nitzschia capitellata*, *N. dissipata*, *N. palea*, *N. incospicua*, and *Surirella brebissonii*.

Key words: Bulgaria, diatoms, epilithon, rivers, taxonomy

Introduction

Benthic diatoms are well known as indicators of water quality (see review by Stevenson & Pan 1999). Diatoms, which constitute a significant part of the stream benthic communities, are largely used in the biomonitoring programs across the world. Algae and especially diatoms are not included in the Bulgarian national monitoring system of rivers, because of the lack of floristic data. Investigations of the stream benthic diatoms in Bulgaria are scarce and mainly focused on the river catchments in the mountainous areas in the southern and western parts of the country (Kawecka 1974; Temniskova-Topalova & Misaleva 1982; Ivanov & al. 2003a, b, 2006a, b; Ivanov & Ector 2006; Ivanov & Kirilova 2006). The only river in Bulgaria studied for benthic diatoms from its springs to the national border is river Mesta (Passy & al. 1999). These authors defined subsets of taxa based on both nutrient and microhabitat preferences.

The benthic diatom flora from the streams and rivers of North Bulgaria is unknown. Thus we focused our investigation of the epilithic diatoms from rivers Vit and Osum. Both rivers take their source from the

Balkan Range and flow into the Danube, which presumes a multiple environmental stressors gradient for the aquatic biota. There are some data on the algal flora of the upper catchment area of river Osum (Kirjakov & Vodenicarov 1986; Vodenicarov & Kirjakov 1987). The authors reported 51 diatom taxa for rivers Beli and Cherni Osum and the adjacent wetlands (Kirjakov & Vodenicarov 1986). On the basis of bioindicator analysis of algal flora (a total of 225 taxa) the saprobiological conditions in the upper reaches of river Osum were revealed (Vodenicarov & Kirjakov 1987).

This study is designed to examine the response of the epilithic diatom community to environmental changes in the watersheds of rivers Vit and Osum. Thus sampling sites were located, starting from the river springs in the mountainous areas and to the Danube. The aim of this paper is to present the taxonomic composition of the epilithic diatom flora from rivers Vit and Osum and to characterize the distributional patterns of the benthic diatom assemblages of both rivers. The study is expected to contribute to the knowledge of periphytic diatoms in the Bulgarian rivers and may help further the diatom-based bioassessment in the region.

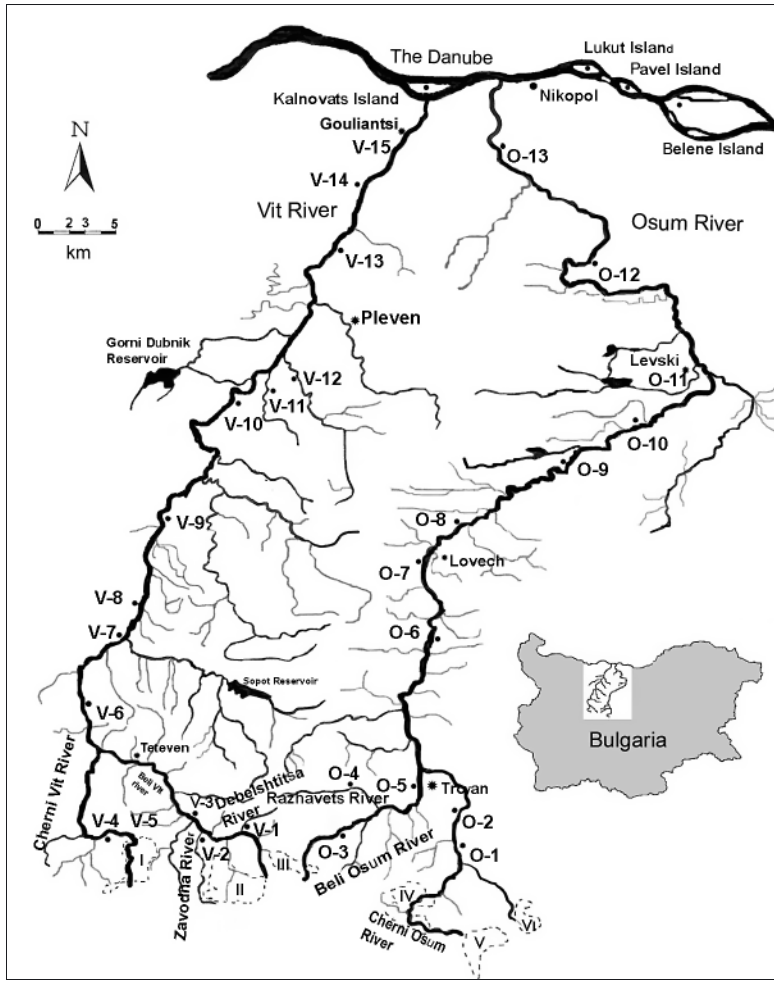


Fig. 1. Map of the study area and sampling sites.
Legend: Numbered black dots mark the sampling sites on river Vit (**V**) and river Osum (**O**). Natural reserves in the study area: **I** – Boatin Reserve; **II** – Tsarichina Reserve; **III** – Kozya Stena Reserve; **IV** – Steneto Reserve; **V** – Stara Reka Reserve; **VI** – Dzhendema Reserve.

Materials and methods

The catchments of rivers Vit and Osum lie within the Danube River basin. River Osum is 314 km long and has a catchment area of 2 820 km^2, while river Vit is 189 km long and with a catchment area of 3 220 km^2. The main water sources of the studied rivers are located between 1800 m and 2030 m a.s.l., in several natural reserves within the Central Balkan National Park in the Balkan Range. In their lower stretches the rivers flow across the Danubian Plain, characteristic with intensive agricultural and urban land use. A total of 28 diatom samples were collected from 15 sites of river Vit and 13 sites of river Osum in May 2006 (Fig. 1).

For the qualitative and quantitative analyses of epilithic diatoms, the periphyton samples were collected under to the single-habitat sampling method of Stevenson & Bahls (1999). The sampled substrates were cobbles obtained from riffles. In low-gradient stream parts where riffles were rare, diatoms on snags or in habitats were collected. Laboratory processing of the samples was carried out after Hasle & Fryxell (1970). For light microscopy, the cleaned material was mounted on permanent slides with Naphrax. Five hundred valves were counted in each sample. Light microscopy was performed with Amplival Carl Zeiss Jena with 100× oil-immersion objectives. The treated samples were also mounted on strubs and coated with 50 nm of gold for scanning electron microscopy (SEM), performed with Jeol JSM-5510 SEM, operated at 10 kV. The material is stored in the algal collection of the Department of Botany of the St. Kliment Ohridski University of Sofia.

Similarity between the epilithic diatom floras of both rivers was calculated by Sørensen's coefficient of similarity (Cs) (Sørensen 1948). To characterize the diatom distributional patterns, nonmetric multidimensional scaling (NMDS) was used. The NMDS extends to all diatoms with relative abundance greater than 1 % in three or more samples (a total of 69 species and varieties). The NMDS analysis was performed using the Bray-Curtis distance with square root data transformation by PRIMER v. 5 software (Clarke & Warwick 2001).

The main taxonomic sources were Krammer & Lange-Bertalot (1986, 1988, 1991a, b), Lange-Bertalot & Krammer (1989), Reichardt & Lange-Bertalot (1991), Lange-Bertalot (1993, 2001), Reichardt (1999, 2004), and Krammer (2000, 2002, 2003). Nomenclature refers to Round & al. (1990), with some additions according to Bukhtiyarova & Round (1996), Krammer (1997a, b, 2000), etc.

Results

A total of 114 diatom taxa (103 species and 11 varieties) from 36 genera were identified in the epilithon of the studied rivers. Seven taxa were determined to generic level. A taxonomic list and diatom distribution by sites are presented in Table 1. The most common and some unknown taxa are accompanied with SEM micrographs (Plates I-IV).

The following genera had the greatest number of species and varieties: *Nitzschia* Hassal (27 taxa), *Navicula* Bory and *Gomphonema* Ehrenb. (13 taxa each), *Cocconeis* Ehrenb. (6 taxa), *Achnanthidium* Kütz. and *Encyonema* Kütz. (5 taxa each).

Thirteen diatoms were found in more that half of the sampling sites on both rivers. The most common diatoms were registered with the percentage of sampling sites in which they occur: *Achnanthidium pyrenaicum* (Hust.) H. Kobayasi (96 %), *A. minutissimum* (Kütz.) Czarn. and *Amphora pediculus* (Kütz.) Grunov (82 % each), *Cocconeis placentula* Ehrenb. (78 %), *Cocconeis placentula* var. *euglypta* (Ehrenb.) Grunov (75 %), *Cocconeis pediculus* Ehrenb. 61 %), *Reimeria sinuata* (79 %), *Gomphonema olivaceum* (Hornem.) Bréb. (71 %), *Gomphonema pumilum* (Grunov) E. Reichardt & Lange-Bert. and *G. rosenstockianum* Lange-Bert. & E. Reichardt (61 % each), *Navicula tripunctata* (O.F. Müll.) Bory (68 %), *N. cryptotenella* Lange-Bert. (57 %), and *Nitzschia dissipata* (Kütz.) Grunov (61 %).

The epilithic diatom floras from both rivers were compared by the Sørensen's coefficient of similarity, which showed high floristic similarity: Cs = 0.737 (with 66 common species). Ninety-eight diatom taxa were found in river Vit and 94 in river Osum. The total species richness in some sites ranged from 10 (site V7) to 43 (site V15) for river Vit, and from 10 (site O2) to 47 (site O13) for river Osum.

Figure 2 presents a NMDS ordination diagram of diatom-based sites on rivers Vit and Osum. A minimum stress of 0.12 corresponds to good ordination with a 2-dimensional plot. Based on relative abundances of the most common epilithic diatoms, the first ordination axis separates samples from the upper and lower reaches of both rivers. The diatom sites from the upper reaches of rivers Vit and Osum are located to the left of Axis I, while the diatom sites from the lower reaches are located to the right of Axis I.

The diatom assemblages of the upper reaches of the studied rivers were dominated by the following taxa (shown with their maximum individual relative abundance): *Achnanthidium pyrenaicum* (94 %), *A. minutissimum* (19.2 %), *Encyonema minutum* (Hilse) D.G. Mann (19.2 %), *E. silesiacum* (Bleisch) D.G. Mann (16 %), *Gomphonema olivaceum* (8 %), *G. pumilum* (6 %), *Reimeria sinuata* (6.2 %), *Amphora pediculus* (16.8 %), and *Cocconeis pediculus* (5.9 %). Within this diatom-site group, the second ordination axis separates three sites (V1, O3 and O4) on the basis of the presence of *Achnanthidium* sp.1, the higher relative abundance of *Gomphonema pumilum* (up to 28.3 %) and *G. rosenstockianum* (up to 2.6 %), and the quantitative prevalence of *Achnanthidium minutissimum* over *A. pyrenaicum.*

The diatom assemblages found in the lower reaches of the studied rivers were dominated by the following taxa (shown with their maximum individual relative abundance): *Navicula cryptotenella* (9.6 %), *N. lanceolata* (C. Agardh) Ehrenb. (21 %), *Eolimna subminuscula* (Manguin) G. Moser, Lange-Bert. & Metzeltin (20.6 %), *Mayamaea atomus* (Kütz.) Lange-Bert. (25.3 %), *M. atomus* var. *permitis* (Hust.) Lange-Bert. (12 %), *Nitzschia capitellata* Hust. (22.7 %), *N. dissipata* (Kütz.) Grunov (9.3 %), *N. palea* (Kütz.) W.M. Smith (31.6 %), *N. incospicua* Grunov (11.4 %), *Surirella brebissonii* Krammer & Lange-Bert. (8.1 %), *Amphora pediculus* (24 %), *Cocconeis placentula* (10.4 %), *C. pla-*

centula var. *lineata* (Ehrenb.) Van Heurck (9.3 %), and *C. placentula* var. *euglipta* (7 %).

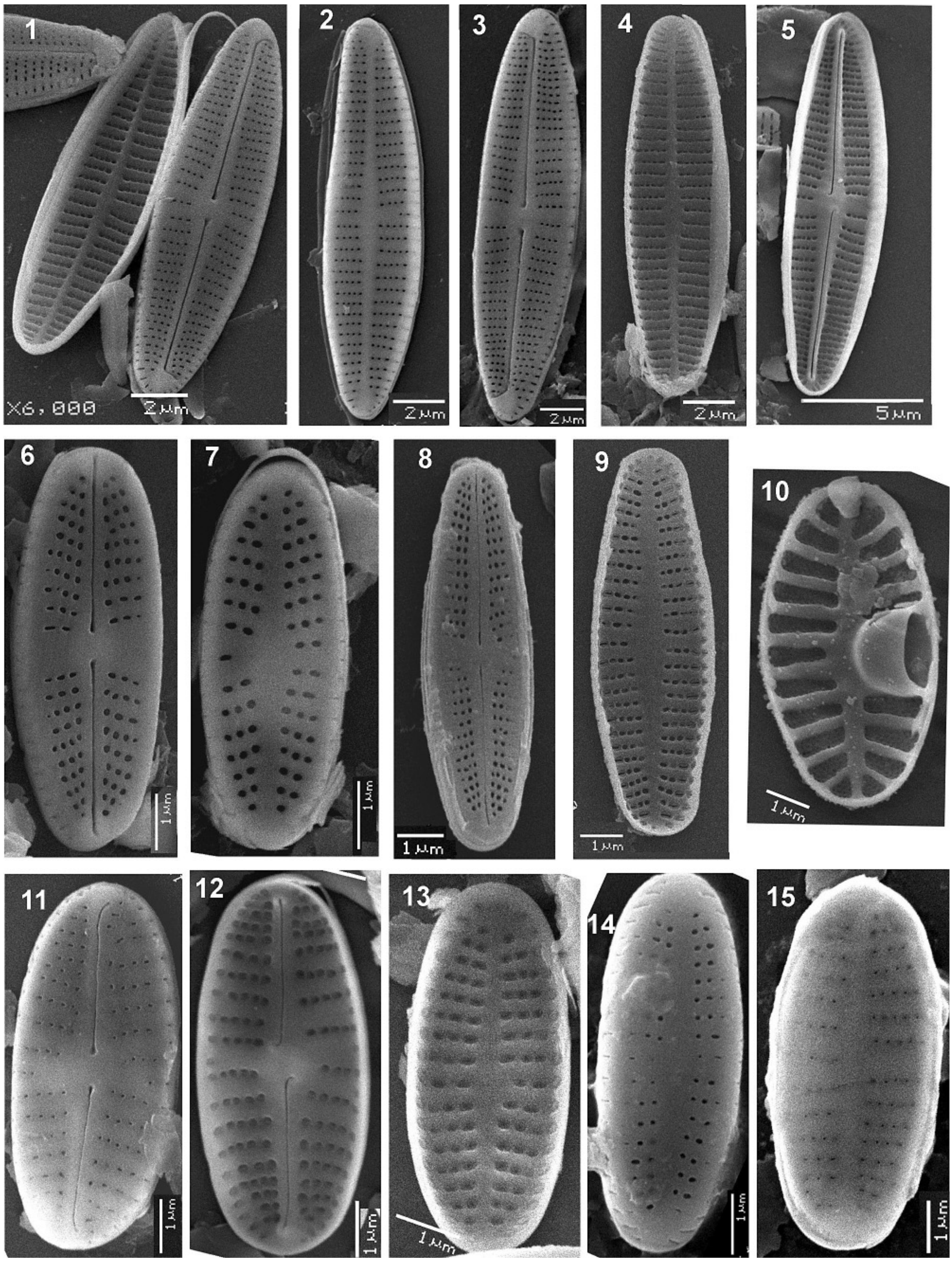
Within the diatom-site group characteristic of the lower reaches, two sites were separated (O8 and O9) by both ordination axes. Their diatom assemblage has transitional characteristics of the presence of *Achnanthidium pyrenaicum, Cocconeis pediculus* and *Encyonema silesiacum,* the maximum distribution of *Mayamaea atomus* var. *permitis* (up to 28.4 %), *Reimeria sinuata* (up to 36 %) and *Gomphonema rosenstockianum* (up to 7.2 %), and the lack of dominant *Nitzschia* taxa.

Table 1. List of epilithic diatoms found in rivers Vit (V) and Osum (O). Taxon names are listed in alphabetical order; (+) – presence, (–) – absence.

Taxon	Site																											
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13
Achnanthidium minutissimum (Kütz.) Czarn.	+	+	–	+	+	+	–	+	–	+	+	+	–	+	+	+	+	+	+	+	+	+	+	+	+	–	+	+
A. pyrenaicum (Hust.) H. Kobayasi	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	–	+
A. subatomus (Hust.) Lange-Bert.	+	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+
Achnanthidium sp.1	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Achnanthidium sp.2	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Adlafia minuscula (Grunov) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–
Amphora pediculus (Kütz.) Grunov	+	–	–	+	–	–	+	+	–	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Caloneis bacillum (Grunov) Cleve	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	+	+	–
Cocconeis disculus (Schum.) Cleve	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
C. neodiminuta Krammer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
C. pediculus Ehrenb.	+	–	–	–	–	–	–	–	+	+	+	+	+	+	+	–	–	+	–	+	+	+	+	+	+	+	–	+
C. placentula Ehrenb.	+	–	+	+	+	–	–	+	+	+	+	+	+	+	+	+	–	+	+	+	+	+	+	+	+	–	+	–
C. placentula var. *euglypta* (Ehrenb.) Grunov	+	–	–	+	+	–	–	–	+	+	+	+	–	+	+	+	–	+	+	+	+	+	+	+	+	+	+	+
C. placentula var. *lineata* (Ehrenb.) Van Heurck	+	+	–	+	–	–	–	–	+	+	+	–	+	+	–	–	+	+	–	+	–	+	+	+	–	+	+	–
Craticula accomoda (Hust.) D.G. Mann	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Cyclotella meneghiniana Kütz.	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	+	–	+
Cymatopleura solea var. *apiculata* (W.M. Smith) Ralfs	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	+
Cymbella affinis Kütz.	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	–	+	–	–	+	–	–	+	+	–	–
C. compacta Østrup	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. helvetica Kütz.	–	–	+	+	–	+	+	+	+	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–	–
C. laevis Nägeli	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Diadesmis contenta (Grunov ex Van Heurck) D.G. Mann	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Diatoma ehrenbergii Kütz.	+	–	+	+	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
D. mesodon (Ehrenb.) Kütz.	+	+	–	+	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
D. moniliformis Kütz.	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	–	–	–	–	+	+	+
D. vulgaris Bory	+	–	–	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Encyonema caespitosum Kütz.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	+	–	–	–
E. minutum (Hilse) D.G. Mann	+	+	+	+	–	+	+	+	+	+	+	–	–	–	+	+	+	+	+	+	+	+	+	–	–	+	–	–
E. reichardtii (Krammer) D.G. Mann	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E. silesiacum (Bleisch) D.G. Mann	+	–	+	–	–	+	+	+	+	–	–	–	+	–	–	–	+	–	+	+	–	+	+	+	+	–	–	+
E. ventricosum (C. Agardh) Grunov	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–
Eolimna minima (Grunov) Lange-Bert.	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	+	+	–	–	+	–	–
E. subminuscula (Manguin) G. Moser, Lange-Bert. & Metzeltin	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	+	+	+	+	+	+	+
Epithemia sorex Kütz.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
Fistulifera saprophila (Lange-Bert. & Bonik) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Fragilaria capucina Desm.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
F. capucina var. *capitellata* (Grunov) Lange-Bert.	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
F. vaucheriae (Kütz.) Petersen	–	+	–	+	–	–	–	+	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
Gomphonema angustatum (Kütz.) Rabenh.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
G. micropus Kütz.	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. minutum (C. Agardh) C. Agardh	–	+	–	–	+	–	–	+	+	–	–	+	+	+	+	–	–	–	–	–	–	–	+	–	–	–	–	–
G. olivaceum (Hornem.) Bréb.	+	–	+	–	–	+	–	+	+	+	+	+	–	+	+	+	–	+	+	–	–	–	+	+	+	+	+	+
G. olivaceum var. *olivaceoides* (Hust.) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	–	–	+	–	–
G. parvulum (Kütz.) Kütz.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. pumilum (Grunov) E. Reichardt & Lange-Bert.	+	+	+	+	+	+	–	+	+	–	+	–	+	–	–	+	+	+	+	+	–	+	+	–	–	–	–	–
G. pumilum var. *elegans* E. Reichardt & Lange-Bert.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. pumilum var. *rigidum* E. Reichardt & Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
G. rosenstockianum Lange-Bert. & E. Reichardt	+	–	–	+	+	–	–	–	+	+	–	–	+	–	–	+	+	+	+	+	+	–	+	+	+	–	+	+
Gomphonema sp.1	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gomphonema sp.2	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gomphonema sp.3	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

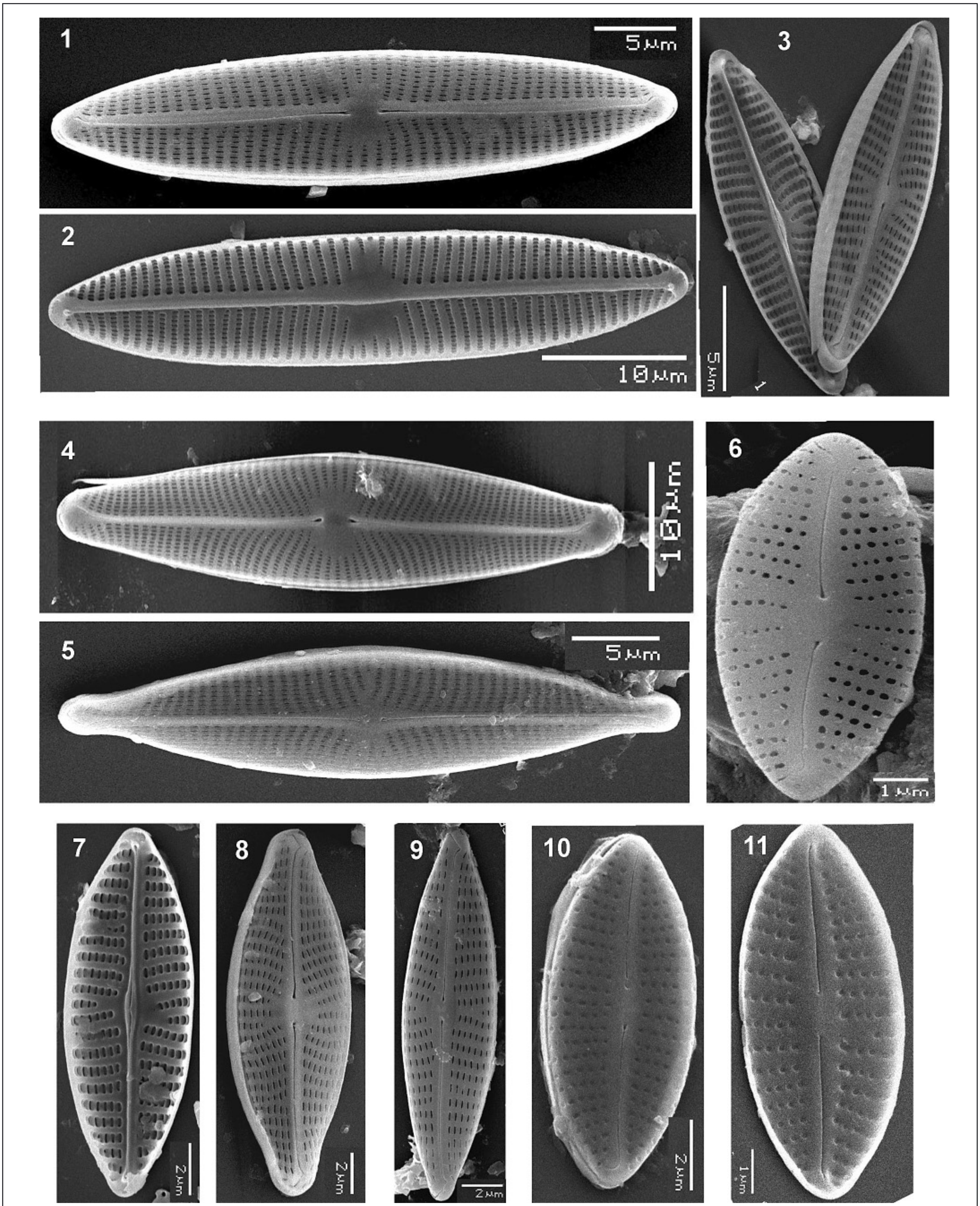
Taxon	Site																											
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13
Gomphonema sp.4	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gyrosigma acuminatum (Kütz.) Rabenh.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	+
Hannaea arcus (Ehrenb.) R.M. Patrick	–	+	+	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hyppodonta capitata (Ehrenb.) Lange-Bert., Mtzeltin & Witkowski	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Kolbesia ploenensis (Hust.) Bukhtiyarova & Round	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mayamaea atomus (Kütz.) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–	–	–	+	–	+	+	+	–	+	+	–	+	+
M. atomus var. *permitis* (Hust.) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	+	–	+	+	+	+	+	+
Melosira varians C. Agardh	–	–	–	–	–	–	–	–	–	–	+	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+
Meridion circulare (Grev.) C. Agardh	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Navicula antonii Lange-Bert.	–	–	–	–	–	–	–	–	–	–	+	+	–	+	+	–	–	–	–	–	–	–	–	–	+	–	–	–
N. capitatoradiata H. Germ.	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–	–	–	–	+	+	+	+	+
N. cryptotenella Lange-Bert.	–	–	–	–	–	–	+	+	+	–	–	+	+	–	+	+	–	–	+	+	+	+	+	+	+	+	+	–
N. cryptotenelloides Lange-Bert.	+	–	–	+	–	–	–	–	–	+	+	–	–	+	–	–	–	+	–	–	–	+	+	–	+	–	+	–
N. gregaria Donkin	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	+	–	+	–	+
N. lanceolata (C. Agardh) Ehrenb.	–	–	–	+	–	–	–	+	–	–	–	+	+	+	+	–	–	–	–	–	–	–	–	–	+	+	+	+
N. radiosa Kütz.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
N. radiosafallax Lange-Bert.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
N. recens (Lange-Bert.) Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
N. reichardtiana Lange-Bert.	–	–	–	–	–	+	–	–	–	–	+	+	+	–	–	–	–	–	+	–	+	+	–	–	–	+	+	+
N. tripunctata (O.F. Müll.) Bory	+	–	–	+	–	–	–	+	+	+	+	+	+	+	+	–	–	–	+	+	+	+	+	+	+	+	–	+
N. trivialis Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Nitzschia acicularis (Kütz.) W.M. Smith	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+
N. agnita Hust.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	–
N. capitellata Hust.	–	–	–	–	–	–	–	–	–	–	–	+	+	–	+	–	–	–	–	–	–	–	–	–	–	+	–	+
N. dissipata (Kütz.) Grunov	+	–	–	–	+	+	+	+	–	+	+	+	+	+	+	–	–	–	–	–	–	–	+	+	+	+	+	+
N. dissipata var. *media* (Hantzsch) Grunov	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. dubia W.M. Smith	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
N. fonticola Grunov	–	–	–	+	–	–	–	–	–	+	–	–	+	–	+	–	–	–	–	–	+	+	–	+	+	–	–	–
N. frustulum (Kütz.) Grunov	–	–	–	–	–	+	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–	+	–	+	–
N. gracilis Hantzsch	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	–
N. graciliformis Lange-Bert. & Simonsen	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+
N. heufleriana Grunov	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	+	–	+
N. incognita Krasske	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
N. inconspicua Grunov	–	–	–	–	–	–	–	–	–	–	–	+	–	+	+	–	–	–	–	–	–	–	–	–	–	–	+	–
N. intermedia Hantzsch ex Cleve & Grunov	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
N. linearis (C. Agardh) W.M. Smith	–	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
N. linearis var. subtilis (Grunov) Hust.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
N. ovalis Arn.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
N. palea (Kütz.) W.M. Smith	–	–	–	–	–	–	+	+	+	–	+	+	+	+	+	–	–	–	+	–	–	–	–	–	–	+	+	+
N. palea var. *debilis* (Kütz.) Grunov	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
N. paleacea (Grunov) Grunov	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+
N. perminuta (Grunov) Perag.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
N. pumila Hust.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
N. recta Hantzsch	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	+
N. sigmoidea (Nitzsch) W.M. Smith	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
N. solita Hust.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
N. supralitorea Lange-Bert.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
N. vermicularis (Kütz.) Hantzsch	–	–	–	–	–	–	–	–	–	–	+	–	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	–
Pinnularia lundii Hust.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinnularia sp.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Planothidium frequentissimum (Lange-Bert.) Lange-Bert.	–	+	–	+	+	–	–	–	–	–	–	–	–	+	+	–	–	+	–	–	–	–	–	–	–	–	–	+
P. subatomoides (Hust.) Bukhtiyarova & Round	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Psammodictyon constrictum (W. Greg.) D.G. Mann	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+
Reimeria sinuata (W. Greg.) Kociolek & Stoermer	–	+	+	+	–	–	+	+	+	+	+	–	+	+	–	+	+	+	+	+	+	+	+	+	+	+	+	–
Rhoicosphenia abbreviata (C. Agardh) Lange-Bert.	–	–	–	–	–	–	–	–	+	–	+	+	+	+	+	–	–	–	–	–	+	–	–	–	–	–	–	+
Stephanodiscus hantzschii Grunov	–	–	–	–	–	–	–	–	–	–	–	+	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–
S. parvus Stoermer & Håk.	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Surirella angusta Kütz.	–	–	–	–	–	–	–	–	–	–	–	+	–	+	+	–	–	–	–	–	–	–	–	–	–	+	–	+
S. brebissonii Krammer & Lange-Bert.	–	–	–	–	–	–	–	–	–	–	+	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	+	+
S. minuta Bréb.	–	–	+	+	–	–	–	+	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	+
Tryblionella calida (Grunov) D.G. Mann	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
T. hungarica (Grunov) D.G. Mann	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	–
Ulnaria ulna (Nitzsch) Compère	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Plate I



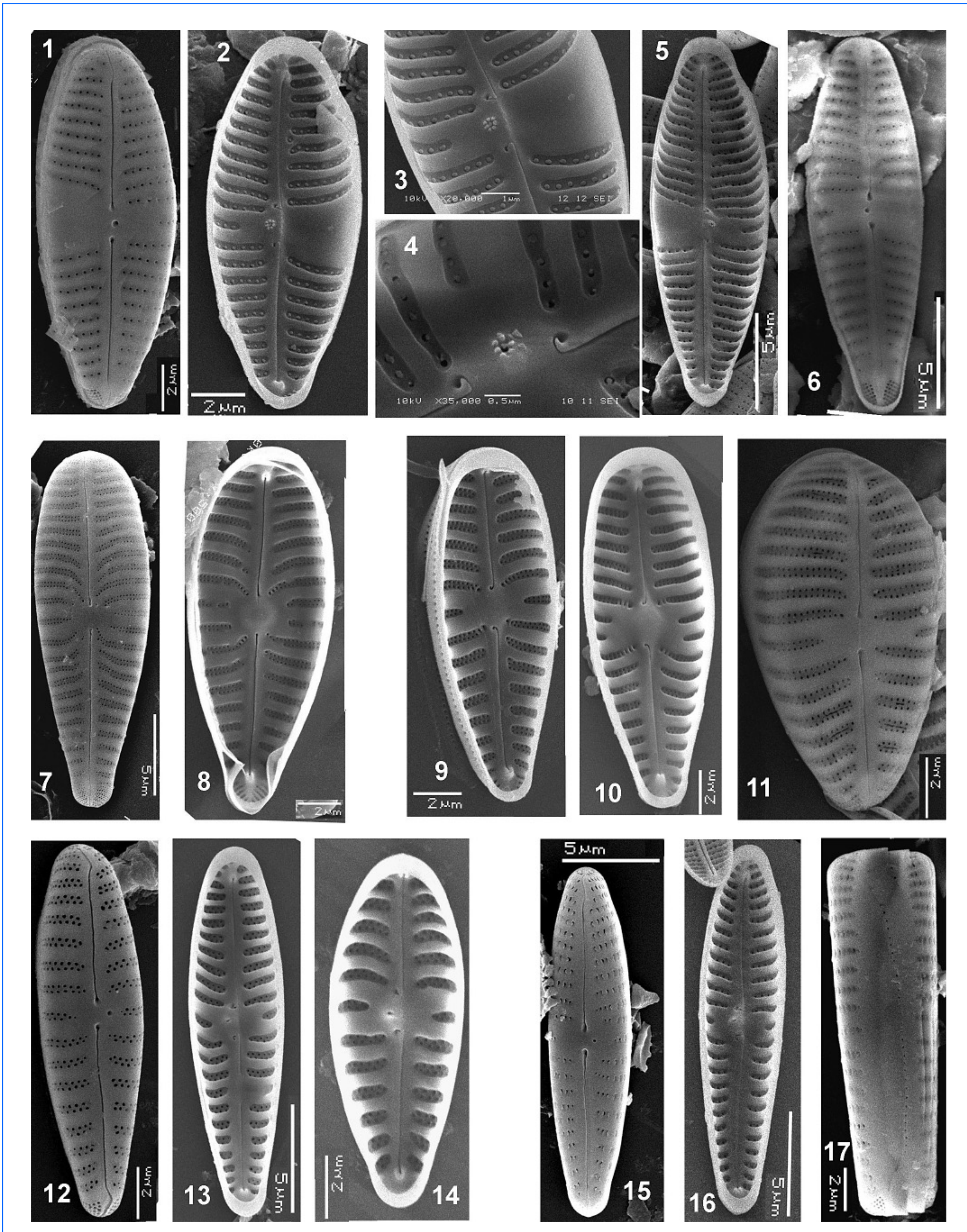
Figs 1-15. SEM micrographs of:
1-5, *Achnanthidium pyrenaicum*; **6-9,** *A. minutissimum*; **10**, *Planothidium frequentissimum*; **11-13**, *A. subatomus*; **14-15**, *Achnantidium* sp.1

Plate II



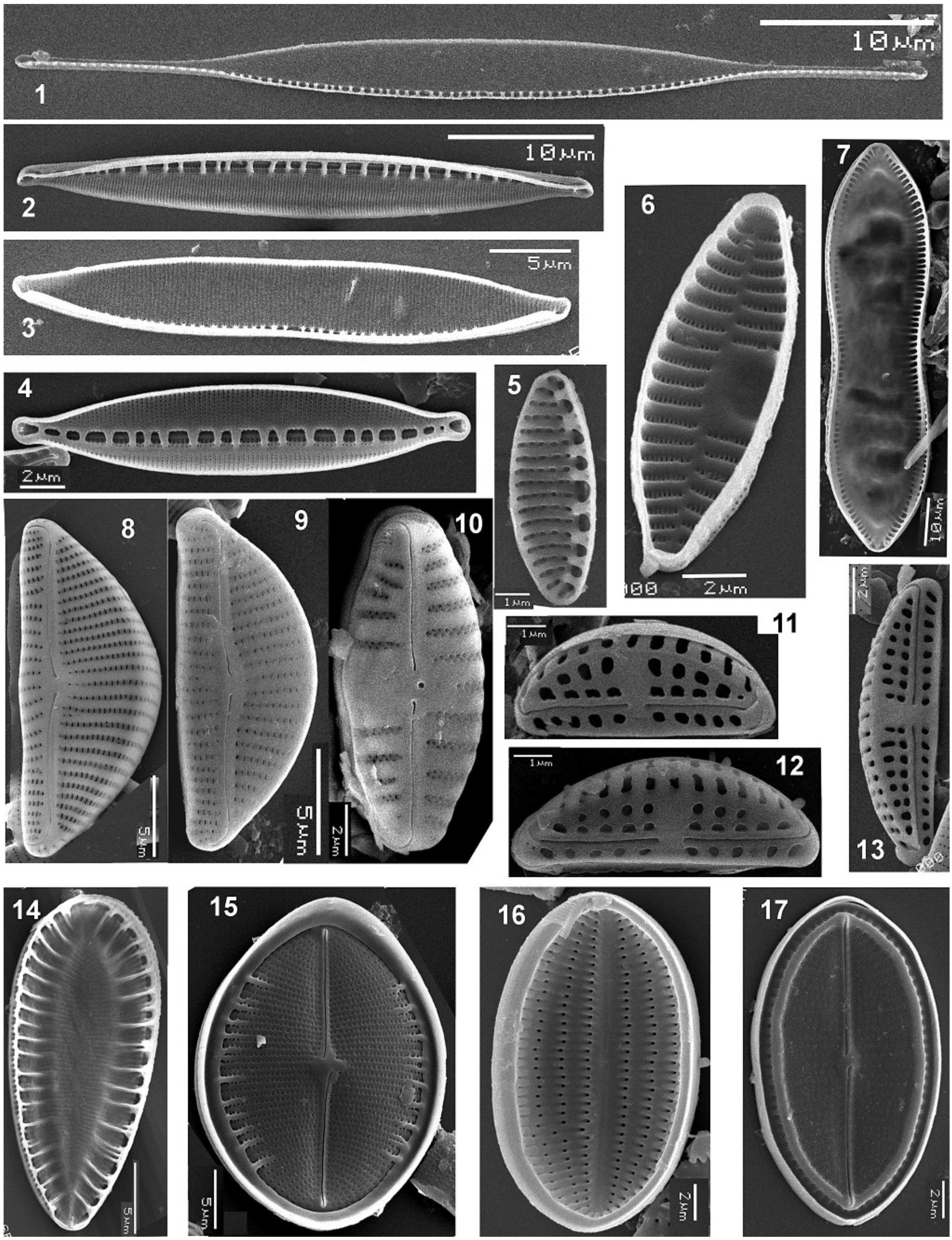
Figs 1-11. SEM micrographs of:
1-2, *Navicula tripunctata*; **3**, *N. cryptotenelloides*; **4**, *N. lanceolata*; **5**, *N. capitatoradiata*; **6**, *Mayamaea atomus* var. *permitis*; **7-8**, *N. reichardtiana*; **9**, *Navicula cryptotenella*; **10-11**, *Eolimna subminuscula*.

Plate III



Figs 1-17. SEM micrographs of:
1-6, *Gomphonema rosenstockianum*; **7-8,** *G. olivaceum*; **9-11**, *G. olivaceum* var. *olivaceoides*; **12-14,** *G. minutum*; **15-17**, *G. pumilum.*

Plate IV



Figs 1-17. SEM micrographs of:
1, *Nitzschia acicularis*; **2**, *N. recta*; **3**, *N. capitellata*; **4**, *N. dissipata*; **5**, *N. inconspicua*; **6**, *Fragilaria vaucheriae*; **7**, *Cymatopleura solea* var. *apiculata*; **8**, *Encyonema silesiacum*; **9**, *Encyonema minutum*; **10**, *Reimeria sinuata*; **11-13**, *Amphora pediculus*; **14,** *Surirella brebissonii*; **15**, *Cocconeis pediculus*; **16-17**, *Cocconeis placentula* var. *euglypta.*

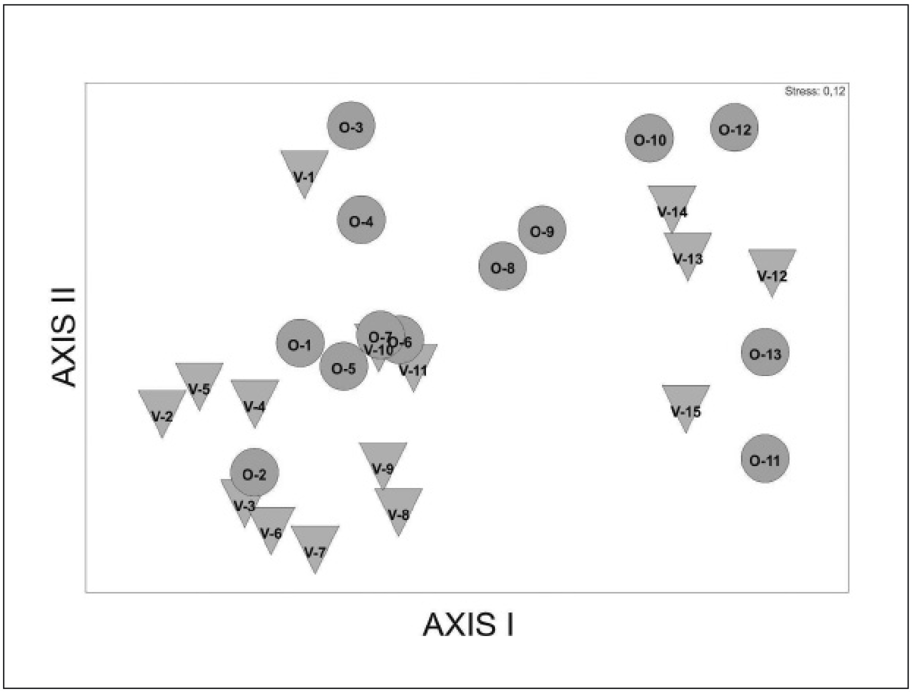


Fig. 2. NMDS ordination plot of diatom-based sites on river Vit (V) and river Osum (O).

Discussion

The epilithic diatom floras from rivers Osum and Vit were characteristically highly similar, which was probably due to natural factors, such as similar geological characteristics and relief of the catchments of both rivers. According to Tison & al. (2005), geology and relief seem to play an important role in the structuring of natural variability of diatom communities.

Two types of diatom assemblages have been found in both studied rivers. The first one was characteristic of the upper reaches of the rivers in the mountainous region between the river springs and Dolni Dubnik reservoir on river Vit, and Lovech town on river Osum. Those epilithic diatom assemblages were dominated by attached life-forms, with prevalence of *Achnanthidium pyrenaicum*. The only exception was the diatom subassemblage from the sites on river Beli Vit (V1) and river Beli Osum (O3 and O4) located at an altitude of 1000 m, within the Central Balkan National Park, close to the boundaries of Kozya Stena Reserve. In those sites *Achnanthidium minutissimum* has quantitatively prevailed over *Achnanthidium pyrenaicum,* which can be explained with late colonization of the substrate after the spring scouring flow, as compared to the sites at lower altitudes. *Achnanthidium minutissimum* was considered the first pioneer species on recently scoured sites, occasionally to the exclusion of all other algae (Stevenson & Bahls 1999). Unfortunately, a comparison between our diatom data and the results obtained by Kirjakov & Vodenicarov (1986) for the Beli Osum river catchment area is impossible, because of the different habitats and sampled stream substrates.

The second type of diatom assemblages was characteristic of the lower reaches of the studied rivers, located in the Danubian Plane at approximately 200 m a.l.s. The epilithic diatom assemblages were dominated by the taxa *Navicula*, *Nitzschia* and *Surirella* Turpin, which possess a raphe system, indicating that they are capable of movement in silt substrates (Lowe 2003). According to Stevenson & Bahls (1999), the high abundance of the above-mentioned genera reflects the degree of natural or human-inflicted siltation. It is in good agreement with the different type of substrates in the lower reaches of the studied rivers and explains in particular the species composition of epilithic diatom assemblages. Persistence of algal species depends on their adaptability to environmental conditions, including water chemistry, type of substrate, water speed, and light (Stevenson 1997).

The presented results are the first step in highlighting the benthic diatom distribution patterns in the studied rivers. The next step will be to relate the epilithic diatom assemblages to physical habitat conditions and other environmental variables in the Vit and Osum watersheds.

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