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A checklist of desmids (Conjugatophyceae, Chlorophyta) of Serbia. I. Introduction and elongate baculiform taxa

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Abstract – In the past century the desmid flora of Serbia has been investigated during several well-defined periods. Investigations have been dedicated mostly to desmid assemblages of peat bogs, fens, marshes, swamps and lakes, as typical desmid habitats. Considering that high-mountain peat bogs in Serbia are the southernmost refuge habitats of many boreal and arctic-alpine desmid taxa, there has been a considerable interest in obtaining data on the composition of the desmid flora in these habitats. In all, 626 desmid taxa belonging to 23 genera have been reported from the Republic of Serbia. On the basis of these records, an annotated checklist has been compiled. In the present paper, the main taxonomic and ecological characteristics of elongate baculiform desmid taxa of the families Mesotaeniaceae, Peniaceae, Closteriaceae and Desmidiaceae (*Actinotaenium*, *Haplotaenium*, *Pleurotaenium* and *Tetmemorus*), comprising 133 taxa (92 species and 41 varieties), are discussed. Among them 40 taxa have been reported from only one locality in Serbia, and therefore they are designated here as exceptionally rare.

Checklist / Desmids / Diversity / Floristics / Ecology / Serbia

Résumé – Checklist des desmidiées (Conjugatophyceae, Chlorophyta) de Serbie. I. Introduction et taxons allongés bacilliformes. Au cours du siècle dernier, la flore desmidiale de Serbie a été étudiée pendant plusieurs périodes bien définies. La plus grande partie des investigations a été consacrée aux communautés desmidiales des tourbières, marécages, marais, et lacs. Considérant que les tourbières des hautes montagnes en Serbie représentent des milieux refuges méridionaux pour un certain nombre de desmidiées d'origine boréales et arctiques alpines, il y a eu un intérêt considérable pour obtenir des données sur la composition de la flore desmidiale et sur ses habitats. En tout, 626 desmidiées appartenant à 23 genres ont été identifiées dans le territoire de la République de Serbie et une liste annotée a été compilée sur la base de ces données. Les caractéristiques principales de l'écologie et la taxinomie des desmidiées allongées bacilliformes des familles Mesotaeniaceae, Peniaceae, Closteriaceae et Desmidiaceae (*Actinotaenium*, *Haplotaenium*, *Pleurotaenium* and *Tetmemorus*) comprenant 133 taxons (92 espèces et 41 variétés) sont discutées dans l'article. Parmi eux, 40 taxons n'ont été notés que d'une seule localité dans le territoire de la Serbie et, par conséquent, elles sont marquées comme exceptionnellement rares.

Checklist / Algues desmidiales / Diversité / Floristique / Ecologie / Serbie

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INTRODUCTION

The territory of the Republic of Serbia houses a large number of suitable habitats for the development of a rich desmid flora (e.g. peat bogs, fens, marshes, swamps, oligo- and mesotrophic pools, fish ponds, oligotrophic glacial and nival lakes, reservoirs, irrigation/drainage canals and slow-running rivers).

As a consequence of this high habitat diversity, floristic-ecological studies on desmid communities in Serbia have a long-standing tradition. The first written record concerning algae in Serbia, including desmids, was published by Schaarschmidt (1883). In the period from 1883 to 1907, desmids were incidentally recorded from most of the investigated freshwater ecosystems (Blaženčić, 1986). The pioneer Serbian phycologists, Simić and Katić (after Milovanović, 1949b) found a number of desmid species in wetlands of several rural areas in Serbia.

The second important period, although very short (1907-1910), is marked by the presence of detailed studies on desmids. The investigations were carried out in high-mountain peat bogs, which are the southernmost refuge habitats for a number of boreal and arctic-alpine taxa. Serbian hydrobiologists (Košanin, 1908a, 1908b, 1910a; Đorđević, 1910; Katić, 1910) published the first records of desmids in high-mountain peat bogs and fens.

Peat bogs are situated in the mountains of southern Serbia (Kopaonik, Željin, Tara, Ostrozub, Golija, Prokletije) and the Valasina plateau, at altitudes of 1211 to 1550 m a.s.l. The number and total area of peat bogs are almost insignificant relative to other freshwater ecosystems in Serbia. Considering that a large number of desmid species is limited to these habitats, it can be concluded that high-mountain peat bogs are important centres of desmid biodiversity. Serbian peat bogs are mainly typified as blanket bogs (peat bogs on Mts. Željin and Ostrozub) and transitional bogs (peat bogs on Mts. Kopaonik and Tara). Geological and paleobotanical studies have confirmed the presence of raised peat bogs during early postglacial periods, where nowadays the blanket peat bogs are distributed. Outgrowths of *Sphagnum* hummocks are frequently developed on the surface of Serbian transitional peat bogs, but they are rather sparse and never form real raised mossy hillocks (Milovanović, 1959). Authentic raised peat bogs are very rare in Serbia nowadays, a boggy area alongside Daićko Lake (on Mt. Golija) being the most extensive.

In hydrobiological studies by Stanković (1932) the qualitative composition of the desmid flora and the algal primary production of several stagnant and running waters were investigated in depth. Several other algolologists who contributed indirectly to the knowledge of the desmid flora of Serbia in the period from 1950 to 1980 are Marinović (1954, 1960), Filipović (1966, 1969), Janković (1966, 1975, 1977) and Obušković (1979, 1992). By far the greatest contribution to the knowledge of floristics, taxonomy and ecology of desmids in the former Yugoslavia has been made by the Serbian phycologist Milovanović. In the period from 1959 to 1973 Milovanović published several papers concerning the desmid flora of peat bogs and lowland fish ponds in Serbia. In all, she recorded over 350 desmid taxa from various freshwater habitats. These investigations also have paleobotanical significance as they contribute to the establishment of the origin of peat bogs in Southeast Europe.

Cvijan and Laušević (1991a, 1991b) studied the development of the desmid community in Vlasina Lake, which was formed after the Vlasina peat bog had sunk. Urošević (1997a) investigated the algal flora of glacial and nival lakes of Mts. Prokletije and Šar-planina in the period from 1990-1998, and revealed a number of boreal, alpine and arctic-alpine desmid taxa in these habitats. Glacial lakes are situated in the mountains of southern Serbia and the Province of Kosovo at the altitude between 1840-2345 m a.s.l., whereas nival lakes are located between 1860-1990 m a.s.l. (Urošević, 1997e).

An investigation of a desmid assemblage of the Province of Vojvodina (north Serbia) during the period 2002-2003, was a pioneer study of that region. A high number of desmid taxa (210), 12 of which were new to the flora of Serbia, was recorded from predominantly alkaline and eutrophic habitats.

The completion of the checklist of desmids from Serbia revealed the presence of over 600 desmid taxa. The present paper deals with the elongate baculiform desmids (representatives of the families Mesotaeniaceae, Peniaceae, Closteriaceae and a number of genera from the Desmidiaceae: *Actinotaenium*, *Haplotaenium*, *Pleurotaenium* and *Tetmemorus*). A complete annotated list is given and the main taxonomic and ecological features are described briefly.

MATERIALS AND METHODS

For the present enumeration, in the first place all available literature sources (published papers, manuscripts and proceedings) concerning desmids occurring in Serbia were examined, including theses dealing with the diversity, distribution and ecology of desmids. Data from articles on general phytoplankton, periphyton and phytobenthos investigations in lakes and rivers of various trophic conditions were also taken into consideration.

In addition, desmids were collected from 55 localities in the Vojvodina Province during the course of 2002 and 2003 by a research team of the Republic Hydrometeorological Service of Serbia (RHSS). Samples of phytoplankton algae were collected by towing a plankton net (mesh size 25 µm) vertically from bottom to surface and horizontally just below the surface. Samples were fixed immediately with formaldehyde to a final concentration of 4%. The water samples for physico-chemical analysis were collected from all the localities studied. This analysis was performed by the research team of the RHSS, by applying standard analytical methods, according to JUS-ISO (APHA, AWWA, WPCF 1989). After preliminary examinations of all collected samples, 237 samples from 41 localities where desmids had been found in comparatively large numbers were selected for a more detailed study.

The taxonomic analysis of the sampled material was carried out using a Reichert Diastar microscope equipped with a Canon Power Shot S40 digital camera. Elongate baculiform desmids were identified based on Wolle (1887), West & West (1904), Krieger (1937), Skuja (1948), Kossinskaja (1951, 1952, 1960), Prescott *et al.* (1972, 1981), Hindák *et al.* (1973), Růžčka (1977, 1981), Lind & Brook (1980), Lenzenweger (1996, 2003), Coesel (1998) and Brook & Johnson (2003). The results of this investigation were included in a thesis by the senior author (Stamenković, 2005). The classification of the phylum Chlorophyta according to Brook & Johnson (2003) was adopted.

Based on all the localities surveyed in Serbia, frequencies of desmid taxa are designated here according to the following scale: very rare (VR) – taxa recorded in < 10% of investigated sites; rare (R) – taxa recorded in 10-30% of investigated sites; common (C) – taxa recorded in 30-70% of investigated sites;

frequent (F) – taxa recorded in 70-90% of investigated sites; very frequent (VF) – taxa recorded in > 90% of investigated sites. Exceptionally rare (ER) taxa are those recorded in only one site in the territory of Serbia.

RESULTS AND DISCUSSION

As surface waters cover 0.13% of the Serbian territory (total 88,361 km^2), Serbia belongs to the category of countries rich in freshwater (Gavrilović & Dukić, 2002). In addition, regarding the presence of various freshwater biotopes in a rather small area it is expected to find a large number of desmid taxa. In all, 626 desmid taxa belonging to 23 genera are known from the whole Serbian territory. The recorded desmid taxa include 428 species, 172 varieties and 26 formae. Representatives of the families Mesotaeniaceae, Peniaceae, Closteriaceae and of selected genera of the Desmidiaceae (*Actinotaenium*, *Haplotaenium*, *Pleurotaenium* and *Tetmemorus*) include 133 taxa (96 species and 42 varieties). Some desmid taxa whose original descriptions were published with illustrations but without Latin diagnoses (*Closterium tumidum* Johnson f. *elongata* Milovanović 1960, *Actinotaenium turgidum* (Bréb.) Teil. f. *crassa* Milovanović 1960, *A. turgidum* (Bréb.) Teil. var. *vlasinensis* Milovanović 1960), are nomeclaturally invalid and hence excluded from the list. The tropical taxon *Pleurotaenium ovatum* (Nordst.) Nordst. recorded from the Vlasina peat bog by Milovanović (1960a) is considered a false identification, and also excluded from the list.

Unfortunately, most phycologists in Serbia have provided only lists of desmid taxa without additional remarks and only few illustrations. Therefore it was not possible to verify older reports and reports of taxa recorded from a single locality. Košanin (1908b) and Đorđević (1910) published a few sketchy illustrations of several rare desmids of the genera *Cosmarium* and *Staurastrum*. Illustrations by Milovanović (1959, 1960a, 1960c) are more accurate and are accompanied by critical remarks on the taxa observed.

In the present list, a species is regarded as the sum of its subordinate taxa. The nominal variety is listed first, followed by the other infraspecific taxa in alphabetical order. Species names in the text (e.g. *Closterium acerosum*) refer the nominal variety (*C. acerosum* var. *acerosum*).

Taxonomic composition of the desmid flora of Serbia

The taxonomic composition of the Serbian desmid flora with respect to families and genera is given in Table 1. According to the data collected, taxa of Desmidiaceae and Closteriaceae are dominant. They comprise 83.1% and 12.5% of all recorded taxa, respectively. Mesotaeniaceae (2.8%) and Peniaceae (1.6%) represent only a small part of all desmid taxa. The dominant genus is *Cosmarium*, comprising 42.3% of all desmid taxa recorded, followed by *Staurastrum* (19.6%) and *Closterium* (12.5%). Together, the above-mentioned genera comprise 74.4% of all desmid taxa. The second group of genera, each comprising 2.9-6.1% of all desmid taxa recorded, comprises *Euastrum* (6.1%), *Staurodesmus* (3.7%) and *Micrasterias* (2.9%). *Mesotaenium*, *Roya*, *Spirotaenia*, *Haplotaenium*, *Hyalotheca*, *Sphaerozosma* and *Teilingia* are the genera with lowest number of taxa, each comprising less than 0.5% of all desmids recorded from Serbia.

Table 1. Taxonomic composition of the Serbian desmid flora

Fam. and genera	*Taxa number*	*Taxa number %*	*Genera*	*Taxa number*	*Taxa number %*
Mesotaeniaceae	**17**	**2.8**	*Desmidium*	5	0.8
Cylindrocystis	5	0.8	*Euastrum*	38	6.1
Mesotaenium	2	0.3	*Haplotaenium*	2	0.3
Netrium	8	1.3	*Hyalotheca*	2	0.3
Roya	1	0.2	*Micrasterias*	18	2.9
Spirotaenia	1	0.2	*Pleurotaenium*	10	1.6
Peniaceae	**10**	**1.6**	*Sphaerozosma*	2	0.3
Gonatozygon	5	0.8	*Spondylosium*	4	0.6
Penium	5	0.8	*Staurastrum*	123	19.6
Closteriaceae	**78**	**12.5**	*Staurodesmus*	23	3.7
Closterium	78	12.5	*Teilingia*	2	0.3
Desmidiaceae	**521**	**83.1**	*Tetmemorus*	4	0.6
Actinotaenium	12	1.9	*Xanthidium*	11	1.8
Cosmarium	265	42.3	**Total**	**626**	**100**

Owing to its high species diversity, the desmid flora of Serbia shows similarities to the rich desmid floras of France (Kouwets, 1999), Great Britain (Brook & Williamson, 1991), Austria (Lenzenweger, 2003), the Netherlands (Coesel, 1998) and Slovakia (Lhotsky *et al.*, 1974). The Serbian algal flora is considerably richer in desmid taxa as compared to Turkey (Şahin, 2005) and Lithuania (Kostkeviciene *et al.*, 2003). This may be related to the presence of a higher number of habitats appropriate for the development of desmids, but also to a more intensive research into this algal group in Serbia.

Distribution of elongate baculiform desmid taxa

The majority of elongate baculiform desmid taxa encountered are designated as here very rare, involving 38.4% of all taxa of this group, whereas 18% of the taxa are considered rare. Exceptionally rare taxa, recorded from only one locality in Serbia, account for 30.1% (40 taxa). Most of them are included in the Red Lists of endangered species of several other European countries – Germany (Mollenhauer & Gutowski, 1996), Austria (Lenzenweger, 1986) and the Netherlands (Coesel, 1998): *Cylindrocysists crassa*, *C. obesa*, *Spirotaenia eboracensis*, *Mesotaenium mirificum*, *Penium cylindrus* var. *cylindrus*, *P. cylindrus* var. *attenuatum*, *Closterium attenuatum*, *C. baillyanum* var. *alpinum*, *C. braunii*, *C. closterioides*, *C. lineatum* var. *elongatum*, *C. ralfsii*, *C. subfusiforme*, *C. subulatum*, *C. toxon*, *Actinotaenium colpopelta*, *A. didymocarpum*, *A. gelidum*, *A. palangula*, etc. More than three quarters of all elongate baculiform desmid taxa are designated as rare, very rare or exceptionally rare (86.5%).

Most of the above mentioned desmid taxa are inhabitants of oligotrophic glacial and nival lakes, high-mountain springs and brooks as well as of dystrophic peat bogs poor in nutrients, situated in Serbian high mountains. However, it should be emphasized that the above-mentioned habitats are scarce in Serbia despite their variability, which is the main reason why the distribution of elongate baculiform desmids in Serbia is low.

Common taxa, e.g. *Closterium aciculare*, *C. acutum*, *C. gracile*, *C. leibleinii*, *C. limneticum* var. *fallax*, *C. parvulum*, *C. pronum*, *C. rostratum*, *C. strigosum* and *C. venus*, comprise 10.5% of all elongate desmid taxa encountered. They are inhabitants of phytoplankton and periphyton communities of both high-mountain and lowland freshwater ecosystems.

Frequently recorded desmid taxa comprise 1.5% of all elongate baculiform desmid taxa (*Closterium limneticum* and *C. ehrenbergii*). Only *Closterium acerosum* and *C. moniliferum* are labelled as very frequent taxa. They are widely distributed on more than 80 localities scattered over the whole of Serbia. These taxa have been recorded in a wide spectrum of habitats – from oligotrophic lakes, brooks and thermomineral springs to swamps, eutrophic fish ponds, hypertrophic canals, salt puddles and wastewater collectors of chemical and food industry (Milovanović, 1960d, 1971). However, their apparent preference for lowland and lower mountainous habitats is obvious, since they have not been recorded in glacial oligotrophic and nival lakes. The upper altitude of the distribution of *Closterium acerosum* and *C. moniliferum* in Serbia is 1290 m a.s.l. (Urošević, 1998b).

Habitats of elongate baculiform desmids in Serbia

Elongate baculiform desmids are widely but unevenly distributed in Serbia. The highest number of elongate baculiform desmid taxa was found in dystrophic ecosystems – high-mountain peat bogs, pits, ditches, mires, etc. (57.1% of all the desmid taxa listed in Annex). It should be noted that 45 desmid taxa have been reported exclusively from these habitats and most of them are designated as exceptionally rare (e.g. *Gonatozygon monotaenium* var. *pilosellum*, *G. pilosum*, *Closterium lunula* var. *biconvexum*, *C. toxon*, *Actinotaenium palangula*, *A. subtile*, *Haplotaenium rectum*, *Pleurotaenium coronatum*, *P. ehrenbergii* var. *elongatum*, *Tetmemorus brebissonii*, etc.).

In all, 19.6% of the elongate desmid taxa occur in oligotrophic high-mountain habitats. Among them 4 taxa are confined to the periphyton community of high-mountain brooks (*Closterium kuetzingii* var. *vittatum*, *C. littorale* var. *crassum*, *C. ralfsii* var. *gracilius* and *C. subfusiforme*), whereas 3 taxa are recorded solely from glacial lakes (*Mesotaenium macroccocum*, *Netrium oblongum* and *Roya obtusa*).

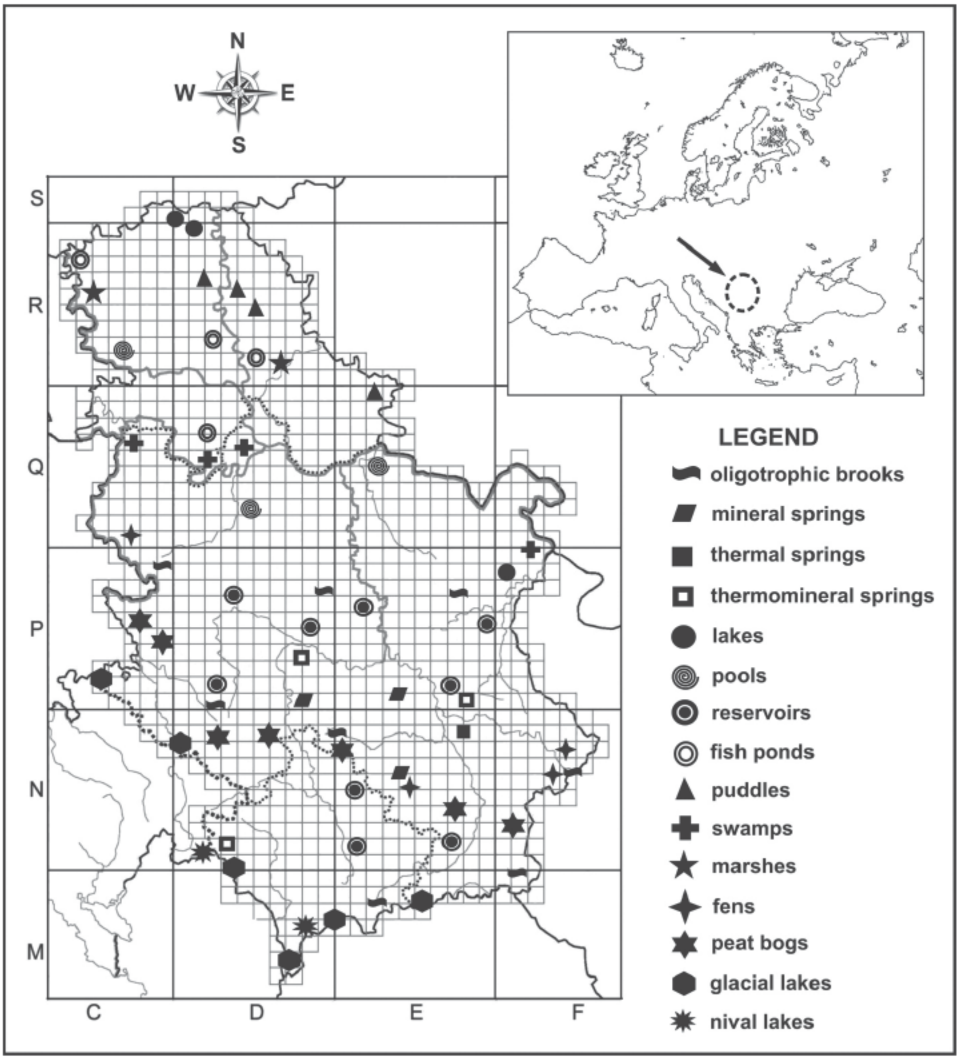
Approximately 18% of the elongate baculiform desmids inhabit mesotrophic stagnant and running freshwater ecosystems. Only 5.3% of the elongate baculiform desmids are found in predominantly eutrophic fish ponds, reservoirs and irrigation/drainage canals (e.g., *Closterium acutum* var. *acutum*, *C. acutum* var. *variabile*, *C. leibleinii* var. *leibleinii*, *C. leibleinii* var. *boergesenii* and *C. strigosum*).

This is an interesting description of the macrophytic vegetation of these habitats but it is outside the scope of this paper, which deals with desmids.

Most of the representatives of genera *Cylindrocystis*, *Mesotaenium*, *Netrium*, *Roya*, *Spirotaenia*, *Penium*, *Actinotaenium*, *Haplotaenium*, *Pleuro-*

taenium and *Tetmemorus* are strictly confined to acidic bogs, glacial, nival and soliflunctional lakes and brooks of the mountains in southern Serbia. Based on the the presence in Serbian peat bogs and oligotrophic biotopes of exceedingly rare desmids included in the Red Lists of several countries, there is an urgent need to preserve these habitats as unique desmid biodiversity centres in Southeast Europe.

In contrast to the above-mentioned genera, representatives of the genus *Closterium* are widely distributed in Serbia. Ponds, puddles, marshes and swamps of the Vojvodina Province are particularly rich in *Closterium* species and therefore they have been studied frequently (Text-fig. 1). Several acidophilous



Text-figure 1. UTM map of Serbia (100 × 100 km) showing the location of the habitats of elongate baculiform desmids.

Closterium taxa have been commonly observed in slightly alkaline and mesotrophic lowland pools and fish ponds (Milovanović & Živković, 1953, 1956, 1959, 1962).

Elongate baculiform desmids have been reported evenly from both periphyton and phytoplankton communities of the previous mentioned habitats in Serbia. Owing to the large cell size, several taxa such as *Closterium ehrenbergii*, *C. lunula*, *C. striolatum*, *C. turgidum*, *Pleurotaenium maximum* and *P. trabecula* have been commonly recorded also from benthic habitats.

Distribution of elongate baculiform desmids in relation to water quality

As typical inhabitants of peat bogs, mires, fens, marshes, swamps and oligotrophic lakes desmids prefer acid and soft-water habitats that are characterized by low conductivity and low concentrations of organic biodegradable compounds (Růžčka, 1977; Tomaszewicz, 1994; Olrik, 2003).

Physico-chemical characteristics of Serbian peat bogs provide optimal conditions for the development of a rich desmid flora. However, in the peat bogs of Serbia the total concentrations of organic compounds are higher compared to those of Central Europe. Due to anthropogenic activities in Serbian mountain areas (e.g. intensive tourism, presence of large hotel complexes, cattle grazing, etc.) it is expected to record relatively high concentrations of organic substances in bogs. Approximately 100-120 mg L^{-1} of total organic compounds have been measured in peat bogs in Mt. Kopaonik. As a consequence of the granite- and silicate-based terrain of this mountain massif, a relatively high concentration of silicon compounds has also been recorded (24 mg L^{-1} SiO_2) (Milovanović, 1959).

The Fe concentration of the Kopaonik peat bogs is relatively high (0.08-0.9 mg L^{-1}), due to low water pH. The Vlasina peat bog is characterized by a moderately high Fe concentration (0.01-0.08 mg L^{-1}) (Milovanović, 1959, 1960a). Ca^{2+} and Mg^{2+} concentrations in Serbian high-mountain peat bogs are higher than in those of Central Europe (e.g. in the Vlasina peat bog Ca^{2+} 10.0-15.0 mg L^{-1}, Mg^{2+} 1.46-2.92 mg L^{-1}) (Vasiljević *et al.*, 1997). The concentration of hydrogen carbonate, as a dominant anion, is also moderately high (HCO_3^- 36.6-67.1 mg L^{-1}). In Kopaonik peat bogs nitrogen compounds have not been recorded, whereas PO_4^{3-} concentrations have reached 0.008 mg L^{-1} due to various human activities. Orthophosphate concentrations in the Vlasina peat bog are between 0.002-0.003 mg L^{-1} (Milovanović, 1959, 1960a). Investigations of this peat bog from 1991 to 1993 showed similar concentrations of phosphorus compounds (PO_4^{3-} 0.001-0.006 mg L^{-1} and total phosphorus 0.003-0.060 mg L^{-1}) (Vasiljević *et al.*, 1997).

Water of Serbian peat bogs is slightly acidic or about neutral (Mts. Kopaonik and Željin pH 6.0-6.9; Mt. Tara pH 6.8-6.9) to moderately acidic (Vlasina peat bog, bogs in Mts. Ostrozub and Golija pH 4.8-5.5) (Milovanović, 1962).

Based on the water physico-chemical characteristics, glacial and nival lakes of Mts. Šar-planina and Prokletije (Province of Kosovo) are favourable desmids habitats. Depending on the geological substrate, pH values vary between 4.9-8.6 (glacial lakes) and 4.0-6.9 (nival lakes). In these habitats water is very soft to soft (dH 0.28-6.72°). Low concentrations of organic compounds are found of these lakes, as judged from the high amounts of dissolved oxygen (up to 10.0 mg L^{-1}), low CO_2 (1.0-34.0 mg L^{-1}) and low COD /$KMnO_4$/ (1.6-5.0 mg L^{-1}).

However the high COD measured in several lakes (17.0 mg L^{-1}) pointed to the oxygen-consumptive reactions of various humic substances in water. No nitrogen compounds monitored in this study (NH_4^+, NO_2^- and NO_3^-) have been detected in the nwater samples. Saprobiological studies have confirmed that glacial and nival lakes of the Province of Kosovo are xenosaprobic, oligosaprobic or oligo-β–mesosaprobic (Urošević, 1994a).

High-mountain brooks and streams in Serbia are also suitable habitats for numerous desmid species. Thus, many elongate baculiform desmids have been observed in the Samokovska River (Mt. Kopaonik) in which the pH is 5.6-6.5, conductivity 28-120 μS cm^{-1}, HCO_3^- concentration between 24.4-84.4 mg L^{-1}, Ca^{2+} 0.9-98 mg L^{-1} and Mg^{2+} 0-8.3 mg L^{-1}. The water quality of this brook has been designated as xenosaprobic to oligo–β-mesosaprobic (Laušević, 1997).

In contrast to the above mentioned mountainous habitats, fish ponds, pools, reservoirs, swamps and marshes of the Province of Vojvodina are located in lowland terrain, formed after the withdrawal of the Pliocene Pannonian Sea. These stagnant freshwater ecosystems are considerably rich in sodium (NaCl, $NaSO_4$, $NaCO_3$, $NaHCO_3$), calcium and magnesium salts, with pH values usually ranging 6.9-8.0. In addition, these habitats are rich in nitrogen and phosphorus compounds; e.g. NH_4^+ 0.13-0.57 mg L^{-1}, NO_3^- 0.03-0.44 mg L^{-1}, PO_4^{3-} 0.01-0.05 mg L^{-1} have been recorded in the Ečka fish ponds (Milovanović & Živković, 1953). A number of mesotrophic *Closterium*, *Gonatozygon* and *Pleurotaenium* species are confined to these nutrient-rich habitats (Milovanović & Živković, 1959).

Recent investigations on desmids in rivers and canals of the Province of Vojvodina, revealed a high number of taxa in mainly alkaline and eutrophic water. Values of pH varied from 6.5-9, conductivity reached 1467 μS cm^{-1}, pointing to a large amount of mineral salts in water. High concentrations of nitrogen compounds were observed in most of the investigated localities (up to 2.8 mg L^{-1} NO_3^-, 0.176 mg L^{-1} NO_2^- and 7.59 mg L^{-1} NH_4^+). Concentrations of phosphorus compounds were remarkably high in several localities; the highest values were measured in the Krivaja River (1,983 mg L^{-1} PO_4^{3-} and 2,500 mg L^{-1} total phosphorus). According to the values of total hardness (between 82-518 mg L^{-1} $CaCO_3$), the water of the Vojvodina rivers and canals was moderately to distinctly hard (Stamenković, 2005).

Some representatives of the genus *Closterium* (*C. acerosum*, *C. leibleinii* var. *leibleinii*, *C. leibleinii* var. *boergesenii*, *C. moniliferum*, *C. limneticum* and *C. strigosum*) were frequently observed in the Vojvodina habitats, which were generally unfavourable for the occurrence of desmids. This fact suggests a high adaptability of the mentioned desmid taxa.

During the floristic-ecological investigation of the neighboring southern Hungarian plain Fehér (2003) also recorded a high number of desmid taxa in distinctly alkaline and saline water bodies. Among them several representatives of the elongate baculiform genera *Gonatozygon*, *Penium* and *Closterium* were frequently observed.

Biogeographic characteristics of elongate baculiform desmids

The floristic composition of elongate baculiform desmids of Serbia is characterized by a common occurrence of cosmopolitan and boreal taxa. There is also a relatively high number of boreal-arctic, arctic-alpine and alpine taxa, e.g. *Mesotaenium mirificum*, *Penium cylindrus* var. *cylindrus*, *P. cylindrus* var.

attenuatum, *P. polymorphum*, *Closterium baillyanum* var. *alpinum*, *C. costatum*, *C. didymotocum*, *C. striolatum* var. *attenuatum*, *Actinotaenium didymocarpum*, *A. gelidum*, *A. palangula*, *A. phymatosporum*, *Tetmemorus laevis* var. *minutus* (Milovanović, 1959; Lenzenweger, 2003; Kostkeviciene *et al.*, 2003; Şahin, 2005). These taxa have been found in high-mountain lakes and peat bogs of southern Serbia.

Closterium subfusiforme has been recorded from one site of the Samokovska River, an oligotrophic brook on Mt. Kopaonik, at 1880 m above sea level, pH 5.8-6.0 (Laušević, 1993). This taxon was originally described from *Sphagnum* peat bogs of the Swiss Alps, at an altitude of 1700 m a.s.l., pH 6.4 (Růžčka, 1977). Subsequently it was found in one locality in Upper Austria at pH 8.5, inducing Lenzenweger (1996) to characterize it as an adaptable but rare taxon. Given that so far *C. subfusiforme* has not been recorded from boreal-arctic and arctic regions, it could be considered as a typical element of the alpine desmid flora.

The presence of arctic-alpine desmid taxa in Serbia specifically demonstrates the prevailing polar climate in their habitats of Southeast Europe. During the Pleistocene glacial periods on the plains of Central Europe, glaciers drew back into the alpine regions of Southeast European high mountains, forming wide arctic-alpine disjunct areas (Wetzel, 1975).

Possibly as a result of the geographic position and climate regime in Southeast Europe, some warm-temperate taxa such as *Closterium navicula* var. *navicula*, *C. navicula* var. *crassum*, *C. exiguum*, *C. lanceolatum* var. *parvum*, *C. ralfsii* var. *gracilius*, *Pleurotaenium coronatum* var. *coronatum*, *P. coronatum* var. *fluctuatum*, *P. maximum*, etc. have also been recorded (3.8%). In addition, a few tropical taxa have been found, e.g. *Pleurotaenium eugeneum* and *Closterium lunula* var. *massartii* (Milovanović, 1960a).

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REFERENCES

(Numbers given in brackets at the end of selected references refer to bibliographical entries in the "Literature" column of Annex)

APHA, AWWA, WPCF, 1989 — *Standard Methods for the Examination of Water & Wastewater*. 17th Edition. Washington, American Public Health Association.

BLAŽENČIĆ J., 1986 — Review of the algological development in Serbia from 1883 to 1983. *Glasnik instituta za botaniku i botaničke bašte univerziteta u Beogradu* 20: 99-108.

BLAŽENČIĆ J. & CVIJAN M., 1980 — Algae in mineral waters of the Ribarska, Brestovačka i Jošanička spas. *Biosistematika* 2: 117-134. **(1)**

BORISEV M., IGIĆ R. & VUKOV D., 2004 — Aquatic macrophytes of the Jegricka River on two connected sections (Zmajevo-Sirig; Sirig-Temerin). *Proceedings of the 35th Conference of the International Association for Danube Research (IAD) and the Austrian Committee Danube Research*: 463-468.

BRANKOVIĆ B., 1992 — Phytoplankton and saprobiological characteristics of Palić Lake. *Proceedings of the 21st Annual Conference of the Yugoslav Water Pollution Control Society*: 75-79. **(2)**

BRANKOVIĆ D., 1993 — Preliminary data on the phytoplankton community and saprobiological characteristics of the River Stari Begej. *Tiscia* 27: 57-60. **(3)**

BRANKOVIĆ D. & BUDAKOV LJ., 1994 — Phytoplankton community and saprobiological characteristics of Ludaš Lake during spring season. *Tiscia* 28: 21-24. **(4)**

BRANKOVIĆ D. & BUDAKOV LJ., 1995 — Phytoplankton in indication of water quality of the nature preserve Stari Begej-Carska Bara. *Zaštita prirode* 47: 145-150. **(5)**

BROOK A.J. & WILLIAMSON D.B., 1991 — *A checklist of desmids of the British Isles*. Ambleside, Freshwater Biological Association, 40 p.

BROOK A.J. & JOHNSON L.R., 2003 — Order Zygnematales. *In:* John D.M., Whitton B.A. & Brook A.J. (eds), *The Freshwater Algal Flora of the British Isles*. Cambridge, the British Phycological Society, the Natural History Museum, Cambridge University Press, pp. 479-593.

COESEL P.F.M., 1998 — *Sieralgen en natuurwaarden*. Utrecht, KNNV nr. 224, 56 p.

CVIJAN M., 1985 — The comparative analysis of algae in ponds on barren soil near the town of Kostolac (Serbia). *Glasnik instituta za botaniku i botaničke bašte univerziteta u Beogradu* 19: 89-101. **(6)**

CVIJAN M., 1986 — *Taxonomical and floristical study of algae in thermomineral springs in the Republic of Serbia*. Doctoral dissertation. Belgrade, University of Belgrade, Faculty of Biology, 189 p. **(7)**

CVIJAN M. & LAUŠEVIĆ R., 1991a — Floristical study of algae of Vlasinsko Lake (Yugoslavia). *Glasnik prirodnjačkog muzeja u Beogradu* 46: 57-69. **(8)**

CVIJAN M. & LAUŠEVIĆ R,. 1991b — Desmids of Vlasinsko Lake-from peat bog to lake. *Archiv für Protistenkunde* 139: 21-37. **(9)**

CVIJAN M. & LAUŠEVIĆ R., 1993 — Saprobiological analysis of the Lugomir River using algae as indicators. *Glasnik instituta za botaniku i botaničke bašte univerziteta u Beogradu* 25: 115-127. **(10)**

CVIJAN M. & LAUŠEVIĆ R., 1995 — Contribution of Nedeljko Košanin (1874-1934) to the algological investigations in Serbia. *Sveske matice srpske* 29: 76-90. **(11)**

CVIJAN M. & LAUŠEVIĆ R., 1998 — The significance of green algae in Vlasinsko Jezero reservoir (Serbia). *Biologia*, *Bratislava* 53 (4): 519-527. **(12)**

ČAĐO S., ĐURKOVIĆ A., MILETIĆ A., ANDREJEVIĆ S. & MALJEVIĆ E., 2004 — The phytoplankton analysis and trophic condition of the Krajkovac Reservoir. *Proceedings of the 33rd Annual Conference of the Yugoslav Water Pollution Control Society*: 217-222. **(13)**

ČAĐO S., MILETIĆ A., DOPUĐA-GLIŠIĆ T. & DENIĆ LJ., 2006 — Physico-chemical characteristics and phytoplankton composition of the Sava River on its lower flow stretch through Serbia. *Proceedings of the 36th Conference of the International Association for Danube Research (IAD) and Austrian Committee Danube Research*: 184-188. **(14)**

ČOMIĆ LJ. & RANKOVIĆ B., 1991 — Changes in bacteria population and phytoplankton and their relationship in the accumulative lake Gruža. *Proceedings of the 9th International Symposium-Evolution of freshwater lakes*, *Phycological Section of the Polish Botanical Association*: 129-140. **(15)**

ĐORĐEVIĆ P., 1910 — Desmidiaceae of the Vlasinsko mud. *Spomenik srpske kraljevske akademije nauka* 8: 1-13. **(16)**

ĐUKIĆ D. & VELJOVIĆ P., 1988 — The role of plankton organisms in determination of saprobiological condition of the Međuvršje Reservoir. *Poljoprivreda i šumarstvo* 34 (2-3): 79-86. **(17)**

ĐURKOVIĆ A. & ČAĐO S., 2004 — Phytoplankton analysis of the Danube River and water quality assessment on the basis of saprobiological examination. *Proceedings of the 2nd Congress of Ecologists of the Republic of Macedonia with International Participation*: 231-237. **(18)**

ĐURKOVIĆ A., ČAĐO S., BUGARSKI R. & MILETIĆ A., 2005 — Phytoplankton, physico-chemical and saprobiological characteristics of the Plovni Begej River on Srpski Itebej site. *Zaštita životne sredine gradova i prigradskih naselja*, *međunarodna eko-konferencija*: 159-164. **(19)**

ĐURKOVIĆ A., ĆAĐO S., MILETIĆ A., BUGARSKI R., ANDREJEVIĆ S. & MALJEVIĆ E., 2004 — Water quality of the Krivaja River related to saprobiological and physico-chemical parameters in 2001 and 2002. *Proceedings of the 33rd Annual Conference of the Yugoslav Water Pollution Control Society*: 75-80. **(20)**

FEHÉR G., 2003 — The desmid flora of some alkaline lakes and wetlands in Southern Hungary. *Biologia*, *Bratislava* 58 (4): 671-683.

FILIPOVIĆ D., 1966 — Limnological characteristics of the Lisinski brook (Kopaonik Mountain). *Archives of biological sciences (Belgrade)* 18 (3-4): 325-337. **(21)**

FILIPOVIĆ D., 1969 — Recherches biocenologiques d'un cours d'eau salmonicole de montagne Balkanique (Serbie). *Ekologija* 4 (1): 61-90. **(22)**

GAVRILOVIĆ LJ. & DUKIĆ D., 2002 — *Rivers in Serbia*. Belgrade, Zavod za udžbenike i nastavna sredstva, 158 p.
GIGOV A. & DJERFI B., 1960 — A report on the floristic composition of the Carska Bara marsh, near the town of Zrenjanin. *Zaštita prirode* 9: 24-32. **(23)**
GIGOV A. & MILOVANOVIĆ D., 1960 — Paleobotanical research of the sediments of Semeteško Lake on Kopaonik Mountain. *Zbornik radova biološkog instituta N. R. Srbije* 3 (2): 1-17. **(24)**
GIGOV A. & MILOVANOVIĆ D., 1963 — Paleobotanical research of the Mala Batura peat bog on Mountain Crni Vrh (Western Serbia). *Zbornik radova biološkog instituta N. R. Srbije* 5 (6): 1-15. **(25)**
GUELMINO J., 1973 — Zenta és környékének növényei. *Građa za monografiju sente* 12: 39-103. **(26)**
HINDÁK F., KOMÁREK J., MARVAN P. & RŮŽČKA J., 1973 — Trieda Conjugatophyceae-Spájanky. *In:* Hindák F. (ed.), *Kl'úč na Unčovanie Výtrusných Rastlín*. Bratislava, pp. 296-344.
JANKOVIĆ M., 1966 — Phytoplankton of the Grošnica Reservoir. *Glasnik botaničkog zavoda i bašte univerziteta u Beogradu* 2 (1-4): 141-174. **(27)**
JANKOVIĆ M., 1973 — Phytoplankton development in the Batlava Reservoir. *Ekologija* 8 (1): 33-44. **(28)**
JANKOVIĆ M., 1975 — The forming of a reservoir on the Batlava River, as a new limnetic ecosystem. *Glasnik instituta za botaniku i botaničke bašte univerziteta u Beogradu* 10 (1-4): 77-137. **(29)**
JANKOVIĆ M., 1977 — The biocenoses development in the Batlava Reservoir. *Ekologija* 12 (2): 89-100. **(30)**
JURIŠIĆ I., 2004 — Benthic algal community structure and water quality of the Zapadna Morava River basin near Čačak. *Acta agriculture Serbica* 9: 13-33. **(31)**
KALAFATIĆ V., OBUŠKOVIĆ LJ. & ŽIVKOVIĆ A., 1982 — Contribution to the knowledge of plankton of the north Banat freshwater ecosystems. *Archives of biological sciences (Belgrade)* 34 (1-4): 89-101. **(32)**
KARADŽIĆ V. & SUBAKOV-SIMIĆ G., 2002 — High production of phytoplankton in the Ponjavica River (south Banat) in winter period. *International association of Danube research* 34: 153-161. **(33)**
KARAN V., MITROVIĆ-TUTUNDŽIĆ V. & ELEZOVIĆ I., 1989 — Ecotoxicological influences of herbicides in irrigation/drainage canals; influences of 2,4-D on plankton and benthic communities. *Pesticidi* 4: 215-219. **(34)**
KATIĆ D., 1910 — History of the Vlasinska peat bog — phytogeographical and paleobotanical study. *Spomenik srpske kraljevske akademije* 8: 14-56. **(35)**
KOSSINSKAJA E.K., 1951 — Desmidievye vodorosli (Desmidiales) Evropejskogo severa SSSR, rody *Penium*, *Closterium*, *Docidium*, *Pleurotaenium*, *Triploceras*, *Tetmemorus*. *Trudy botaničeskogo instituta imeni V. L. Komarova Akademii nauk SSSR, Ser. 2, Sporovye rastenija* 7: 481-712.
KOSSINSKAJA E.K., 1952 — *Flora sporovyh rastenij SSSR*. Mezotenovye i gonatozigovye vodorosly. Tom 2. Moskva, Leningrad, Izdateljstvo Akademii nauk SSSR, 162 p.
KOSSINSKAJA E. K., 1960 — *Flora sporovyh rastenij SSSR*. Desmidievye vodorosly. Tom 5. Moskva, Leningrad, Izdateljstvo Akademii nauk SSSR, 704 p.
KOSTKEVICIENE J., BRISKAITE R., BAKUNAITE J. & JAKIMAVICIUTE I., 2003 — Desmids (Chlorophyta, Desmidiales) from Lithuania. *Biologia*, *Bratislava* 58 (4): 685-695.
KOŠANIN N., 1908a — Algae of the Vlasinsko mud. *Nastavnik* 20 (2): 3-7. **(36)**
KOŠANIN N., 1908b — Daićko Lake on Golija Mountain–hydrobiological study. *Glas srpske kraljevske akademije nauka* 75: 1-50. **(37)**
KOŠANIN N., 1910a — Vlasina; the phytogeographical study. *Glas srpske kraljevske akademije nauka* 81: 85-186. **(38)**
KOŠANIN N., 1910b — Representatives of the Vlasinska peat bog flora (Algae, Bryophyta, Pteridophyta et Phanerogamae). *Muzej srpske zemlje* 10: 6-11. **(39)**
KOUWETS F.A.C., 1999 — *A check-list of desmids (Chlorophyta, Zygnemaphyceae) of France*. Paris, Muséum national d'Histoire naturelle, Collection Patrimoines Naturels 41, 150 p.
KRIEGER W., 1937 — *Die Desmidiaceen Europas mit Berücksichtigung der außereuropäischen Arten*. 1 Teil. Dr. L. Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz. Leipzig, Akademische Verlagsgesellschaft, 712 p.
LAUŠEVIĆ R., 1993 — Floristical composition of algae in the Samokovska River. *Archives of biological sciences (Belgrade)* 45 (3-4): 125-136. **(40)**
LAUŠEVIĆ R., 1997 — Benthic algal communities in the Samokovska River (Kopaonik Mts, Yugoslavia). *Acta hydrobiologica* 39: 77-91. **(41)**
LAUŠEVIĆ R. & CVIJAN M., 1996 — A check-list of the algae of Kopaonik Mountain. *Ekologija* 31 (1): 17-42. **(42)**

LAUŠEVIĆ R. & NIKITOVIĆ J., 1994 — Floristical composition of the algae of Borsko jezero Lake (Yugoslavia). *Bulletin of natural history museum* 48: 73-81. **(43)**
LAUŠEVIĆ R., NIKITOVIĆ J. & TOMAŠEVIĆ V., 1998 — Phytoplankton in the Sava River near Belgrade. *Ekologija* 33 (1-2): 29-40. **(44)**
LENZENWEGER R., 1986 — Rote Liste gefährdeter Zieralgen (Desmidiales) Österreichs. *In:* Niklfeld, H. *et al.* (eds), *Rote Liste gefährdeter Pflanzen Österreichs*. Vienna, Grüne Reihe des Bundesministeriums für Gesundheit und Umweltshutz, pp. 200-202.
LENZENWEGER R., 1996 — *Desmidiaceenflora von Östereich*. Teil 1. Bibliotheca Phycologica 102. Stutgart, J. Cramer, 162 p.
LENZENWEGER R., 2003 — *Desmidiaceenflora von Östereich*. Teil 4. Bibliotheca Phycologica 111. Stutgart, J. Cramer, 87 p.
LHOTSKY O., ROSA K. & HINDÁK F., 1974 — *Supis sinic a rias Slovenska*. Bratislava, Vydavatelstvo Slovenskej Akad. v. Bratislava, 197 p.
LIND E.M. & BROOK A.J., 1980 — *Desmids of the English Lake District*. Wareham, Freshwater Biological Association Publication No. 42, 123 p.
MALOSEJA Ž. & GECAJ A., 1983 — Algological investigations of the River Sitnica from Kuzmin to Velika Reka. *Acta biologiae et medicinae experimentalis* 8: 19-23. **(45)**
MARINOVIĆ Ž.R., 1954 — Contribution to the knowledge of algal flora of the Negotinski rit swamp. *Glasnik prirodnjačkog muzeja srpske zemlje* 6: 45-58. **(46)**
MARINOVIĆ Ž.R., 1955 — Contribution to the knowledge of algal flora of the stagnant and running freshwater ecosystems near Belgrade. *Glasnik prirodnjačkog muzeja srpske zemlje* 7: 83-116. **(47)**
MARINOVIĆ Ž.R., 1957 — Phycological investigations of the Grabovačko-posavski Canal. *Glasnik prirodnjačkog muzeja srpske zemlje* 10: 63-75. **(48)**
MARINOVIĆ Ž.R., 1960 — Saprobiological investigations of the Popovo vrelo spring. *Zaštita prirode* 17: 7-11. **(49)**
MARINOVIĆ Ž.R. & KRASNIQI F.D., 1963 — Algat e ujnave të tharbta-minerale të Deçanit. *Revistë kulturore dhe shkencore* 7: 473-482. **(50)**
MARTINOVIĆ-VITANOVIĆ V. & GUCUNSKI D., 1983 — Saprobiological analysis of the Južna Morava River and its tributaries. *Proceedings of the 12th Annual Conference of the Yugoslav Water Pollution Control Society*: 101-107. **(51)**
MARTINOVIĆ-VITANOVIĆ V., 1994 — *Ecological study of the phytoplankton in the Obedska bara swamp*. Doctoral dissertation. Belgrade, University of Belgrade, Faculty of Biology, 469 p. **(52)**
MILJANOVIĆ B., ĐUKIĆ N., PUJIN V., IVANC A., ŽIVIĆ N., MILENKOVIĆ P. & NAKIĆ S., 2005 — Physico-chemical and biological parameters in the water quality evaluation of the Bovan Reservoir. *Proceedings of the 34th Annual Conference of the Yugoslav Water Pollution Control Society*: 213-218. **(53)**
MILOVANOVIĆ D., 1949a — Seasonal composition of algae in a pond of the Obedska bara swamp. *Glasnik prirodnjačkog muzeja srpske zemlje* 2: 127-162. **(54)**
MILOVANOVIĆ D., 1949b — Bibliographic review of the algological studies in Serbia up to 1947. *Glasnik prirodnjačkog muzeja srpske zemlje* 2: 323-329.
MILOVANOVIĆ D., 1959 — Desmidiaceae in *Sphagnum* peat bogs in Serbia. I. (Desmidiaceae in peat bogs on Kopaonik Mountain). *Zbornik radova biološkog instituta N. R. Srbije* 3: 1-22. **(55)**
MILOVANOVIĆ D., 1960a — Desmidiaceae in *Sphagnum* peat bogs in Serbia. II. (Revision and supplement into the desmid flora of peat bogs at Vlasina). *Glasnik prirodnjačkog muzeja u Beogradu* 15: 131-152. **(56)**
MILOVANOVIĆ D., 1960b — Desmidiaceae in *Sphagnum* peat bogs in Serbia. III. (Desmidiaceae in peat bogs on Željin Mountain). *Glasnik prirodnjačkog muzeja u Beogradu* 15: 113-118. **(57)**
MILOVANOVIĆ D., 1960c — Desmidiaceae in *Sphagnum* peat bogs in Serbia. IV. (Revision and supplement into the desmid flora of Daićko Lake). *Zbornik radova biološkog instituta N. R. Srbije* 4: 1-9. **(58)**
MILOVANOVIĆ D., 1960d — The primary production of the fish pond Jegrička. *Glasnik prirodnjačkog muzeja u Beogradu* 15: 119-129. **(59)**
MILOVANOVIĆ D., 1962 — Desmidiaceae in *Sphagnum* peat bogs on Tara Mountain and Ostrozub Mountain. *Zbornik radova biološkog instituta N. R. Srbije* 6: 3-12. **(60)**
MILOVANOVIĆ D., 1965 — Phytoplankton of the Yugoslav part of the Danube River (1281-1092 km). *Archives of biological sciences (Belgrade)* 17 (1-2): 29-42. **(61)**
MILOVANOVIĆ D., 1971 — Several aspects of the annual phytoplankton development in a reservoir of the Brestovačka River. *Archives of biological sciences (Belgrade)* 23 (1-2): 37-52. **(62)**
MILOVANOVIĆ D., 1973 — Phytoplankton of Vlasinsko Lake in period from 1949 to 1964. *Archives of biological sciences (Belgrade)* 25 (3-4): 177-194. **(63)**

MILOVANOVIĆ D. & ŽIVKOVIĆ A., 1953 — Investigations of the plankton production in the Ečka fish ponds. *Zbornik radova Instituta za ekologiju i biogeografiju* 3: 1-47. **(64)**
MILOVANOVIĆ D. & ŽIVKOVIĆ A., 1956 — Limnological studies of a reservoir on the Vlasina River. *Zbornik radova Instituta za ekologiju i biogeografiju* 5: 1-47. **(65)**
MILOVANOVIĆ D. & ŽIVKOVIĆ A., 1959 — Plankton production in the fish pond Živača. *Zbornik radova biološkog instituta N. R. Srbije* 5: 1-17. **(66)**
MILOVANOVIĆ D. & ŽIVKOVIĆ A., 1962 — The composition and dynamics of a plankton community in the fish pond Jegrička in 1959 and 1960. *Zbornik radova biološkog instituta N. R. Srbije* 6: 3-30. **(67)**
MOLLENHAUER D. & GUTOWSKI A., 1996 — Zu den Roten Listen für die Algen Deutschlands. *Schriftenreihe für Vegetationskunde* 28: 527-546.
NEMEŠ K., OBUŠKOVIĆ LJ. & MATAVULJ M., 2004 — Phytoplankton investigations in the Banat region of the Danube-Tisa-Danube hydrosystem (Vojvodina, Serbia and Montenegro). *International association for Danube research* 35: 563-569. **(68)**
NIKITOVIĆ J. & LAUŠEVIĆ R., 1995 — Algological and saprobiological analysis of the Beljevina River (Yugoslavia). *Ekologija* 30 (1-2): 27-39. **(69)**
NIKOLIĆ LJ., STOJANOVIĆ S., PUJIN V. & LAZIĆ D., 2002 — Primary producers of Lake Provala. *International association for Danube research* 34: 183-188. **(70)**
OBUŠKOVIĆ LJ., 1979 — Fünfjährige Phytoplanktonforschungen am Stauraum Djerdap. *Internationale Arbeitsgemeinschaft fûr Donauforschung. 29. Jubiläumstagung Donauforschung*: 215-219. **(71)**
OBUŠKOVIĆ LJ., 1989 — Phytoplankton and saprobiological characteristics of the Danube River in 1988. *Proceedings of the 18th Annual Conference of the Yugoslav Water Pollution Control Society*: 30-36. **(72)**
OBUŠKOVIĆ LJ., 1992 — Phytoplankton and saprobiological characteristics of some waters in the region of south Banat. *Archives of biological sciences (Belgrade)* 44: 203-212. **(73)**
OBUŠKOVIĆ LJ., 1996 — Algological and saprobiological characteristics of the Barje Reservoir. *Proceedings of the 25th Annual Conference of the Yugoslav Water Pollution Control Society*: 85-89. **(74)**
OBUŠKOVIĆ LJ. & OBUŠKOVIĆ M., 2000 — Algological and saprobiological investigations of the Veliki Rzav River and the Mali Rzav River. *Proceedings of the 19th Annual Conference of the Yugoslav Water Pollution Control Society*: 181-186. **(75)**
OLRIK K., 2003 — The occurrence of planktonic desmid species in Danish lakes and ponds related to total nitrogen and phosphorus contents of the water body. *Biologia, Bratislava* 58 (4): 709-716.
PETROVSKA LJ., 1969 — Mikroflora na termalnite izvori vo Niška Banja. *Fragmenta Balcanica* 7: 21-30. **(76)**
PRESCOTT G.W., CROASDALE H.T. & VINYARD W.C., 1972 — *North American Flora*. Desmidiales, Saccodermae, Mesotaeniaceae. New York, The New York Botanical Garden, 53 p.
PRESCOTT G.W., CROASDALE H.T., VINYARD W.C. & BICUDO C.E. de M., 1981 — *A Synopsis of North American Desmids*. 2 Desmidiaceae, Placodermae. Section 3. Lincoln & London, University of Nebraska Press, 720 p.
PROTIĆ Đ., 1931 — Hydrobiological studies of the canals — Kanal Kralja Petra and Kanal Kralja Aleksandra. I. *Spomenik srpske kraljevske akademije nauka* 73: 1-17. **(77)**
PROTIĆ Đ., 1935 — Hydrobiological studies of the canals — Kanal Kralja Petra and Kanal Kralja Aleksandra. II. *Spomenik srpske kraljevske akademije nauka* 80: 1-35. **(78)**
PROTIĆ Đ., 1936 — Hydrobiological studies of the canal — Kanal Kralja Petra. III. Relationships between nanoplankton and zooplankton. *Spomenik srpske kraljevske akademije nauka* 85: 59-87. **(79)**
PROTIĆ Đ., 1939 — Plankton; studies of the Danube River and its main tributaries. *Spomenik srpske kraljevske akademije nauka* 90: 34-69. **(80)**
PUJIN V., RATAJAC R., DJUKIĆ N., SVIRČEV Z. & KILIBARDA P., 1987 — Saisonmässige variationen der Zusammensetzung des Planktons und der Bodenbesiedlung in der Carska Bara (Jugoslawien). *Tiscia* 22: 83-91. **(81)**
PUJIN V., STOJKOVIĆ S. & DROBAC A., 1998 — Phytoplankton and zooplankton organisms as indicators of water quality of the Tamiš River. *In:* Marković S. & Svirčev Z. (eds), *The Tamiš River*. Novi Sad, University of Novi Sad, Institute for Geography, pp. 65-74. **(82)**
RAJKOVIĆ D., OBREHT Z., KOSTIĆ D., RATAJAC R. & STOJKOVIĆ S., 1995 — Composition of phytoplankton, crustaceans and aquatic mites in temporary waters of the Tisa basin. *Zbornik matice srpske za prirodne nauke* 89: 23-27. **(83)**
RANKOVIĆ B. & SIMIĆ S., 1997 — Algological and saprobiological analysis of the Dulenska River. *Proceedings of the 26th Annual Conference of the Yugoslav Water Pollution Control Society*: 355-358. **(84)**

RANKOVIĆ B. & SIMIĆ S., 2005 — Phytoplankton of the Gruža Reservoir. *In:* Čomić Lj. & Ostojić A. (eds), *The Gruža Reservoir*. Kragujevac, Faculty of Natural Sciences and Mathematics, pp. 65-78. **(85)**

RANKOVIĆ B., ČOMIĆ LJ. & SIMIĆ S., 1992 — Phytoplankton of the Ćelije Reservoir. *Proceedings of the 21st Annual Conference of the Yugoslav Water Pollution Control Society*: 91-95. **(86)**

RATAJAC R., RAJKOVIĆ D., STOJKOVIĆ S., SVIRČEV Z. & BOBIĆ M., 1997 — Biodiversität des Geschützten Ökosystems Obedska Bara im Zuflussgebiet von der Sava. *Wissenschaftliche Referate, 32. Konferenz der IAD*: 167-170. **(87)**

RATAJAC R., STOJKOVIĆ S., SVIRČEV Z., RAJKOVIĆ D., MARKOVIĆ S., PETROVIĆ O. & MILETIĆ M., 1995 — Investigations of the Zlatica River biocenoses in the Province of Vojvodina. *Proceedings of the International Conference "Preventive engineering and environment"* C19: 1-4. **(88)**

RŮŽIČKA J., 1977 — *Die Desmidiaceen Mitteleuropas*, 1-1. Stuttgart, E. Schweizerbart'sche Verlagsbuchhandlung, 292 p.

RŮŽIČKA J., 1981 — *Die Desmidiaceen Mitteleuropas*, 1-2. Stuttgart, E. Schweizerbart'sche Verlagsbuchhandlung, 736 p.

RŽANIČANIN A., CVIJAN M. & KRIZMANIĆ J., 2005 — Phytoplankton of the Tisa River. *Archives of Biological Sciences* 57 (3): 223-235. **(89)**

SCHAARSCHMIDT J., 1883 — Fragmenta phycologiae Bosniaco-Serbiacae I. *Magyar növénytani lapok* 7: 33-39. **(90)**

SELEŠI Đ., 1982 — Limnological investigations of Palić Lake. *Vode Vojvodine* 10: 345-368. **(91)**

SENĆANSKI G., 1972 — The comparative analysis of spring and autumnal phytoplankton composition of the Sava River and the Danube River near Belgrade. *Archives of biological sciences (Belgrade)* 24 (1-2): 35-43. **(92)**

SIMIĆ S., 1996 — Algae of the Trgoviški Timok River (Serbia, Yugoslavia). *Glasnik instituta za botaniku i botaničke bašte univerziteta u Beogradu* 30: 107-118. **(93)**

SKUJA H., 1948 — Taxonomie des Phytoplanktons einiger Seen in Uppland, Schweden. *Symbolae botanicae Upsalienses* 9: 1-399.

STAMENKOVIĆ M., 2005 — *Diversity and distribution of the desmid flora in main rivers and canals in the Province of Vojvodina*. Master's thesis. Belgrade, University of Belgrade, Faculty of Biology, 146 p. **(94)**

STAMENKOVIĆ M., 2006 — Results of the application WQI on Vojvodina rivers and canals and the correlation among the desmid community. *Proceedings of the 35th Annual Conference of the Yugoslav Water Pollution Control Society*: 95-100. **(95)**

STAMENKOVIĆ M. & CVIJAN M., 2006 — Diversity and seasonal dynamics of the desmid community in the qualitative sense on Vojvodina segment of the Danube basin. *Proceedings of the 36th Conference of the International Association for Danube Research (IAD) and the Austrian Committee Danube Research*: 204-209. **(96)**

STANKOVIĆ S., 1932 — Partticularites limnologiques des eaux karstiques de la region de Belgrade. *Glasnik botaničke bašte i zavoda univerziteta u Beogradu* 2 (1-2): 1-19.

STEVANOVIĆ V., PAVIĆ S. & STEVANOVIĆ B. (1995a) — Diversity of the mosses (Bryophyta) of Yugoslavia with a survey of the internationally significant species. *In:* Stevanović V. & Vasić V. (eds), *Biodiversity of Yugoslavia with a survey of the internationally significant species*. Belgrade, Ecolibri, the Faculty of Biology, pp. 174-182.

STEVANOVIĆ V., JOVANOVIĆ S., LAKUŠIĆ D. & NIKETIĆ, M. (1995b) — Diversity of the vascular flora of Yugoslavia with a survey of the internationally significant species. *In:* Stevanović V. & Vasić V. (eds), *Biodiversity of Yugoslavia with a survey of the internationally significant species*. Belgrade, Ecolibri, the Faculty of Biology, pp. 183-217.

SUBAKOV G., 2001 — *Seasonal changes of the qualitative and quantitative algal composition and water quality of the Tisa River and the Veliki Bački Canal*. Master's thesis. Belgrade, University of Belgrade, Faculty of Biology, 163 p. **(97)**

SZABADOS M., 1966 — Data to the knowledge of microorganisms of the Yugoslav reaches of the Tisa River and the Danube-Tisa Canal. *Tiscia* 2: 3-10. **(98)**

ŞAHIN B., 2005 — A preliminary checklist of desmids of Turkey. *Cryptogamie, Algologie* 26 (4): 399-415.

TOMASZEWICZ G.H., 1994 — Abundance and composition of the desmid flora in series of peat pits, in relation to pH and some other habitat parameters. *Biologia*, *Bratislava* 49: 519-524.

UROŠEVIĆ V., 1989 — A supplement to the studies of algae of the Sitnica River and the Ibar River. *Acta biologiae et medicinae experimentalis* 14: 117-127. **(99)**

UROŠEVIĆ V., 1990a — Ecological condition and bioproduction in the Batlava Reservoir. *Acta biologiae et medicinae experimentalis* 15: 105-112. **(100)**

UROŠEVIĆ V., 1990b — Seasonal changes of the primary production of the Gračanica Reservoir. *Acta biologiae et medicinae experimentalis* 15: 91-98. **(101)**

UROŠEVIĆ V., 1994a — *Algae in lakes of the Sirinić part of Šar-planina Mountain*. Priština, University of Priština, 95 p. **(102)**

UROŠEVIĆ V., 1994b — Periphyton algae of glacial Livadičko Lake on Šar-planina Mountain. *Univerzitetska misao-prirodne nauke* 1: 13-19. **(103)**

UROŠEVIĆ V., 1997a — Periphyton algae in the system of Djeravica Lakes on the spring branch of the Erenik River. *University Thought*, *Natural Sciences* 3 (2): 11-21. **(104)**

UROŠEVIĆ V., 1997b — Periphyton algae of Gornje Tupankamensko Lake and Donje Tupankamensko Lake on Šar-planina Mountain. *Fizičko-geografski procesi na Kosovu i metohiji* 2: 49-58. **(105)**

UROŠEVIĆ V., 1997c — Periphyton algae of Gornje Veljinbeško Lake on Šar-planina Mountain. *Proceeding of the 5th meeting of the Flora of Southeastern Serbia*: 8-18. **(106)**

UROŠEVIĆ V., 1997d — Periphyton algae in two small lakes on the spring branch of the Crnkamenska River on Šar-planina Mountain. *University thought*, *natural sciences* 4 (1): 15-21. **(107)**

UROŠEVIĆ V., 1997e — The Ginevodna lakes algae on Šar-planina Mountain. *University thought*, *natural sciences* 4 (2): 79-87. **(108)**

UROŠEVIĆ V., 1998a — Periphyton algae of the Yugoslav part of Šar-planina Mountain lake ecosystems. *University thought*, *natural sciences* 5 (1): 43-57. **(109)**

UROŠEVIĆ V., 1998b — A supplement to the knowledge of algae in two water ecosystems of the Nedžinat mountain saddle. *University thought*, *natural sciences* 5 (2): 85-89. **(110)**

UROŠEVIĆ V., 1998c — Alge u izvorima Velike podine na Nedžinatskom sedlu. *Fizičko-geografski procesi na kosovu i metohiji* 3: 97-105. **(111)**

UROŠEVIĆ V. & GUCUNSKI D., 1983 — Phytoplankton of the accumulation lake Batlava. *Acta biologiae et medicinae experimentalis* 8: 41-47. **(112)**

UROŠEVIĆ V. & SAVIĆ A., 1997 — Algae of the Lepenac springs on Šar-planina Mountain. *University thought*, *natural sciences* 3 (1): 23-32. **(113)**

VASILJEVIĆ M., KEZELA B. & BALAĆ M., 1997 — Physical and chemical characteristics of Vlasinsko jezero reservoir. *In:* Blaženčić J. (ed.), *Vlasina Lake, hydrobiological study*. Belgrade, the Faculty of Biology, pp. 35-40.

VELJIĆ M. & CVIJAN M., 1997 — Qualitative analysis of algae of the confluences and the middle course of the Kolubara River. *Archives of biological sciences (Belgrade)* 49 (1-2): 43-49. **(114)**

WEST W. & WEST G.S., 1904 — *A Monograph of the British Desmidiaceae*. 1. London, The Ray Soc., 224 p.

WETZEL R.G., 1975 — *Limnology*. Philadelphia, London & Toronto, W. B. Saunders Company, 743 p.

WOLLE F., 1887 — *Freshwater algae of the United States; (exclusive of the Diatomaceae) complemental to desmids of the United States*. Bethlehem, The Comenius Press, 151 p.

ANNEX. LIST OF ELONGATE BACULIFORM DESMID TAXA IN SERBIA

Literature: the numbers in the literature column refer to the numbers in brackets after the references in the References list.
Bas.: basionym; Syn.: synonym.
Habitats: 1. rivers, 2. oligotrophic brooks (in periphyton), 3. stagnant tributaries of rivers, 4. irrigation/drainage canals, 5. mineral springs, 6. thermal springs, 7. thermomineral springs, 8. sublacustrine springs, 9. fens, 10. lakes, 11. pools, 12. swamps, 13. reservoirs, 14. fish ponds, 15. lowland salt puddles, 16. marshes, 17. high-mountain peat bogs, 18. high-mountain glacial lakes, 19. high-mountain nival lakes, 20. high-mountain solifluctional lakes.
Frequency: exceptionally rare (ER); very rare (VR); rare (R); common (C); frequent (F); very frequent (VF).

Family Mesotaeniaceae

Genus *Cylindrocystis* Meneghini *ex* De Bary 1858
C. brebissonii (Menegh. *ex* Ralfs) de Bary 1858 var. *brebissonii* – Lit.: 16, 56, 57, 104, 107. – Hab.: 8, 17, 18. – R
C. brebissonii var. *jenneri* (Ralfs) Hansgirg 1886 – Lit.: 42, 55, 60. – Hab.: 17. – VR
C. brebissonii var. *minor* W. *et* G. S. West 1902 – Lit.: 75, 104. – Hab.: 13, 18. – VR
C. crassa De Bary 1858 – Lit.: 16, 42, 55. – Hab.: 17. – VR
C. obesa W. *et* G. S. West 1902 – Lit.: 16. – Hab.: 17. – ER

Genus *Mesotaenium* Nägeli 1849
M. macrococcum (Kütz. *ex* Kütz.) Roy *et* Biss. 1894 – Lit.: 102, 109. – Hab.: 18. – ER
M. mirificum Archer 1864 – Lit.: 16, 56. – Hab.: 17. – ER

Genus *Netrium* (Nägeli) Itzigsohn *et* Rothe 1856
N. digitus (Ehrenb. *ex* Ralfs) Itzigsohn *et* Rothe 1856 var. *digitus* (Bas.: *Penium digitus* Ehrenb. *ex* Ralfs 1848) – Lit.: 8, 16, 25, 42, 55, 56, 57, 60. – Hab.: 2, 17. – R
N. digitus var. *lamellosum* (Bréb.) Grönbl. 1920 **(Fig. 1)** (Bas.: *Penium lamellosum* Bréb. 1856) – Lit.: 8, 9, 11, 37, 42, 55, 56, 57, 58, 60. – Hab.: 17. – R
N. digitus var. *naegelii* (Bréb.) W. Krieger 1935 (Bas.: *Penium naegelii* Bréb. 1861) – Lit.: 11, 16, 35, 36, 37, 38, 39, 56, 58. – Hab.: 17. – VR
N. digitus var. *ventricosum* (Lagerheim) Lagerheim 1903 (Bas.: *Penium digitus* f. *ventricosum* Lagerheim 1896) – Lit.: 8, 9. - Hab.: 17. - ER
N. interruptum (Bréb. *ex* Ralfs) Lütkem. 1902 var. *interruptum* (Bas.: *Penium interruptum* Bréb. *ex* Ralfs 1848) – Lit.: 16, 56, 102, 105, 107, 109. – Hab.: 17, 18, 20. – VR
N. interruptum var. *minor* (Borge) W. Krieger 1933 (Bas.: *Penium interruptum* f. *minor* Borge 1909) – Lit.: 56, 58, 60. – Hab.: 17. – VR
N. oblongum (De Bary) Lütkem. 1902 var. *oblongum* (Bas.: *Penium oblongum* De Bary 1858) – Lit.: 104, 106, 109. – Hab.: 18, 19. – VR
N. oblongum var. *cylindricum* W. *et* G. S. West 1903 (Syn.: *Netrium oblongum* var. *cylindricum* f. *curvatum* Fritsch 1918) – Lit.: 60. – Hab.: 17. – ER

Genus *Roya* W. *et* G. S. West 1896
R. obtusa (Bréb.) W. *et* G. S. West 1896 – Lit.: 102, 104, 109. – Hab.: 18, 19. – VR

Genus *Spirotaenia* Brébisson *ex* Ralfs *emend.* Brook 1997
S. eboracensis G. S. West 1903 – Lit.: 56. – Hab.: 17. – ER

Family Peniaceae

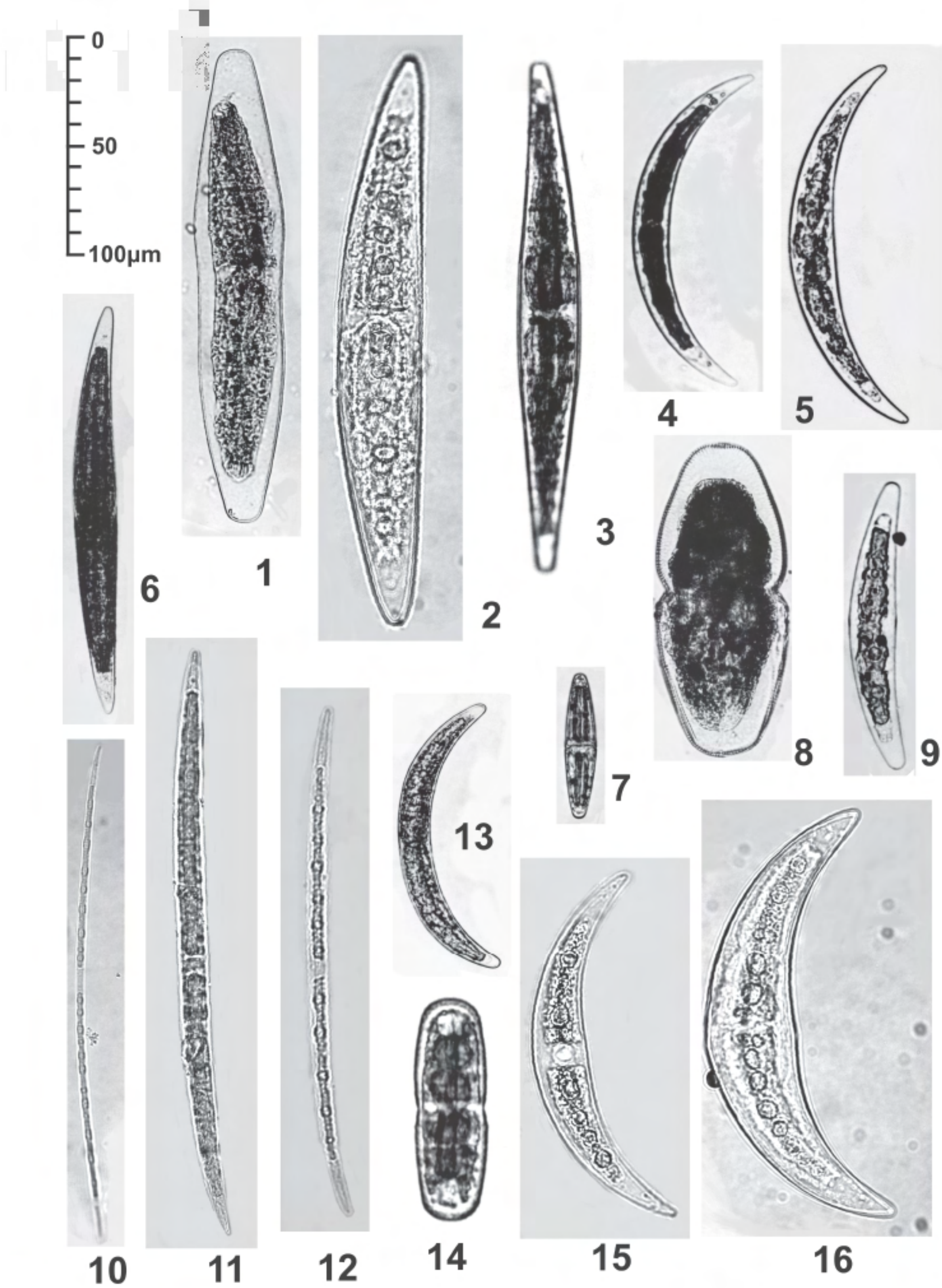
Genus *Gonatozygon* De Bary 1858
G. brebissonii De Bary 1858 – Lit.: 56, 64, 106, 109. – Hab.: 14, 17 . – VR
G. kinahanii (Arch.) Rabenh. 1868 – Lit.: 11, 16, 38, 39, 56. – Hab.: 17. – ER
G. monotaenium De Bary *in* Rabenh. 1856 var. *monotaenium* – Lit.: 42, 55, 64, 104, 109, 112. – Hab.: 13, 14, 17, 18. – VR

G. monotaenium var. *pilosellum* Nordst. 1886 – Lit.: 11, 36, 38, 39, 56. Hab.: 17. – ER
G. pilosum Wolle 1882 – Lit. : 16, 56. – Hab.: 17. – ER

Genus *Penium* Brébisson *ex* Ralfs *emend.* Kouwets *et* Coesel 1984
P. cylindrus (Ehrenb.) Bréb. *ex* Ralfs 1848 var. *cylindrus* – Lit.: 42, 55, 56, 60, 102. – Hab.: 17, 18. – VR
P. cylindrus var. *attenuatum* Raciborski 1889 – Lit.: 37. – Hab.: 17. – ER
P. margaritaceum (Ehrenb.) Bréb. *ex* Ralfs 1848 – Lit.: 16, 43, 56, 102, 103. – Hab.: 13, 17, 18. – R
P. polymorphum (Perty) Perty 1852 – Lit.: 11, 37, 104, 106, 108, 109. – Hab.: 17, 18, 19. – VR
P. spirostriolatum Barker 1869 – Lit.: 56, 57, 60, 102, 104, 106, 107, 109. – Hab.: 17, 18, 19. – VR

Family Closteriaceae

Genus *Closterium* Nitzsch *ex* Ralfs 1848
C. abruptum W. West 1892 **(Fig. 9)** (Syn.: *C. nilssonii* Borge 1906, *C. abruptum* W. West f. *brevius* W. & G. S. West 1894, *C. abruptum* var. *brevius* (W. & G. S. West) W. & G. S. West 1904) – Lit.: 16, 40, 42, 60, 104. – Hab.: 2, 17, 18. – VR
C. acerosum (Schrank) Ehrenb. *ex* Ralfs 1848 var. *acerosum* – Lit.: 3, 4, 5, 6, 7, 10, 12, 13, 14, 17, 18, 19, 20, 22, 26, 28, 29, 30, 35, 40, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 58, 59, 60, 61, 66, 67, 71, 72, 75, 76, 78, 80, 81, 84, 86, 92, 94, 95, 97, 98, 99, 100, 101, 111, 114. – Hab.: 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17. – VF
C. acerosum var. *elongatum* Bréb. 1856 – Lit.: 60, 61, 77. – Hab.: 1, 17. – VR
C. acerosum var. *minus* Hantzsch in Rabenh. 1861 **(Fig. 2)** – Lit.: 26, 83, 89, 94. – Hab.: 1, 4. – R
C. aciculare T. West 1860 (Syn.: *C. subpronum* W. *et* G. S. West 1894, *C. aciculare* T. West var. *subpronum* (W. *et* G. S. West) W. *et* G. S. West 1904) – Lit.: 14, 19, 32, 52, 54, 68, 74, 89, 92, 94, 96. – Hab.: 1, 3, 4, 10, 12, 16. – C
C. acutum Bréb. *ex* Ralfs 1848 var. *acutum* – Lit.: 26, 47, 48, 79, 94, 96. – Hab.: 1, 4, 10, 11, 12, 13. – C
C. acutum var. *linea* (Perty) W. *et* G. S. West 1900 (Bas.: *C. linea* Perty 1892) – Lit.: 16, 94, 95. – Hab.: 1, 4, 17. – R
C. acutum var. *variabile* (Lemm.) W. Krieger 1935 (Bas.: *C. pseudospirotaenium* Lemm. var. *variabile* Lemm. 1896) – Lit.: 14, 26, 64, 66, 88, 94, 96, 98. – Hab.: 1, 3, 4, 14. – C
C. archerianum Cleve *in* Lundell 1871 – Lit.: 16, 56, 94. – Hab.: 4, 15, 17. – R
C. attenuatum Ralfs 1848 – Lit.: 16. – Hab.: 17. – ER
C. baillyanum (Bréb. *ex* Ralphs) Bréb. 1856 var. *baillyanum* (Bas.: *C. didymotocum* Ralfs var. *baillyanum* Bréb. *ex* Ralfs 1848) – Lit.: 40, 42, 93. – Hab.: 1, 2. – VR
C. baillyanum var. *alpinum* (Viret) Grönbl. 1919 **(Fig. 17)** (Bas.: *C. didymotocum* Ralfs var. *alpinum* Viret 1909) – Lit.: 9. – Hab.: 17. – ER
C. braunii Reinsch 1867 **(Fig. 21)** – Lit.: 40, 42, 94. – Hab.: 1, 2. – VR
C. calosporum Wittrock 1869 – Lit.: 6. – Hab.: 11. – ER
C. ceratium Perty 1852 (Syn.: *C. acutum* Bréb. var. *ceratium* (Perty) W. Krieger 1935) – Lit.: 26, 79, 80, 94, 96. – Hab.: 1, 4, 10, 11. – R
C. closterioides (Ralfs) Louis & Peeters 1967 var. *closterioides* (Bas.: *Penium closterioides* Ralfs 1848; Syn.: *Closterium libellula* Focke 1847) – Lit.: 16, 35, 36, 38, 56, 64. – Hab.: 14, 17. – VR
C. closterioides var. *intermedium* (Roy & Bisset) Růžička 1973 (Bas.: *Penium libellula* Focke *ex* Nordst. var. *intermedium* Roy & Bisset 1894; Syn.: *P. libellula* var. *interruptum* (W. *et* G. S. West) W. *et* G. S. West 1904 ; *C. libellula* var. *intermedium* (Roy & Biss.) G. S. West 1914) – Lit.: 16. – Hab.: 17. – ER
C. cornu Ehrenb. *ex* Ralfs 1848 – Lit.: 16, 102, 109. – Hab.: 17, 18, 19. – VR
C. costatum Corda *ex* Ralfs 1848 – Lit. : 46, 47, 48, 102, 109. – Hab.: 4, 9, 11, 12, 18, 19. – VR
C. dianae Ehrenb. *ex* Ralfs 1848 var. *dianae* – Lit.: 11, 16, 35, 36, 39, 52, 56, 73, 75, 90, 102, 104, 109, 112, 114. – Hab.: 1, 4, 10, 11, 12, 15, 17, 18, 19. – C
C. dianae var. *pseudodianae* (Roy) W. Krieger 1935 (Bas.: *C. pseudodianae* Roy 1890) – Lit. : 64, 66. – Hab. : 14. – VR
C. didymotocum Ralfs 1848 – Lit. : 11, 16, 35, 36, 37, 38, 39, 55, 56, 57, 58, 60. – Hab. : 17. – R



Figs 1-16: **1.** *Netrium digitus* var. *lamellosum*, **2.** *Closterium acerosum* var. *minus*, **3.** *C. subfusiforme*, **4.** *C. parvulum* var. *parvulum*, **5.** *C. parvulum* var. *cornutum*, **6.** *C. littorale* var. *littorale*, **7.** *C. navicula* var. *navicula*, **8.** *Actinotaenium turgidum*, **9.** *Closterium abruptum*, **10.** *C. limneticum* var. *tenue*, **11.** *C. limneticum* var. *fallax*, **12.** *C. limneticum* var. *limneticum*, **13.** *C. jenneri*, **14.** *Actinotaenium gelidum*, **15.** *Closterium leibleinii* var. *leibleinii*, **16.** *C. leibleinii* var. *boergesenii*.

C. directum Archer 1862 (Syn.: *C. ulna* Focke *ex* W. B. Turner 1892) – Lit.: 16, 50. – Hab. : 7, 17. – VR
C. ehrenbergii Menegh. *ex* Ralfs 1848 var. *ehrenbergii* (Syn.: *C. malinvernianum* De Not. 1865 ; *C. ehrenbergii* var. *malinvernianum* (De Not.) Rabenh. 1868 – Lit.: 16, 20, 33, 36, 38, 39, 56, 82, 90, 94. – Hab.: 1, 3, 4, 5, 7, 10, 11, 12, 13, 14, 16, 17. – F
C. ehrenbergii var. *atumidum* Grönbl. *in* W. Krieger 1935 – Lit.: 94, 96. – Hab.: 1. – ER
C. exiguum W. *et* G. S. West 1902 – Lit. : 94. – Hab. : 4. – ER
C. gracile Bréb. ex Ralfs 1848 (Syn.: *C. gracile* Bréb. *ex* Ralfs var. *elongatum* W. *et* G. S. West 1904) – Lit.: 16, 26, 32, 50, 56, 60, 64, 75, 89, 94, 96, 114. – Hab.: 1, 3, 4, 5, 10, 11, 13, 14, 17. – C
C. idiosporum W. *et* G. S. West 1900 – Lit.: 52, 89, 94. – Hab.: 1, 4, 12. – VR
C. intermedium Ralfs 1848 **(Fig. 20)** – Lit.: 16, 40, 42, 56, 58, 60. – Hab.: 2, 17. – VR
C. jenneri Ralfs 1848 **(Fig. 13)** (Syn.: *C. cynthia* De Not. 1867, *C. cynthia* var. *jenneri* (Ralfs) W. Krieger 1935, *C. cynthia* var. *latum* Schmidle 1898) – Lit.: 16, 26, 40, 42, 56, 57, 102, 104, 107, 109, 114. – Hab.: 1, 2, 3, 17, 18. – R
C. juncidum Ralfs 1848 (Syn.: *C. juncidum* var. *brevius* (Rabenh.) Roy 1890, *C. juncidum* f. *brevius* Roy 1910, *C. juncidum* var. *brevius* f. *intermedium* Skuja 1928, *C. juncidum* var. *elongatum* Roy *in* Roy *et* Biss. 1894) –Lit.: 11, 16, 37, 42, 56, 58, 63, 94, 102, 109. – Hab.: 4, 17, 18. – R
C. kuetzingii Bréb. 1856 var. *kuetzingii* **(Fig. 19)** – Lit.: 8, 9, 11, 16, 36, 38, 39, 50, 56, 81, 106, 109. – Hab.: 5, 12, 16, 17, 19. – VR
C. kuetzingii var. *vittatum* Nordst. 1887 – Lit.: 40, 42. – Hab.: 2. – ER
C. lanceolatum Kütz. ex Ralfs 1848 var. *lanceolatum* – Lit.: 6, 10, 114. – Hab.: 1, 11. – VR
C. lanceolatum var. *parvum* W. *et* G. S. West 1897 – Lit.: 94. – Hab.: 1. – ER
C. leibleinii Kütz. *ex* Ralfs 1848 var. *leibleinii* **(Fig. 15)** – Lit.: 10, 16, 28, 29, 30, 32, 46, 47, 50, 51, 54, 56, 61, 64, 71, 81, 90, 94, 96, 102, 110, 113. – Hab.: 1, 2, 3, 4, 5, 9, 10, 11, 12, 13, 14, 17. – C
C. leibleinii var. *boergesenii* (Schmidle) Skvortzow 1932 **(Fig. 16)** – Lit.: 94. – Hab.: 1, 4. – VR
C. limneticum Lemm. 1899 var. *limneticum* **(Fig. 12) –** Lit.: 14, 26, 44, 52, 62, 91, 94, 95, 96. – Hab.: 1, 3, 4, 10, 11, 12, 13. – F
C. limneticum var. *fallax* Růžička 1962 **(Fig. 11)** – Lit.: 94, 96. – Hab.: 1, 4. – C
C. limneticum var. *tenue* Lemm. 1899 **(Fig. 10)** – Lit.: 94, 96. – Hab.: 1, 4. – C
C. lineatum Ehrenb. *ex* Ralfs 1848 var. *lineatum* – Lit.: 16, 28, 29, 30, 51, 89, 104. – Hab.: 1, 10, 13, 16, 17, 18. – R
C. lineatum var. *elongatum* (Rosa) Croasdale 1955 – Lit.: 94, 95. – Hab.: 4. – VR
C. littorale Gay 1884 var. *littorale* **(Fig. 6)** – Lit.: 10, 26, 31, 40, 42, 93, 94, 114. – Hab.: 1, 2, 3. – R
C. littorale var. *crassum* W. *et* G. S. West 1896 – Lit.: 40, 42, 69. – Hab.: 2. – VR
C. lunula (O. F. Müll.) Nitzsch *ex* Ralfs 1848 var. *lunula* – Lit.: 8, 9, 11, 37, 41, 42, 46, 47, 50, 55, 56, 58, 60, 93, 104, 109, 114. – Hab.: 1, 4, 5, 11, 12, 16, 17, 18, 20. – C
C. lunula var. *biconvexum* Schmidle 1895 – Lit.: 11, 36, 38, 39. – Hab.: 17. – ER
C. lunula var. *massartii* (De Wildeman) W. Krieger 1937 (Bas.: *C. massartii* De Wildeman 1900) – Lit.: 56. – Hab.: 17. – ER
C. macilentum Bréb. 1856 – Lit.: 26, 28, 29, 30, 94, 96. – Hab.: 1, 12, 13. – R
C. moniliferum (Bory) Ehrenb. *ex* Ralfs 1848 var. *moniliferum* (Syn.: *C. moniliferum* var. *submoniliferum* (Woronichin) W. Krieger 1935) – Lit.: 1, 2, 3, 6, 8, 9, 10, 14, 16, 17, 20, 21, 23, 26, 28, 29, 30, 32, 34, 42, 46, 47, 48, 49, 50, 52, 54, 55, 56, 57, 60, 61, 64, 68, 75, 78, 81, 82, 85, 89, 93, 94, 95, 96, 99, 100, 111, 114.– Hab.: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17. – VF
C. moniliferum var. *concavum* Klebs 1879 – Lit.: 94, 96. – Hab. 1, 4. – VR
C. navicula (Bréb.) Lütkem. 1902 var. *navicula* **(Fig. 7)** (Bas.: *Penium navicula* Bréb. 1856) – Lit.: 8, 9, 11, 16, 37, 56, 60, 89. – Hab.: 1, 17. – R
C. navicula var. *crassum* (W. *et* G. S. West) Grönbl. 1920 (Bas.: *Penium navicula* Bréb. var. *crassum* W. *et* G. S. West 1904) – Lit.: 16, 56. – Hab.: 17. – ER
C. parvulum Nägeli 1849 var. *parvulum* **(Fig. 4)** – Lit.: 17, 20, 26, 42, 46, 47, 49, 50, 55, 56, 57, 60, 61, 70, 79, 87, 94, 105, 107, 109, 113. – Hab.: 1, 2, 3, 4, 5, 9, 10, 12, 13, 16, 17, 18, 20. – C
C. parvulum var. *angustum* W. *et* G. S. West 1900 – Lit.: 42, 55, 64, 66. – Hab.: 14, 17. – VR
C. parvulum var. *cornutum* (Playfair) W. Krieger 1935 **(Fig. 5)** – Lit.: 40, 42, 94, 96. – Hab. : 1, 2. – VR

Figs 17-27: **17.** *Closterium baillyanum* var. *alpinum*, **18.** *C. tumidulum*, **19.** *C. kuetzingii*, **20.** *C. intermedium*, **21.** *C. braunii*, **22.** *C. rostratum*, **23.** *C. strigosum* var. *elegans*, **24.** *C. striolatum* var. *attenuatum*, **25.** *C. turgidum*, **26.** *Pleurotaenium ehrenbergii* var. *ehrenbergii*, **27.** *C. strigosum* var. *strigosum*.

C. praelongum Bréb. 1856 var. *praelongum*– Lit.: 27, 52, 54, 89, 94. – Hab.: 1, 4, 12, 13, 16. – R
C. praelongum var. *brevius* (Nordst.) W. Krieger 1935 – Lit.: 40, 42, 94, 96. – Hab.: 1, 2, 4. – VR
C. pritchardianum Archer 1862 – Lit.: 6, 26, 40, 42, 64, 65, 94, 114. – Hab.: 1, 2, 4, 11, 13, 14, 17. – R
C. pronum Bréb. 1856 (Syn.: *C. pronum* Bréb. f. *brevius* W. West 1912) – Lit.: 8, 9, 12, 26, 52, 64, 75, 80, 89, 94, 95, 96. – Hab.: 1, 4, 10, 11, 12, 13, 14, 17. – C
C. pseudolunula Borge 1909 – Lit.: 10, 40, 42, 94. – Hab.: 1, 2. – VR
C. ralfsii Bréb. *ex* Ralfs var. *gracilius* (Maskell) W. Krieger 1935 – Lit.: 40, 42. – Hab.: 2. – ER
C. ralfsii var. *hybridum* Rabenh. 1863 – Lit.: 16. – Hab.: 17. – ER
C. rostratum Ehrenb. *ex* Ralfs 1848 var. *rostratum* **(Fig. 22)** – Lit.: 16, 40, 42, 46, 47, 48, 50, 52, 54, 55, 56, 60, 80. – Hab.: 1, 2, 4, 5, 10, 11, 12, 16, 17. – C
C. rostratum var. *brevirostratum* W. West 1889 – Lit.: 64. – Hab.: 14. – ER
C. setaceum Ehrenb. *ex* Ralfs 1848 var. *setaceum* – Lit.: 16, 26, 27, 79, 82, 87, 97. – Hab.: 1, 4, 13, 17. – R
C. setaceum var. *elongatum* W. *et* G. S. West 1905 – Lit.: 26. – Hab.: 1. – ER
C. strigosum Bréb. 1856 var. *strigosum* **(Fig. 27)** – Lit.: 18, 19, 20, 26, 35, 51, 52, 81, 87, 91, 94, 95, 96, 98, 114. – Hab.: 1, 4, 10, 12, 13, 14, 16, 17. – C
C. strigosum var. *elegans* (G. S. West) W. Krieger 1935 **(Fig. 23)** – Lit.: 6, 40, 42, 94, 96. – Hab.: 1, 2, 4, 11. – R
C. striolatum Ehrenb. *ex* Ralfs 1848 var. *striolatum* – Lit.: 8, 9, 11, 16, 36, 37, 38, 39, 42, 55, 56, 57, 58, 102, 104, 109. – Hab.: 17, 18. – R
C. striolatum var. *attenuatum* Kaiser 1924 **(Fig. 24)** – Lit.: 9. – Hab.: 17. – ER
C. striolatum var. *rectum* (W. West) W. Krieger 1935 – Lit.: 56. – Hab.: 17. – ER
C. subfusiforme Messikommer 1951 **(Fig. 3)** – Lit.: 40, 42. – Hab.: 2. – ER
C. subulatum (Kütz.) Bréb. 1856 – Lit.: 26, 94, 96. – Hab.: 1. – VR
C. toxon W. West 1892 – Lit.: 16. – Hab.: 17. – ER
C. tumidulum Gay 1884 **(Fig. 18)** – Lit.: 8, 9, 40, 42, 94. – Hab.: 1, 2, 17. – VR
C. tumidum Johnson 1895 – Lit.: 40, 42, 89. – Hab.: 1, 2. – VR
C. turgidum Ehrenb. *ex* Ralfs 1848 **(Fig. 25)** – Lit.: 8, 9, 16, 46, 47, 50. – Hab.: 4, 5, 11, 12, 17. – VR
C. venus Kütz. *ex* Ralfs 1848 – Lit.: 10, 11, 15, 16, 23, 36, 39, 42, 46, 47, 50, 55, 56, 57, 58, 64, 85. – Hab.: 1, 4, 5, 10, 11, 12, 13, 14, 17. – C

Family Desmidiaceae

Genus *Actinotaenium* (Nägeli) Teiling 1954
A. clevei (Lund.) Teiling 1954 (Bas.: *Penium clevei* Lund. 1871; Syn.: *Calocylindrus clevei* (Lund.) Wolle 1892, *Cosmarium clevei* (Lund.) Lütkem. 1902) – Lit. : 11, 35, 37, 38, 39. – Hab.: 17. – VR
A. colpopelta (Bréb. *ex* Archer) Compère 1976 (Bas.: *Cosmarium colpopelta* Bréb. *ex* Archer 1861) – Lit. : 56. – Hab.: 17. – ER
A. cucurbita (Bréb. *ex* Ralfs) Teiling 1954 (Bas.: *Cosmarium cucurbita* Bréb. *ex* Ralfs 1848 ; Syn.: *Calocylindrus cucurbita* (Bréb. *ex* Ralfs) Kirchner 1878, *Dysphinctium cucurbita* (Bréb. *ex* Ralfs) Reinsch *in* Bailey 1895) – Lit. : 11, 37, 40, 42, 46, 47, 50, 55, 56, 102, 109, 111. – Hab.: 2, 4, 5, 12, 17, 18. – R
A. cucurbitinum (Bisset) Teiling 1954 (Bas.: *Penium cucurbitinum* Bisset 1884 ; Syn.: *Cosmarium cucurbitinum* (Bisset) Lütkem. 1902) – Lit.: 16, 56, 60. – Hab.: 17. – VR
A. curtum (Bréb. *ex* Ralfs) Teiling 1954 (Bas.: *Cosmarium curtum* Bréb. *ex* Ralfs 1848; Syn.: *Penium curtum* (Bréb. *ex* Ralfs) Bréb. *ex* Kütz. 1849) – Lit.: 11, 16, 37, 56. – Hab.: 17. – VR
A. didymocarpum (Lund.) Coesel *et* Delfos 1986 (Bas.: *Penium didymocarpum* Lund. 1871) – Lit. : 11, 37, 57, 58. – Hab.: 17. – VR
A. gelidum (Wittrock) Růžička *et* Pouzar 1978 **(Fig. 14)** (Bas.: *Penium gelidum* Wittrock 1883 ; Syn.: *A. clevei* (Lund.) Teiling var. *gelidum* (Wittrock) Teiling 1954) – Lit. : 8, 9, 12. – Hab.: 17. – ER
A. palangula (Bréb.) Teiling 1954 (Bas.: *Cosmarium palangula* Bréb. *ex* Ralfs 1848) – Lit.: 11, 37. – Hab.: 17. – ER

A. phymatosporum (Nordst.) Kouwets *et* Coesel 1984 (Bas.: *Penium phymatosporum* Nordst. *in* Nordst. *et* Wittrock 1876) – Lit.: 16, 104. – Hab.: 17, 18. – VR
A. spinospermum (Joshua) Kouwets & Coesel 1984 (Bas.: *Penium spinospermum* Joshua 1883) – Lit.: 11, 16, 36, 38, 39, 56, 60, 102, 104, 109. – Hab.: 17, 18. – R
A. subtile (W. *et* G. S. West) Teiling 1954 (Bas.: *Penium subtile* W. *et* G. S. West 1897; Syn.: *Cosmarium subtile* (W. *et* G. S. West) Lütkem. 1910) – Lit.: 42, 55. – Hab.: 17. – ER
A. turgidum (Bréb. *ex* Ralfs) Teiling 1954 **(Fig. 8)** – Lit.: 8, 9, 11, 16, 36, 38, 39, 56, 60. – Hab.: 17. – VR

Genus *Haplotaenium* Bando 1988
H. minutum (Ralfs) Bando 1988 (Bas.: *Docidium minutum* Ralfs 1848; Syn.: *Penium minutum* (Ralfs) Cleve 1864, *Pleurotaenium minutum* (Ralfs) Delponte 1877) – Lit.: 16, 56, 104. – Hab.: 17, 18. – VR
H. rectum (Delponte) Bando 1988 (Bas.: *Pleurotaenium rectum* Delponte 1877; Syn.: *P. trabecula* (Ehrenb.) *ex* Näg. var. *rectum* (Delponte) W. *et* G. S. West 1904) – Lit.: 8, 12, 56. – Hab.: 17. – ER

Genus *Pleurotaenium* Nägeli 1849
P. coronatum (Bréb. *ex* Ralfs) Rabenh. 1868 var. *coronatum* (Bas.: *Docidium coronatum* Bréb. *ex* Ralfs 1848) – Lit.: 60. – Hab.: 17. – ER
P. coronatum var. *fluctuatum* W. West 1892 – Lit.:16, 56. – Hab.: 17. – ER
P. ehrenbergii (Ralfs) De Bary 1858 var. *ehrenbergii* **(Fig. 26)** (Bas.: *Docidium ehrenbergii* Ralfs 1848; Syn.: *P. ehrenbergii* var. *constrictum* (Playfair) W. Krieger 1937, *P. ehrenbergii* var. *granulatum* (Ralfs) W. *et* G. S. West 1904) – Lit.: 11, 12, 16, 35, 36, 38, 39, 56, 65, 107, 110. – Hab.: 17, 18. – VR
P. ehrenbergii var. *elongatum* (W. West) W. West 1892 (Bas.: *Docidium ehrenbergii* Ralfs var. *elongatum* W. West 1890) – Lit.: 56. – Hab.: 17. – ER
P. eugeneum (Turner) W. *et* G. S. West 1904 (Bas.: *Docidium eugeneum* Turner 1892) – Lit.: 8, 9, 12. – Hab.: 17. – ER
P. maximum (Reinsch) Lund. 1871 (Bas.: *Docidium maximum* Reinsch 1867; Syn.: *P. trabecula* (Ehrenb.) Näg. var. *maximum* (Reinsch) Roll 1927) – Lit. : 8, 11, 36, 38, 39, 56. – Hab.: 17. – VR
P. nodulosum (Bréb. *ex* Ralfs) De Bary 1858 (Bas.: *Docidium nodulosum* Bréb. *ex* Ralfs 1848 ; Syn.: *P. coronatum* (Bréb. *ex* Ralfs) Rabenh. var. *nodulosum* (Bréb. *ex* Ralfs) W. West 1892) – Lit. : 35, 90. – Hab.: 11, 17. – VR
P. trabecula (Ehrenb.) Näg. 1849 var. *trabecula* – Lit.: 24, 42, 55, 56, 58, 64, 73, 103, 106, 107, 109. – Hab.: 1, 13, 14, 17, 18, 19. – R
P. trabecula var. *crassum* Wittrock 1872 – Lit.: 60. – Hab.: 17. – ER
P. truncatum (Bréb. *ex* Ralfs) Näg. 1849 (Bas.: *Docidium truncatum* Bréb. *ex* Ralfs 1848) – Lit. : 11, 16, 36, 38, 39, 56, 60. – Hab.: 17. – VR

Genus *Tetmemorus* Ralfs 1848
T. brebissonii (Menegh.) Ralfs 1848 – Lit. : 56. – Hab.: 17. – ER
T. granulatus Bréb. *ex* Ralfs 1848 – Lit. : 11, 36, 39, 56, 57, 60. – Hab.: 17. – VR
T. laevis Kütz. *ex* Ralfs 1848 – Lit.: 11, 16, 36, 38, 56, 57, 58, 60, 102, 104, 107, 108, 109, 110. – Hab.: 17, 18, 20. – R
T. laevis var. *minutus* (De Bary) W. Krieger 1937 – Lit.: 16, 55. – Hab.: 17. – VR