Biologia **63**/6: 888—894, 2008
Section Botany
DOI: 10.2478/s11756-008-0138-4

# Desmids from ephemeral pools and aerophytic habitats from the Czech Republic*

Jan Šťastný

*Charles University in Prague, Faculty of Science, Department of Botany, Benátská 2, CZ-12801 Praha 2, Czech Republic; e-mail: stastny.jan@centrum.cz*

**Abstract:** The distribution and ecology of desmids in wetland habitats in the Czech Republic were studied during 2003–2007. Samples were taken also from various aerophytic habitats and temporary pools thet had not been sufficiently studied before. Altogether 110 desmids taxa were found in 31 samples which were ordinated on the basis of their desmid species composition using a multivariate statistic method. The discussion focuses on the most interesting findings and on the factors that influence the distribution of desmids in different types of aerophytic habitats.

**Key words:** aerophytic habitats; desmids; drainage gutters; ecology; ephemeral pools; rare taxa; wet rocks

## Introduction

During 2003–2007, I closely studied the biodiversity and ecology of desmids in Czech wetlands. From almost 800 samples taken, 31 originated from various types of aerophytic habitats.

Most desmid taxa occur in shallow, oligo-mesotrophic water bodies, like moorland pools and fen hollows (Coesel 1998); desmids preferring aerophytic conditions are considered rather an exception (Růžička 1977). Although this specific desmid group has been recorded by some authors (e.g. Grönblad 1934, 1935; Růžička 1964, 1967; Brook & Williamson 1990; Kouwets 1997; Williamson 1999, 2000, 2002; Brook 2001; Coesel & Meesters 2001; Dingley 2002; Coesel & Hindák 2003; Coesel at al. 2006), including assemblage classification (Laporte 1931; Krieger 1937), our knowledge of it remains rather poor.

The main goal of this study is to summarize the data on desmid occurrence and autecology and to discuss the main factors that influence their distribution and biodiversity in different types of aerophytic habitats.

### Material and methods

Samples were taken from three main types of habitats: temporary pools, wet or dripping rocks and man-made substrata, in particular from concrete drainage gutters. Most samples were taken during summer and autumn.

*List of samples*

1) Periodically desiccating concrete drainage gutter near the railway corridor in the town of Roztoky u Prahy-Žalov (50°10′4.531″ N, 14°21′52.071″ E).

2) Periodically desiccating concrete drainage gutter near the railway corridor in the town of Roztoky u Prahy (50°9′9.57″ N, 14°23′50.497″ E); pH 7.9, cond. 175 $\mu$S cm$^{-1}$.

3) Periodically desiccating concrete drainage gutter near the railway station Praha-Sedlec (50°7′52.835″ N, 14°23′50.875″ E).

4) Periodically desiccating concrete drainage gutter near the railway station Praha-Běchovice (50°4′56.166″ N, 14°35′34.494″ E).

5) Periodically desiccating concrete drainage gutter near the railway station Praha-Libeň (50°6′2.194″ N, 14°30′5.367″ E); pH 7.2, cond. 129 $\mu$S cm$^{-1}$.

6) Mucilaginous growths on the concrete wall of an artificial pool in the town of Mariánské Lázně (49°57′30.381″ N, 12°41′52.407″ E). Leg. Ladislav Hodač, Charles University, Prague.

7) Moss-covered rocks in the "Pohořský" stream, Novohradské hory Mts Protected Landcape Area (48°37′9.252″ N, 14°40′18.788″ E).

8) Wet mosses on the margin of "Pohořský" pond, Novohradské hory Mts Protected Landcape Area (48°37′3.285″ N, 14°40′25.809″ E).

9) Ephemeral pool near the "Kapelunk" pond, Novohradské hory Mts Protected Landcape Area (48°36′37.703″ N, 14°42′42.019″ E); pH 6.2, cond. 39 $\mu$S cm$^{-1}$

10) Ephemeral pool near the "Mlýnský" pond, Novohradské hory Mts Protected Landcape Area (48°42′33.085″ N, 14°42′47.087″ E); pH 5.6, cond. 13 $\mu$S cm$^{-1}$

11) Wet mosses on the margin of "Mlýnský" pond, Novohradské hory Mts Protected Landcape Area (48°42′40.246″ N, 14°42′40.487″ E).

12) Ephemeral pool near "Břehyňský" pond (50°34′32.274″ N, 14°40′49.548″ E); pH 5.8, cond. 98 $\mu$S cm$^{-1}$.

---

* Presented at the International Symposium *Biology and Taxonomy of Green Algae V*, Smolenice, June 26–29, 2007, Slovakia.

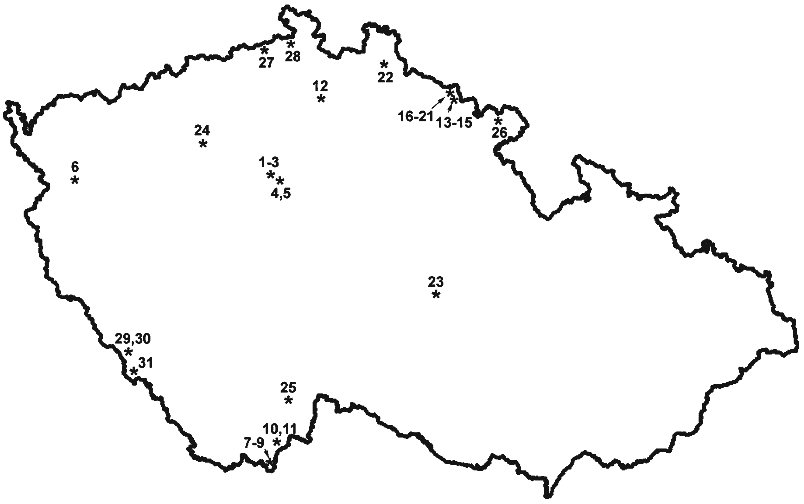


Fig. 1. Location of the sampling sites in the territory of the Czech Republic (for numbers of localities see Material and methods).

13) Ephemeral pool near "Černohorské rašeliniště" peat bog, Krkonoše Mts National Park (50°39′56.511″ N, 15°45′ 4.678″ E); pH 4.6, cond. 21 $\mu$S cm$^{-1}$.

14) Ephemeral pool near "Černohorské rašeliniště" peat bog, Krkonoše Mts National Park (50°40′31.574″ N, 15°43′ 29.858″ E); pH 5.7, cond. 119 $\mu$S cm$^{-1}$

15) Ephemeral pond near the "Černá hora" mountain, Krkonoše Mts National Park (50°39′57.278″ N, 15°44′ 11.483″ E); pH 4.3, cond. 16 $\mu$S cm$^{-1}$.

16) Ephemeral pond near the town of Pec pod Sněžkou, Krkonoše Mts National Park (50°40′51.298″ N, 15°43′ 33.932″ E).

17) Wet, sometimes moss-covered granite rocks in the "Úpský" waterfall, Zone I of the Krkonoše National Park (50°43′56.018″ N, 15°42′44.678″ E); pH 5.6, cond. 12 $\mu$S cm$^{-1}$, sample 1.

18) Wet, sometimes moss-covered granite rocks in the "Úpský" waterfall, Zone I of the Krkonoše Mts National Park (50°43′55.297″ N, 15°42′44.347″ E); pH 5.6, cond. 12 $\mu$S cm$^{-1}$, sample 2.

19) Wet, moss-covered granite rocks in the "Zelený" stream, Krkonoše Mts National Park (50°42′8.248″ N, 15°41′54.283″ E); pH 6.6, cond. 14 $\mu$S cm$^{-1}$.

20) Wet, moss-covered granite rocks in the "Modrý" stream, Krkonoše Mts National Park (50°41′50.466″ N, 15°42′11.761″ E).

21) Ephemeral pool in the "Zelený důl" valley, Krkonoše Mts National Park (50°42′5.601″ N, 15°42′25.239″ E).

22) Ephemeral pool near the "Josefův důl" water reservoir, Jizerské hory Mts Protected Landcape Area (50°47′41.902″ N, 15°11′49.596″ E); pH 4.9, cond. 35 $\mu$S cm$^{-1}$.

23) Ephemeral pool near the "Velké Dářko" pond (49°38′ 20.722″ N, 15°53′4.679″ E); pH 5.3, cond. 49 $\mu$S cm$^{-1}$.

24) Ephemeral pool in the "V Bahnách" Nature Reserve (50°10′27.247″ N, 13°51′31.884″ E).

25) Ephemeral pool in the "V Rájích" Nature Reserve (48°59′10.237″ N, 14°42′31.605″ E).

26) Ephemeral pool in the "Adršpašsko-Teplické skály" Nature Reserve (50°36′39.477″ N, 16°6′35.144″ E).

27) Wet rocks in an unnamed forest stream, "Labské pískovce" Protected Landscape Area (50°49′1.282″ N, 14°10′1.632″ E); pH 6.0, cond. 244 $\mu$S cm$^{-1}$.

28) Wet sandstone rocks in the National Park Bohemian Switzerland (50°53′20.996″ N, 14°22′16.909″ E). Leg. Marie Pažoutová, Charles University, Prague.

29) Ephemeral pool in the "Hůrecké slatě" peat bog, Šumava National Park, sample 1 (49°6′36.204″ N, 13°23′ 28.752″ E).

30) Ephemeral pool in the "Hůrecké slatě" peat bog, Šumava National Park, sample 2 (49°6′37.633″ N, 13°23′ 29.424″ E).

31) Ephemeral pool near the mountain "Březník", Šumava National Park (48°58′18.903″ N, 13°28′3.801″ E); pH 5.3, cond. 17 $\mu$S cm$^{-1}$.

The sampling sites are indicated on the map shown in Fig. 1. The algal samples were collected by squeezing out mosses, sucking off the algae from the sediment with a syringe and by scraping gelatinous matter using a knife. Where possible, environmental variables (pH, conductivity) were measured, either with Combo HI 98129 (HANNA, Germany) or with a pH-meter WTW 330 and conductometer WTW LF 315 (WTW, Germany). Shortly after sampling, one part of the material was fixed with formaldehyde to a final concentration of about 4% and later used for semiquantitative assessment according to the following scale: rr – very rare; r – scattered; c – abundant; cc – very abundant. Light microscope observations were done mostly on living material to achieve better visibility of the details of cell-wall structure. Preparations were made by mixing one drop of material with one drop of glycerine, and drawings were made with the aid of a drawing apparatus. Following abbreviations are used in the text: Dim. – dimensions; Occ. – occurrence; L – length; W – width; I – isthmus.

Detrended correspondence analysis (DCA) with Canoco for Windows 4.5 (Ter Braak & Šmilauer 1998) was used for statistic evaluation. The evaluation focussed on the differences in species data among sampling sites. The basic detrending analysis was made by segments without any transformation and with respect to downweighting of rare species. The desmid flora of sample no. 21 was too distinct to be compared with other samples; therefore, it was excluded from the analysis.

## Results and discussion

### *Taxonomy*

In the samples studied, a total of 110 desmid taxa from 17 genera were found. The list of all taxa with

Table 1. List of all taxa found with frequency of their occurrence (number of localities).

| | |
|---|---|
| *Actinotaenium curtum* (Ralfs) Teiling | 9 |
| *Actinotaenium diplosporum* (P.Lundell) Teiling | 3 |
| *Actinotaenium diplosporum* var. *americanum* (W. et G.S.West) Teiling | 1 |
| *Actinotaenium inconspicuum* (W. et G.S.West) Teiling | 1 |
| *Actinotaenium kriegeri* (Messik.) Kouwets | 4 |
| *Actinotaenium silvae-nigrae* (Rabanus) Kouwets et Coesel | 1 |
| *Actinotaenium subglobosum* (Nordst.) Teiling | 2 |
| *Actinotaenium* spp. | 12 |
| *Closterium abruptum* W.West | 2 |
| *Closterium cornu* var. *upsaliense* Nordst. | 4 |
| *Closterium intermedium* Ralfs | 3 |
| *Closterium moniliferum* Ralfs | 1 |
| *Closterium navicula* (Bréb.) Lütkem. | 3 |
| *Closterium parvulum* Nägeli | 3 |
| *Closterium pritchardianum* Archer | 1 |
| *Closterium pseudopygmaeum* Kouwets | 1 |
| *Closterium pusillum* Hantzsch in Rabenhorst | 1 |
| *Closterium rostratum* Ralfs | 2 |
| *Closterium striolatum* Ralfs | 2 |
| *Closterium tumidulum* F.Gay | 1 |
| *Closterium tumidum* Johnson | 1 |
| *Closterium tumidum* var. *nylandicum* Grönblad | 4 |
| *Cosmarium anceps* P.Lundell | 5 |
| *Cosmarium basiornatum* (Grönblad) Coesel | 3 |
| *Cosmarium botrytis* var. *gemmiferum* (Bréb.) Nordst. | 1 |
| *Cosmarium caelatum* Ralfs | 10 |
| *Cosmarium crenatum* Ralfs | 6 |
| *Cosmarium crenatum* var. *bicrenatum* Nordst. | 2 |
| *Cosmarium cyclicum* P.Lundell | 2 |
| *Cosmarium cyclicum* var. *arcticum* Nordst. | 2 |
| *Cosmarium davidsonii* Roy et Bisset | 1 |
| *Cosmarium decedens* (Reinsch) Racib. | 2 |
| *Cosmarium decedens* var. *minutum* (Gutw.) Willi Krieg. et Gerloff | 2 |
| *Cosmarium dentiferum* var. *alpinum* Messik. | 2 |
| *Cosmarium formosulum* Hoff | 1 |
| *Cosmarium galeritum* Nordst. | 1 |
| *Cosmarium garrolense* Roy et Bisset | 2 |
| *Cosmarium goniodes* var. *subturgidum* W. et G.S.West | 1 |
| *Cosmarium holmiense* var. *integrum* P.Lundell | 10 |
| *Cosmarium hornavanense* (Schmidle) Gutw. | 1 |
| *Cosmarium impressulum* Elfving | 3 |
| *Cosmarium microsphinctum* Nordst. | 2 |
| *Cosmarium nasutum* Nordst. | 5 |
| *Cosmarium nitidulum* De Not. | 1 |
| *Cosmarium norimbergense* var. *depressum* (W. et G.S.West) Willi Krieg. et Gerloff | 3 |
| *Cosmarium notabile* var. *transiens* Insam et Krieg. | 4 |
| *Cosmarium obliquum* Nordst. | 1 |
| *Cosmarium ochthodes* Nordst. | 3 |
| *Cosmarium orthopunctulatum* Schmidle | 6 |
| *Cosmarium parvulum* var. *undulatum* Schmidle | 1 |
| *Cosmarium pericymatium* Nordst. | 4 |
| *Cosmarium pericymatium* var. *corrugatum* Brook | 1 |
| *Cosmarium quadratum* Ralfs | 10 |
| *Cosmarium regnellii* Wille | 4 |
| *Cosmarium speciosum* var. *simplex* Nordst. | 6 |
| *Cosmarium sportella* var. *subnudum* W. et G.S.West | 6 |
| *Cosmarium subcrenatum* Hantzsch | 1 |
| *Cosmarium subcucumis* Schmidle | 4 |
| *Cosmarium subspeciosum* var. *transiens* Messik. | 4 |
| *Cosmarium tinctum* Ralfs | 3 |
| *Cosmarium turpinii* var. *podolicum* Racib. | 1 |
| *Cosmarium* cf. *pokornyanum* var. *taylorii* Grönblad | 3 |
| *Cosmarium* sp. 1 | 1 |
| *Cosmarium* sp. 2 | 1 |
| *Cylindrocystis brebissonii* (Ralfs) De Bary | 20 |
| *Cylindrocystis crassa* De Bary | 1 |
| *Euastrum ansatum* Ralfs | 1 |
| *Euastrum ansatum* var. *pyxidatum* Delponte | 1 |
| *Euastrum bidentatum* Nägeli | 4 |
| *Euastrum binale* var. *gutwinskii* (Schmidle) Homfeld | 3 |
| *Euastrum crassicolle* P.Lundell | 2 |
| *Euastrum denticulatum* F.Gay | 1 |

Table 1. (continued).

| | |
|---|---|
| *Euastrum dubium* Nägeli | 2 |
| *Euastrum elegans* Ralfs | 1 |
| *Euastrum humerosum* Ralfs | 1 |
| *Euastrum montanum* W. et G.S.West | 1 |
| *Euastrum oblongum* Ralfs | 2 |
| *Euastrum subalpinum* Messik. | 1 |
| *Gonatozygon brebissonii* var. *alpestre* Růžička | 1 |
| *Hyalotheca dissiliens* Ralfs | 3 |
| *Mesotaenium macrococcum* (Kütz.) Roy et Bisset | 3 |
| *Mesotaenium macrococcum* var. *minus* (De Bary) Compère | 2 |
| *Micrasterias americana* var. *boldtii* Gutw. | 2 |
| *Micrasterias papillifera* Bréb. | 2 |
| *Netrium digitus* (Bréb.) Itzigs. et Rothe | 5 |
| *Netrium interruptum* (Bréb.) Lütkem. | 1 |
| *Netrium interruptum* var. *minor* (Borge) Willi Krieg. | 2 |
| *Netrium oblongum* (De Bary) Lütkem. | 2 |
| *Penium cylindrus* Bréb. | 1 |
| *Penium margaritaceum* Bréb. | 2 |
| *Penium spirostriolatum* J.Barker | 3 |
| *Polytaenia obscura* (Ralfs) Brook | 3 |
| *Roya obtusa* (Bréb.) W.et G.S.West | 11 |
| *Spirotaenia condensata* Ralfs | 2 |
| *Spirotaenia erythrocephala* Itzigs. | 3 |
| *Staurastrum capitulum* Ralfs | 3 |
| *Staurastrum echinatum* Ralfs | 1 |
| *Staurastrum habeebense* Irénée-Marie | 3 |
| *Staurastrum hirsutum* Ralfs | 6 |
| *Staurastrum hirsutum* var. *muricatum* (Bréb. ex Ralfs) Kurt Först. | 3 |
| *Staurastrum margaritaceum* Ralfs | 4 |
| *Staurastrum meriani* Reinsch | 1 |
| *Staurastrum orbiculare* var. *extensum* Nordst. | 3 |
| *Staurastrum pileolatum* Ralfs | 2 |
| *Staurastrum punctulatum* Ralfs | 13 |
| *Staurastrum sexcostatum* Ralfs | 3 |
| *Staurastrum spongiosum* var. *perbifidum* W.West | 2 |
| *Tetmemorus granulatus* Ralfs | 3 |
| *Tetmemorus laevis* Ralfs | 9 |
| *Tortitaenia bahusiensis* (Nordst. et Lütkem.) Coesel | 1 |

the frequency of their occurrences are shown in Table 1). The rather high number of taxa found is probably due to the very diverse character of the sampling sites and substrata; all extensive studies on aerophytic desmids published until now concerned only one particular type of substratum, most often wet or dripping rocks (Grönblad 1934; 1935, Růžička 1964; Williamson 2000; Dingley 2002).

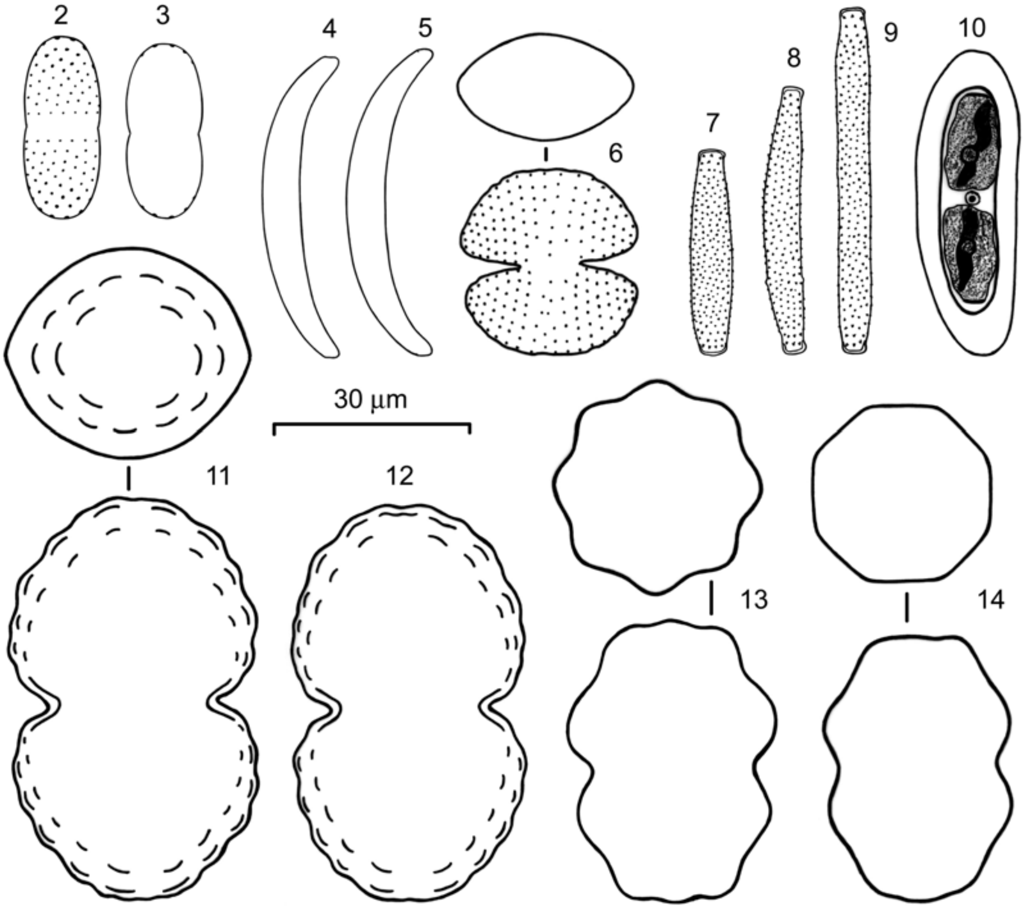
Fifty taxa found during my extensive sampling in the territory of the Czech Republic (see above) were not found in any other type of biotope. This indicates that they most probably live exclusively in aerophytic habitats. Many of the taxa are very rare, at least judging from the number of their published findings; however, in the majority of cases this “rareness” is most probably due to the insufficient knowledge of the relevant biotopes. This is especially true of desmids from untypical biotopes, such as drainage gutters, fountains, garden ornaments, etc. The most interesting findings are discussed below.

**Actinotaenium kriegeri** (Messik.) Kouwets (Figs 2, 3)
Dim.: L: 24–30 $\mu$m; W: 11.3–13.5 $\mu$m
Occ.: 8rr; 9cc; 10r

According to Kouwets (1997) and Coesel (1998), the species in question prefers oligomesotrophic, ephemeric and hemi-atmophytic habitats, which corresponds well with my findings. According to Kouwets (1997), it is an arctic-alpine species, widely distributed but rather scarce anywhere it occurs which probably applies also to Central Europe, although there are as yet almost no data on its distribution in this area – the only finding which at least approximately matches the discussed species is mentioned by Messikommer (1942, p. 193, Taf. IV, Fig. 20) under the synonym *Cosmarium adelochondrum* (Elfv.) Lütkem. var. *kriegeri* from the Swiss Alps.

**Closterium pseudopygmaeum** Kouwets (Figs 4, 5)
Dim.: L: 42.5–55 $\mu$m; W: 5.7–7 $\mu$m
Occ.: 10rr

This species in question is characterized by its small dimensions and a slanted apex with an apical pore (Kouwets 2001). However, the pore is often quite inconspicuous and is easily overlooked, especially on fixed material. Until now this alga has been known only from several sites in France (Kouwets 2001) which makes my finding the first within Central Europe, where it was found in a locality that corresponds well with those in France.



Figs 2–14. The most interesting findings. 2, 3 – *Actinotaenium kriegeri*; 4, 5 – *Closterium pseudopygmaeum*; 6 – *Cosmarium orthopunctulatum*; 7–9 – *Gonatozygon brebissonii* var. *alpestre*; 10 – *Tortitaenia bahusiensis*; 11, 12 – *Cosmarium pericymatium* var. *corrugatum*; 13, 14 – *Staurastrum habeebense.*

***Cosmarium orthopunctulatum*** Schmidle (Fig. 6)
Dim.: L: 26.3–30.5 $\mu$m; W: 25–28.5 $\mu$m; I: 8.8–11.3 $\mu$m
Occ.: 16cc; 17c; 18r; 26rr; 28rr; 31c

This remarkable species has a predominantly arctic-alpine distribution (Coesel 1992), as is corroborated by previous reports of its occurrence at sites in the Czech Republic situated approximately 820–1400 m a.s.l. (Fischer 1924; Lhotský 1949; Rybníček 1958) and by my own observations at localities approximately 950–1390 m a.s.l. (sampling sites Nos 16, 17, 18, 31). The other records, from ravines in sandstone rock massives (samples Nos 27 and 28), are interesting from an ecological point of view. These ravines are situated only 450–500 m above sea level, but due to the inverse character of their inner climate the temperatures at their bottom are often very low, comparable to much higher altitudes.

***Cosmarium pericymatium*** Nordst. var. corrugatum Brook (Figs 11, 12)
Dim.: L: 60–65 $\mu$m; W: 34–40 $\mu$m; I: 23–26 $\mu$m
Occ.: 2c

Like the typical variety of the species var. *corrugatum* also prefers ephemeral, periodically desiccating substrata. Until now it had been recorded only from two localities in Great Britain (Brook 2001, Williamson 2002) which makes my finding the first in Central Europe.

***Gonatozygon brebissonii*** De Bary var.***alpestre*** Růžička (Figs 7–9)
Dim.: L: 33.5–65 $\mu$m; W: 5.8–7.5 $\mu$m
Occ.: 10rr

This is a rare taxon, until now reported only from the High Tatra Mountains (Růžička 1967) and from the Eastern Pyrenees (Kouwets 1997). The altitude of the Czech locality (750 m a.s.l.) corresponds well with the Slovak and French localities thus confirming the probable arctic-alpine distribution of this taxon (Kouwets 1997).

***Staurastrum habeebense*** Irénée-Marie (Figs 13, 14)
Dim.: L: 36.5–45 $\mu$m; W: 24–31 $\mu$m; I: 21–23 $\mu$m
Occ.: 2r; 3cc

A remarkable species, probably rather widely distributed in artificial, periodically desiccating substrata like roof and drainage gutters or garden ornaments, as indicated by its relatively frequent recent findings from

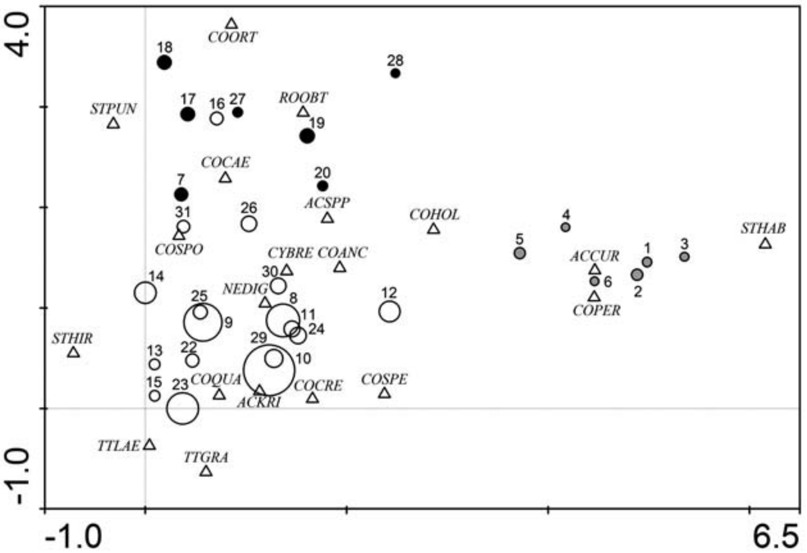


Fig. 15. The results of DCA in ordination space of the first two axes. (The size of symbols correlates with the species richness of the samples. White – ephemeral pools samples; grey – man-made habitats samples; black – wet rocks samples. Only the statistically most relevant species are depicted. Taxon abbreviations: ACCUR – *Actinotaenium curtum*; ACKRI – *A. kriegeri*; ACSPP – *A. spp.*; COANC – *Cosmarium anceps*; COCAE – *C. caelatum*; COCRE – *C. crenatum*; COHOL – *C. holmiense* var. *integrum*; COORT – *C. orthopunctulatum*; COPER – *C. pericymatium*; COQUA – *C. quadratum*; COSPE – *C. speciosum* var. *simplex*; COSPO – *C. sportella* var. *subnudum*; CYBRE – *Cylindrocystis brebissonii*; NEDIG – *Netrium digitus*; ROOBT – *Roya obtuse*; STHAB – *Staurastrum habeebense*; STHIR – *St. hirsutum*; STPUN – *St. punctulatum*; TTGRA – *Tetmemorus granulatus*; TTLAE – *T. laevis*).

similar habitats (Belcher & Swale 1984; Williamson 2002; Coesel & Hindák 2003; Coesel et al. 2006). For a more detailed discussion of the ecology of this species see Coesel & Hindák (2003).

***Tortitaenia bahusiensis*** (Nordst. et Lütkem.) Coesel (Fig. 10)
Dim.: L: 25–45 $\mu$m; W: 10–10.5 $\mu$m;
Occ.: 2rr

The morphology and ecology of my specimens are in full accordance with Coesel's data (1998, as *Spirotaenia bahusiensis* Lütkem.); however, the cells I found differed by the presence of a mucilage capsule.

*Ecology*

The ordination diagram (Fig. 15) shows that the 1st ordination axis clearly separates samples from man-made substrata (in particular from concrete drainage gutters) from the other samples. The former were generally very poor in species (2–5 taxa per sample), on the other hand, the abundance of the particular species within the samples was mostly very high.

The environmental data indicate that the above-mentioned difference is caused most probably by high pH combined with an extreme water regime of the given sites. For the larger part of the year they are completely dry; the only exceptions are usually periods of heavy summer rains or snow melting in spring (personal observation). It can therefore be assumed that the dominant representatives found on these sites (*Actinotaenium curtum*, *Cosmarium pericymatium*, *Staurastrum habeebense*, *Cosmarium pericymatium* var. *corrugatum*) have a strong resistance to desiccation inhabiting primarily soil substrata. This hypothesis is supported also by previous authors (Brook 2001; Williamson 2002; Coesel & Hindák 2003; Coesel et al. 2006) and by the fact that the above-mentioned algae are only rarely if ever reported from other kinds of aerophytic habitats. These taxa developed morphological adaptations (small surface/volume ratio, thick cell walls and copious mucilage secretion), allowing them to survive very long periods of drought – at least several months (see Brook & Williamson 1990; Coesel & Hindák 2003). Desmids from other types of subaerial habitats (mountain ephemeral pools or wet rocks) mostly do not have to face such lengthy drought periods.

Desmid communities from temporary pools and wet rocks form a single cluster in the ordination diagram; still, there are some notable differences. Samples taken from wet rocks can be characterized by low species richness (2–8 taxa per sample) and abundance while ephemeral pools have a relatively rich desmid flora (4–53 taxa per sample). This is in general agreement with data from the literature (Grönblad 1934, 1935, Kouwets 1997, Williamson 2000); the most likely cause of this are the different water regimes of the sites.

The two species that occurred on wet rocks most frequently were *Roya obtusa* and *C. orthopunctulatum.* The former is known to be a frequent inhabitant of this particular habitat (Růžička 1967; Williamson 2000), whereas the latter is considered as rare (see above).

The dominant species of ephemeral pools included, amongst others, *Cylindrocystis brebissonii*, *Cosmarium caelatum*, *C. holmiense var. integrum*, *C. quadratum*, *C. crenatum*, *C. anceps*, *C. speciosum* var. *simplex*, and, in more acidic pools especially *Tetmemorus laevis* and *Staurastrum hirsutum*, which are all taxa generally considered to be typical for aerophytic habitats (see e.g. Coesel 1974, 1998; Williamson 2000).

The key factor influencing the distribution of desmids in ephemeral pools is most likely pH. While samples taken from strongly acidic pools were generally rather poor in species, the richest samples came either from places where I recorded a local increase of pH (e.g. due to calcium leakage arising from limestone gravelling of mountain tracks nearby) or from larger pools that fall dry during longer periods and which offer the desmids longer time for potential colonisation as well as a broader range of microhabitats. Aerophytic habitats, due to their very dynamic nature, are biotopes for which the collection of reliable environmental data presents a significant challenge. Therefore the conclusions mentioned above require statistical corroboration and further work is needed for a better understanding of the distribution and the life strategies of desmids in various types of subaerial habitats.

## Acknowledgements

I wish to thank Ladislav Hodač and Marie Pažoutová for kindly providing me with samples for this study. I would also like to thank to my sister Zuzana for helping me with the English. The study was supported by grant 164/2006/B-BIO/PrF of the Grant Agency of the Charles University in Prague, and by the research project No. 21620828 of the Czech Ministry of Education.

## References

Belcher J.H. & Swale E.M.F. 1984. Unusual and surprising algae from a Cambridge roof. Microscopy **35:** 136–143.

Brook A.J. 2001. The drought-resistant desmid, *Cosmarium pericymatium* Nordstedt, and a description of a new var. *corrugatum*. Quekett J. Micr. **39:** 127–132.

Brook A.J. & Williamson D.B. 1990. *Actinotaenium habeebense* (Irénée-Marie) nov. comb., a rare drought-resistent desmid. Br. Phycol. J. **25:** 321–327.

Coesel P.F.M. 1974. Bijdragen tot de kennis der Nederlandse Desmidiaceeënflora 1. Einige interessante soorten uit het plassengebied van N.W.– Overijssel. Gorteria **7:** 20–26.

Coesel P.F.M. 1992. Desmid assemblies along altitude gradients in Colombia. Nova Hedwigia **55:** 353–366.

Coesel P.F.M. 1998. Sieralgen en Natuurwaarden. Uitgeverij Koninklijke Nederlandse Natuurhistorische Vereniging, Utrecht, 56 pp.

Coesel P.F.M. & Hindák F. 2003. *Staurastrum habeebense* Irénée-Marie, an intriguing, drought-resistant desmid recorded for the first time from continental Europe. Biologia **58:** 661–663.

Coesel P.F.M. & Meesters K. 2001. *Cosmarium pokornyanum* (Grunow) W. et G.S.West, een arctisch-alpiene desmidiaceënsoort nieuw voor de Nederlandse flora. Gorteria **27:** 115–118.

Coesel P.F.M., Meesters K. & Schulp H. 2006. Subatmofytische sieralgsoorten, nieuw voor de Nederlandse flora. Gorteria **31:** 137–141.

Dingley M. 2002. Desmids (Chlorophyta) recorded from wet rocks in Australia. Algol. Studies **105:** 87–94.

Fischer R. 1924. Ökologische Skizzen zur Algenflora des mährisch-schlesischen Gesenkes. Schriften f. Süsswasser-u. Meereskunde, Heft **7:** 1–20.

Grönblad R. 1934. A contribution to the knowledge of sub-aërial Desmids. Soc. Sci. Fenn. Commen. Biol. **4:** 1–7.

Grönblad R. 1935. Sub-aërial Desmids II. Soc. Sci. Fenn. Commen. Biol. **5:** 1–4.

Kouwets F.A.C. 1997. Contributions to the knowledge of the french desmid flora I. New and noteworthy taxa from Central and Eastern Pyrenees. Arch. Protistenknd. **148:** 33–51.

Kouwets F.A.C. 2001. Contributions to the knowledge of the French desmid flora III. New and rare taxa from the regions of Dordogne and Limousin. Algol. Studies **101:** 27–55.

Krieger W. 1937. Die Desmidiaceen Europas mit Berücksichtigung der aussereuropäischen Arten. Rabenhorst‘s Kryptogamen – Flora von Deutschland, Österreich und der Schweiz, Abt. 1, Teil 1. Akad. Verlagsges., Leipzig, 712 pp.

Laporte L.J. 1931. Recherches sur la Biologie et la Systématique des Desmidiées. Encycl. Biol. **9:** 1–150.

Lhotský O. 1949. Poznámka k flóře Desmidiaceí Hrubého Jeseníku. Čas. Vlast. spolku mus. v Olomouci **58:** 149–155.

Messikommer E. 1942. Beitrag zur Kenntniss der Algenflora und Algenvegetation des Hochgebirges um Davos. Beitr. Geobot. Landesaufn. Schweiz **24:** 1–452.

Růžička J. 1964. Desmidiaceen der feuchten Felsen in der Hohen Tatra. Fragm. Flor. et Geobot. **10:** 103–119.

Růžička J. 1967. Interessante Zieralgen aus der Hohen Tatra I. Preslia **39:** 244–259.

Růžička J. 1977. Die Desmidiaceen Mitteleuropas, Band 1, 1. Lief. E. Schweizerbart‘sche Verlagsbuchhandlung, Stuttgart, 292 pp.

Rybníček K. 1958. Krásivky pramenné oblasti Branné v Hrubém Jeseníku. Přírodov. sbor. Ostravského kraje **19:** 97–122.

Ter Braak C.J.F. & Šmilauer P. 1998. CANOCO reference manual and user‘s guide to Canoco for Windows. Software for Canonical Community Ordination (version 4). CPRO-DLO, Wageningen, 353 pp.

Williamson D.B. 1999. A proposed new desmid genus *Cruciangulum* and descriptions of three new desmid species from rock pools in the Western Cape, South Africa. Algol. Studies **93:** 55–62.

Williamson D.B. 2000. Some Desmid Floras of Wet Rock Surfaces. Algol. Studies **97:** 11–27.

Williamson D.B. 2002. Rare desmids from garden ornaments and Scottish lochs. Algol. Studies **105:** 79–86.

Received September 1, 2007
Accepted March 17, 2008