Moss diatom (Bacillariophyceae) flora of the Nature Reserve Adršpašsko-Teplické Rocks (Czech Republic)

Rozsivková flóra mechorostů NPR Adršpašsko-Teplické skály (ČR)

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Abstract

Epiphytic diatom flora on bryophytes of the genus *Sphagnum* was studied at 32 sites. Low species richness, altogether 15 diatom species, corresponds with very low pH at all sites. *Eunotia paludosa, Eunotia exigua, Pinnularia rupestris* and *P. subcapitata* were the most frequent species. *Caloneis aerophila* from the rock face is a new species for the Czech Republic. The abundance and vertical distribution of diatoms on bryophytes were influenced by the moisture of the site studied.

Introduction

The Adršpašsko-Teplické Rocks represent an exceptional locality with unique ecological conditions. So far, the research has focused on vascular plants (DOHNAL 1952, SÝKORA & HADAČ 1984), bryophytes (DOHNAL 1950, GUTZEROVÁ 1988, KURKOVÁ 1977, ZITTOVÁ-KURKOVÁ 1984), and paleobotanical analysis (CHALOUPKOVÁ 1995, NOVÁKOVÁ 2000). Algae have not been studied in this area yet.

Similarly to other previously studied acidic places in the Czech Republic, algal flora of the investigated area is strongly influenced by low pH, (LEDERER 1996, 1999, LEDERER et al. 1998, NOVÁKOVÁ 2002, POULÍČKOVÁ et al. 2001, PRÁT 1944, 1955). While extremely acidic sites (pH up to 3) are dominated usually by one or two species of flagellates (*Euglena, Chlamydomonas,* PRÁT 1955), the localities with pH higher then 4 (5) are characterised by high species richness and the prevalence of Desmidiales and Bacillariophyceae (LEDERER 1996, 1999).

This study reports on the algal flora of the Adršpašsko-Teplické Rocks, its spatial distribution and relations to selected environmental variables, especially pH and moisture.

Material and methods

The investigated area Adršpašsko-Teplické Rocks is a part of the Broumov Highland and is situated in the spring area of the River Metuje between the villages of Horní Adršpach, Dolní Adršpach, Bučnice, Teplice nad Metují, Skály, Studnice, Janovice, and Hodkovice. The sandstones are formed of flint grains with the admixture of feldspar (VÍTEK 1986). The amount of rainfall ranges from 700 to 1000 mm per year, and average annual temperatures range from 5 to 6 °C (QUITT 1971). Temperature inversion and low light intensities are characteristic features of the investigated area (GUTZEROVÁ & HERBEN 1998). Due to the oligotrophic and acidic substrate, the flora of vascular plants is very poor (SÝKORA & HADAČ 1984); on the other hand, bryophytes are very common (ZITTOVÁ-KURKOVÁ 1984). Temperature inversion allows the occurrence of hardy alpine species with higher humidity requirements.

Table 1 presents a list of localities and samples. Except for the samples 1-3 (rock face), all samples represent diatoms inhabiting wet bryophytes of the genus *Sphagnum* (predominantly epiphytic and metaphytic species).

The sampling took place in May, August and October 2000. Environmental variables (pH, conductivity, and temperature) were measured in situ using mobile instruments (WTW company). The moisture of the samples was estimated by a subjective scale (1 - dry, 2 - medium, 3 - wet) in situ. The exact water content (in g per 1g of dry bryophyte matter) was measured in the laboratory as the difference between the fresh and dry weight of the bryophyte samples.

Samples of the same volume of bryophytes were taken with a cutting tool and carried to the laboratory in polyethylene bags. Samples for the estimation of vertical distribution were obtained by cutting the layers of bryophytes 2 cm thick on the area of 20 cm^2. In addition, some samples were brushed from the rock faces.

The fresh bryophyte sample was weighed and then washed out in 100 ml of distilled water and thoroughly squeezed. The content (water with algae and mud) was transferred quantitatively into a cylinder of a small diameter (up to 20 mm). The sample was left to settle for about 20 minutes, and then decanted. The sediment was fixed with formaldehyde and stored in a 50 ml sample container. The squeezed bryophyte material was used for the dry matter assessment. The dry-mass of each bryophyte sample was obtained after oven drying at 85° C for 48 hours. The quantity of diatoms was expressed as a number of individuals per 1 g of dry bryophyte matter. The effectiveness of the washing procedure was experimentally tested by mineralising the whole bryophyte sample, and it reached ~80% (POULÍČKOVÁ et al. 2001). Diatom frustules were mounted in Pleurax and identified according to KRAMMER & LANGE-BERTALOT (1986, 1988, 1991a,b). The relative abundance (%) of individual diatom species in samples was estimated by counting 400 individuals in permanent preparations. The basic

statistical evaluation was performed according to ZAR (1996) using the EXCEL programme of MICROSOFT software. The relations of diatoms to environmental variables were evaluated according to VAN DAM et al. (1994).

Results and discussion

Floristic part

The sites under investigation are characterized by very low pH, low conductivity and low summer temperatures ranging from 9.5 to 13.5 °C (Tab.1). These extremely acidic sites are overgrown by bryophytes of the genus *Sphagnum.* The epiphytic algae were represented only by diatoms, with the exception of several specimens of the genus *Euglena* and *Mesotaenium* at the site Volská studna. Altogether, 15 diatom species were identified during the present study. *Eunotia* and *Pinnularia* were the most frequent genera in the material studied. *Caloneis aerophila,* found on a rock face at the site Sibiř, is a new species for the Czech Republic. Description, size ranges and autecological remarks of the taxa identified are given below.

***Achnanthes minutissima* KÜTZING**
The frustules are 17 - 20 μm long, and 3.5 - 4 μm wide. Although this species represents cosmopolitan diatoms with wide ecological amplitude, it was very rare at the investigated sites, with the only exception being locality 26 (pH 3.92). The occurrence of this species was previously reported from the sites where pH ranged from 4.3 to 9.2 (KRAMMER-LANGE-BERTALOT 1991b). Our finding probably represents the most acidic site of this species. Although NOVÁKOVÁ (2002) reports this species from the Pančavské rašeliniště peat bog in the Krkonoše Mts., where pH of different samples ranged from 3.4 - 5.5, its occurrence in the most acidic samples is uncertain. The occurrence at dry sites corresponds to the data published by VAN DAM et al. 1994.
***Caloneis aerophila* BOCK**
The frustules are 20-25 μm long and 4-5 μm wide with 15-16 striae in 10 μm. This species was found only at the site Sibiř on a rock face. *C. aerophila* is a new species for the Czech Republic. It is a rare, aerophilous mountain species, living on wet rocks (KRAMMER & LANGE-BERTALOT 1991 a). Its taxonomic position is uncertain. Unfortunately, its rare occurrence in samples excluded SEM investigations.
***Eunotia bilunaris* (EHRENBERG) MILLS**
The frustules are 40-63 μm long, and 3-5 μm wide. This species dominated wet sites - Chrámové stěny (proportion 43%, pH 3.36) and Vlčí rokle (proportion 68%, pH 3.72) and was present at the site Sibiř (proportion 1%, pH 3.46) with medium moisture. *E. bilunaris* is a cosmopolitan species, frequently identified from wet bryophytes at acidic mountain localities (KRAMMER &LANGE-

BERTALOT 1991 a). It is a typical species of water bodies and regularly wet places (VAN DAM et al. 1994), frequent in Bohemia (NOVÁKOVÁ 2002, PROCHÁZKA 1924, POULÍČKOVÁ 1997).

***Eunotia exigua* (BRÉBISSON ex KÜTZING) RABENHORST**

The frustules are 10-25 µm long, and 2.5-4 µm wide. It was the third most common species at the investigated area. This cosmopolitan mountain species prefers acidic, oligotrophic waters and lives on bryophytes (*Sphagnum, Fontinalis, Drepanocladus,* KRAMMER & LANGE-BERTALOT 1991a). *E. exiqua* is a common species in Bohemia (NOVÁKOVÁ 2002, PROCHÁZKA 1924).

***Eunotia paludosa* GRUNOW**

The frustules are 8-25 µm long, and 2.5-3.5 µm wide. Sometimes, it is not easy to differentiate this species from the previous one. The species was dominant at a majority of the investigated sites. This cosmopolitan species is typical for mountain peat bogs with the occurrence of *Sphagnum* sp. and for wet sandstone rocks (KRAMMER & LANGE-BERTALOT 1991a). Its tolerance to desiccation was reported by VAN DAM et al. (1994). *E. paludosa* is a common Bohemian species (PROCHÁZKA 1924) and it has been found in the Western Carpathians (POULÍČKOVÁ et al. 2003).

***Eunotia praerupta* var. *bigibba* (KÜTZING) GRUNOW**

The frustules are 19-25 µm long, and 5-8 µm wide with 12-13 striae per 10 µm. Its occurrence was rare at sites Sibiř, Sloní náměstí, Milenci and Jelení rokle at different pH (3.46 - 4.14), only in dry bryophytes. *E. praerupta* was reported from middle and high mountains of northern Europe, on wet rocks or bryophytes (KRAMMER & LANGE-BERTALOT 1991a, VAN DAM et al. 1994). *E. praerupta* was previously found in the Krkonoše Mts. (NOVÁKOVÁ 2002, PROCHÁZKA 1924). The taxonomic position and distribution of the variety *bigibba* is unclear.

***Eunotia steineckei* PETERSEN**

The frustules are 24-30 µm long, and 2.5 - 4 µm wide. This problematic species can hardly be distinguished from *E. exigua*, and transient forms are very frequent. It was dominant at the site Dvorská rokle (46%, pH 3.77). Its autecology and distribution is poorly known; nevertheless the species is known from mountains (e.g. KRAMMER & LANGE-BERTALOT 1991a). The species was found in the springs of the West Carpathians (POULÍČKOVÁ et al. 2001).

***Eunotia tenella* (GRUNOW) HUSTEDT**

Only several specimens of this species were found in Modrá rokle and Dvorská rokle. The distribution is poorly known; it was reported from acidic waters and wet places (KRAMMER & LANGE-BERTALOT 1991, VAN DAM et al. 1994). It is common in the Krkonoše Mts. (NOVÁKOVÁ 2002).

Frustulia rhomboides (EHRENBERG) DE TONI

The frustules are 40-60 µm long, and 12-28 um wide. It was dominant at several sites at places with different moisture and pH 3.46-4.14. It is a cosmopolitan species occurring in springs and littoral zone and tolerates desiccation. The species was found to be common in the Krušné hory Mts. (SPRENGER 1926),

Krkonoše Mts. (NOVÁKOVÁ 2002), and the West Carpathians (POULÍČKOVÁ et al. 2003).

Gomphonema parvulum (KÜTZING) KÜTZING

The frustules are 12-20 μm long, and 4-6.5 μm wide. Although this species is considered cosmopolitan with wide ecological amplitude (e.g. HINDÁK ed. 1978, KRAMMER & LANGE-BERTALOT 1986), it was rare, probably due to oligotrophic character of sites investigated. *G. parvulum* is more common at eutrophic sites (VAN DAM et al. 1994)

***Pinnularia borealis* EHRENBERG**

The frustules are 47-50 μm long, and 10-14 μm wide with 5-6 striae in 10 μm. The species was found only at the locality Sibiř, on the rock face and on bryophytes at dry sites. The species can be characterised as aerophytic (KRAMMER & LANGE -BERTALOT 1986). Although the pH optimum around 7 was reported by VAN DAM et al. (1994), the species was found at acidic sites (pH 3.46), similarly to its occurrence in Krkonoše Mts. (NOVÁKOVÁ 2002) and the West Carpathians (POULÍČKOVÁ et al. 2001).

***Pinnularia gibba* EHRENBERG**

The frustules are 60-65 μm long, and 8-9 μm wide with 12 striae in 10 μm. Several specimens were found in Sibiř (dry and acidic site). This cosmopolitan species with a number of ecological modifications prefers clean, slightly acidic waters (HINDÁK ed. 1978) and tolerates desiccation (VAN DAM et al. 1994).

***Pinnularia rupestris* HANTZSCH**

The frustules are 50-70 μm long and 8-11 μm wide with 12-15 striae in 10 μm. It was the second most abundant species in the investigated material. This species replaced the dominant taxa at acidic, wet places, where the proportion of *Eunotia paludosa* decreased. *P. rupestris* was previously reported from several Bohemian localities (FEDERLE 1938, SPRENGER 1926), and recently found by POULÍČKOVÁ et al. (2003) from acidic springs in the West Carpathians.

***Pinnularia subcapitata* GREGORY**

The frustules are 25-40 μm long, and 5-6 μm wide with 14 striae in 10 μm. It was the fourth most abundant species in the investigated material. This cosmopolitan species prefers acidic mountain sites (KRAMMER & LANGE - BERTALOT 1986, VAN DAM et al. 1994). Previous records are from the Krušné hory Mts. (SPRENGER 1931), the Krkonoše Mts. (NOVÁKOVÁ 2002), and the West Carpathians (POULÍČKOVÁ et al. 2003).

***Tabellaria flocculosa* (ROTH) KÜTZING**

The frustules are 25-35 μm long, and 5-8 μm wide. *T. flocculosa* has wide ecological amplitude and is typical for dystrophic waters and wet places (HINDÁK ed. 1978, NOVÁKOVÁ 2002, POULÍČKOVÁ et al. 2003). However, it also tolerates moderate pollution (VAN DAM et al. 1994).

Ecological part

The quantity of diatoms on bryophytes ranged from 6.10^5 to $5.2.10^5$ diatoms per 1 g of dry bryophyte matter. The abundance of diatoms and their species composition are influenced by the moisture of microsites (Fig. 1A). Figure 1B presents the relationship between moisture and representation of *Eunotia paludosa*. The number of algae, species diversity and evenness increases slightly with increasing moisture. Species dominance increases slightly with decreasing moisture, but all these relations and trends were not significant (Tab. 2). The same trends have been found significant in the West Carpathians (POULÍČKOVÁ et al. in press.). Fig. 2 presents the proportion of several dominant species. The most common species at the investigated sites were *Eunotia paludosa*, *E. exigua*, *Pinnularia rupestris*, and *P. subcapitata.* Dry places were dominated by *E. paludosa*, and wet places by *Pinnularia* species.

Moss diatom communities have been studied recently in Antarctic and sub–Antarctic regions (VAN DE VIJVER & BEYENS 1997, 1999; VAN DE VIJVER et al. 2001). These papers focus on floristic aspects, without any effort to quantify relationships between diatoms and moisture.

Similarly, all tested relations to pH were not significant (Fig. 1C). The pH range was narrow at sites investigated, but the results predicted that some species are able to tolerate pH around 3.5 and can attain high abundance under such conditions. Substantial pH gradient was previously identified in Western Carpathians (POULÍČKOVÁ et al. in press.), where vicariant species *E. paludosa* and *E. arcus* seem to be regulated by pH.

The relationship of algae to pH has been studied previously by several authors (FOTT 1956, LEDERER 1999, POULÍČKOVÁ et al. 2001, PRÁT 1955). This factor was found as the most important ecological variable influencing diatom distribution in the West Carpathians (POULÍČKOVÁ et al. 2001). The sites with very low pH around 4 can be characterised by low species richness and are usually dominated by species of the genus *Eunotia* and *Pinnularia. Eunotia paludosa* was found as the most tolerant species (POULÍČKOVÁ et al. 2001).

Vertical distribution of diatoms on bryophyte plants was found to be influenced by the source of moisture. The number of diatoms is the highest in the lower part of bryophyte plant at sites near a pool or a stream (Fig 3B,C). Diatoms on bryophytes growing on rocks with high air humidity as the only source of moisture concentrate in upper parts (Sibiř, Fig. 3A). Vertical distribution of diatoms has been studied previously in springs in the West Carpathians (substrate as the source of moisture). The prevalence of diatoms in the lower part of bryophytes (in the depths 8 - 16 cm) was observed (POULÍČKOVÁ et al. 2003b)

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References

DOHNAL, Z. (1950): Nástin bryologických poměrů Adršpašsko-teplických skal [Bryoflora of Adršpašsko-Teplické Rocks]. - Ms.[MSc thesis; depon. in: Dept. Bot. Charles Univ., Prague].

DOHNAL, J. (1952): Nástin vegetačních poměrů Adršpašsko-teplických skal. - Čs. Bot. Listy, 4: 137-139.

FEDERLE, E. (1938): Die Kieselalgen des Bielaflusses von der Quelle bis zur Mündung. - Lotos 86: 1-44.

FOTT, B. (1956): Les Flagelles des eaux extriment acides. - Revue Algologique 3: 24-30.

GUTZEROVÁ, N. (1988): Sukcese mechorostů na dnech skalních pískovcových měst [The bryophyte succession on the sandstone rocks]. - Ms. [MSc thesis; depon. in: Dept. Bot. Charles Univ., Prague].

GUTZEROVÁ, N. & HERBEN, T. (1998): Mikroklima a vegetace pískovcových skalních měst. – In: CÍLEK,V. & KOPECKÝ, J. (eds.): Pískovcový fenomén: klima, život a reliéf, Svazek 32, p. 25-32, Česká speleologická společnost, Nakladatelství Zlatý kůň, Praha-Broumov.

HINDÁK, F. ed. (1978): Sladkovodné riasy [Freshwater algae]. - 724 pp., SPN, Bratislava.

CHALOUPKOVÁ, K. (1995): Pylové analýzy v Adršpašsko-teplických skalách [Polen analysis in Adršpašsko-Teplické Rocks]. - Ms. [MSc thesis; depon. in: Dept. Bot. Charles Univ., Prague].

KRAMMER, K. & LANGE-BERTALOT, H. (1986): Bacillariophyceae. 1. Teil: Naviculaceae - In: ETTL H., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D. (eds): Süsswasserflora von Mitteleropa 2/1, 876 pp., G. Fischer Verlag, Stuttgart.

KRAMMER, K. & LANGE-BERTALOT, H. (1988): Bacillariophyceae. 2. Teil: Bacillariaceae, Epithemiaceae, Surierellaceae. - In: ETTL H., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D.(eds): Süsswasserflora von Mitteleropa 2/2, 596 pp., G. Fischer Verlag, Stuttgart.

KRAMMER, K. & LANGE-BERTALOT, H. (1991a): Bacillariophyceae. 3. Teil: Centrales, Fragilariaceae, Eunotiaceae. - In: ETTL H., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D.(eds): Süsswasserflora von Mitteleropa 2/3, 576 pp., G. Fischer Verlag, Stuttgart.

KRAMMER, K. & LANGE-BERTALOT, H. (1991b): Bacillariophyceae. 4. Teil: Achnanthaceae, Kristische Ergänzungen zu *Navicula (Lineolate)* und *Gomphonema*. - In: ETTL H., GERLOFF, J., HEYNIG, H. & MOLLENHAUER, D. (eds): Süsswasserflora von Mitteleropa 2/4, 437 pp., G. Fischer Verlag, Stuttgart.

KURKOVÁ, J. (1977): Společenstvo mechorostů na pískovcích v Čechách [Bryophytes on Czech sandstone rocks]. - Ms. [MSc thesis; depon. in: Dept. Bot. Charles Univ., Prague].

LEDERER, F., GARDAVSKÝ, A., LUKEŠOVÁ, A., KUBEČKOVÁ, K., ČÁPOVÁ, R., LODROVÁ, E. & TROJÁNKOVÁ, K. (1998): Biodiverzita a ekologie sinic a řas minerálních pramenů a rašelinišť na území NPR Soos a v okolí Františkových Lázní a Mariánských Lázní. [Biodiversity and ecology of algae of mineral springs and peat bogs in National

Natural Reserve Soos and in the vicinity of Františkovy Lázně and Mariánské Lázně]. - In: LEDERER, F. & CHOCHOLOUŠKOVÁ, Z. (eds.): Flóra a vegetace minerálních pramenů a rašelinišť NPR Soos, Sborník katedry biologie, p. 14-58, Západočeská Universita Plzeň.

LEDERER, F. (1996): Řasová flóra šumavských rašelinišť. - In: FOŠUMOVÁ, P., HAKR, P. & HUSÁK, Š. (eds.): Sborník mokřady ČR, Sborník abstraktů z celostátního semináře k 25. výročí Ramsarské konvence, p. 86-87, Třeboň.

LEDERER, F. (1999): Algal flora of the Červené blato peat bog (Třeboň Basin, Czech Republic). - Preslia 70**:** 303 – 311.

NOVÁKOVÁ, D. (2000): Rekonstrukce paleoekologických poměrů rašelinišť NPR Adršpašsko-teplické skály metodou analýzy makrozbytků [Paleoecological reconstruction of peat-bogs of Nature Reserve Adršpašsko-Teplické Rocks]. - Ms. [MSc thesis; depon. in: Dept. Bot. Charles Univ., Prague].

NOVÁKOVÁ, S. (2002): Algal flora of subalpine peat bog pools in the Krkonoše Mts. - Preslia, 74: 45-56.

POULÍČKOVÁ, A. (1997): Rozsivková flóra povodí Lužnice. - Preslia 68: 257-264.

POULÍČKOVÁ, A., BOGDANOVÁ, K., HEKERA, P., & HÁJKOVÁ, P. (2003): Epiphytic diatoms of the spring fens in the flysh area of the Western Carpathians. - Biologia 58 (4): 749-757.

POULÍČKOVÁ, A., DUCHOSLAV, M., HEKERA, P., HÁJKOVÁ, P. & NOVOTNÝ, R. (2001): Ecology of diatoms of sloping springs in the flysh area of the West Carpathians. - In: ECONOMOU-AMILLI, A. (ed.): Proceedings 2001, p. 225-236, Athens.

POULÍČKOVÁ, A., HÁJKOVÁ, P., KŘENKOVÁ, P. & HÁJEK, M. (in press.): Distribution of diatoms and bryophytes on the linear transects through spring fens. - Nova Hedwigia, in press.

POULÍČKOVÁ, A., NOVÁKOVÁ, J. & KRÁSOVÁ, P. (2003b): Vertical distribution of epiphytic algae on the mosses and thein relation to moisture. - Czech Phycology 3: 119-124.

PRÁT, S. (1944): Rašeliny a slatiny po stránce biologické. - Věstník Čes. fysiatrické spol. 23: 15-27.

PRÁT, S. (1955): Vegetace v silně kyselých vodách a regenerace železitých slatin. - Preslia 27: 225-233.

PROCHÁZKA, J. S. (1924): Katalog českých rozsivek. - Arch. přírodov. výzk. Čech, vol. 17, No. 2 (107): 1-114.

QUITT, E. (1971): Klimatické oblasti Československa. - 73 pp., Geografický ústav ČSAV, Brno.

SPRENGER, E. (1926): Ein Beitrag der Diatomeenflora von Böhmen I. Bacillariales aus der Umgebung von Hirschberger in Böhmen. - Lotos 74: 183-218.

SPRENGER, E. (1931): Ein Beitrag zur kenntnis der Kiesselalgen flora des Bezirkes Komotau. – Bd. 1 – Natur, HF6 (13): 57-112.

SÝKORA, T. & HADAČ, E. (1984): Příspěvek k fytogeografii Adršpašsko-teplických skal. - Preslia 56: 359-376.

VAN DAM, H., MERTENS, A. & SINKELDAM, J. (1994): A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands. - Neth. J. Aquatic Ecol., 28: 117-133.

VAN DE VIJVER, B. & BEYENS, L.(1997): The epiphytic diatom flora of mosses from Strømness Bay area, South Georgia. - Polar Biol. 17: 492-501.

VAN DE VIJVER, B. & BEYENS, L. (1999): Moss diatom communities from Ile de la Possession (Crozet, Subantarctica) and their realtionship with moisture. - Polar Biol. 22: 219-231.

VAN DE VIJVER, B., LEDEGANCK, P. & BEYENS, L. (2001): Habitat preferences in freshwater diatom communities from sub-Antarctic Îles Kerguelen. - Antarctic Science 13: 28-36.

VÍTEK, J. (1986): Geomorfologie navrhované Chráněné krajinné oblasti Broumovsko. - Ms. [Správa CHKO Broumovsko] Police nad Metují.

ZAR, J. H. (1996): Biostatistical analysis. - 662 pp., Prentice-Hall, London.

ZITTOVÁ-KURKOVÁ, J. (1984): Bryophyte communities in sandstone rocks in Bohemia. - Preslia 56: 125-152.

Table 1: Environmental variables at localities (conductivity in $\mu S.cm^{-1}$, temperature in ºC)

Locality/Sample	Coordinates	pH	Conductivity	Temperature
Sibiř/1-6	50º35´32´´N/16º07´34´´E	3.46	87	9.5
Chrámové stěny/7-9	50º35´54´´ N /16º07´32´´E	3.36	62	12.5
Černý příkop 1/10-11	50º35´35´´ N /16º07´10´´E	3.35	142	10.2
Černý příkop 2/12-13	50º35´30´´ N /16º07´06´´E	3.32	50	11.5
Vlčí rokle/14-16	50º36´16´´ N /16º07´33´´E	3.72	143	13.0
Vodopádová rokle/17	50º36´00´´ N /16º07´35´´E	3.67	120	13.5
Pod Střmenem/18-20	50º35´44´´ N /16º08´21´´E	4.70	103	12.6
Sloní náměstí 1/21	50º36´42´´ N /16º06´59´´E	4.14	91	10.7
Sloní náměstí 2/22	50º36´40´´ N /16º06´56´´E	4.03	113	9.5
Adršpach Jezírko/23	50º36´29´´ N /16º06´55´´E	3.98	90	12.4
Milenci/24	50º36´35´´ N /16º06´56´´E	3.80	47	10.0
Uhlířka-Varhany/25	50º36´45´´ N /16º06´51´´E	3.70	47	9.8
Skalní kaple/26	50º36´41´´ N /16º06´48´´E	3.92	98	10.0
Jelení rokle/27	50º36´58´´ N /16º06´03´´E	3.75	88	12.2
Modrá rokle/28	50º36´54´´ N /16º06´01´´E	3.76	69	12.5
Starozámecký vrch/29	50º36´58´´ N /16º05´50´´E	3.58	141	12.0
Dvorská rokle/30-31	50º37´04´´ N /16º05´59´´E	3.77	130	11.4
Ozvěna-Adršpach/32	50º36´55´´ N 16º06´19´´E	3.88	78	12.0

Table 2: Characteristics of the communities at dry, middle and wet places (AVG±STD)

Moisture	Dry	Middle	Wet
Diversity	1.316±0.715	1.499±0.576	1.389±0.194
Dominance	0.540±0.230	0.431±0.205	0.452±0.820
Eveness	0.572±0.250	0.679±0.204	0.744±0.129
Richness	5.294±2.824	4.700±1.735	3.800±0.748
pH relations	1.787±0.302	1.871±0.363	1.972±0.105
Moisture relations	3.378±0.294	3.163±0.421	3.180±0.166

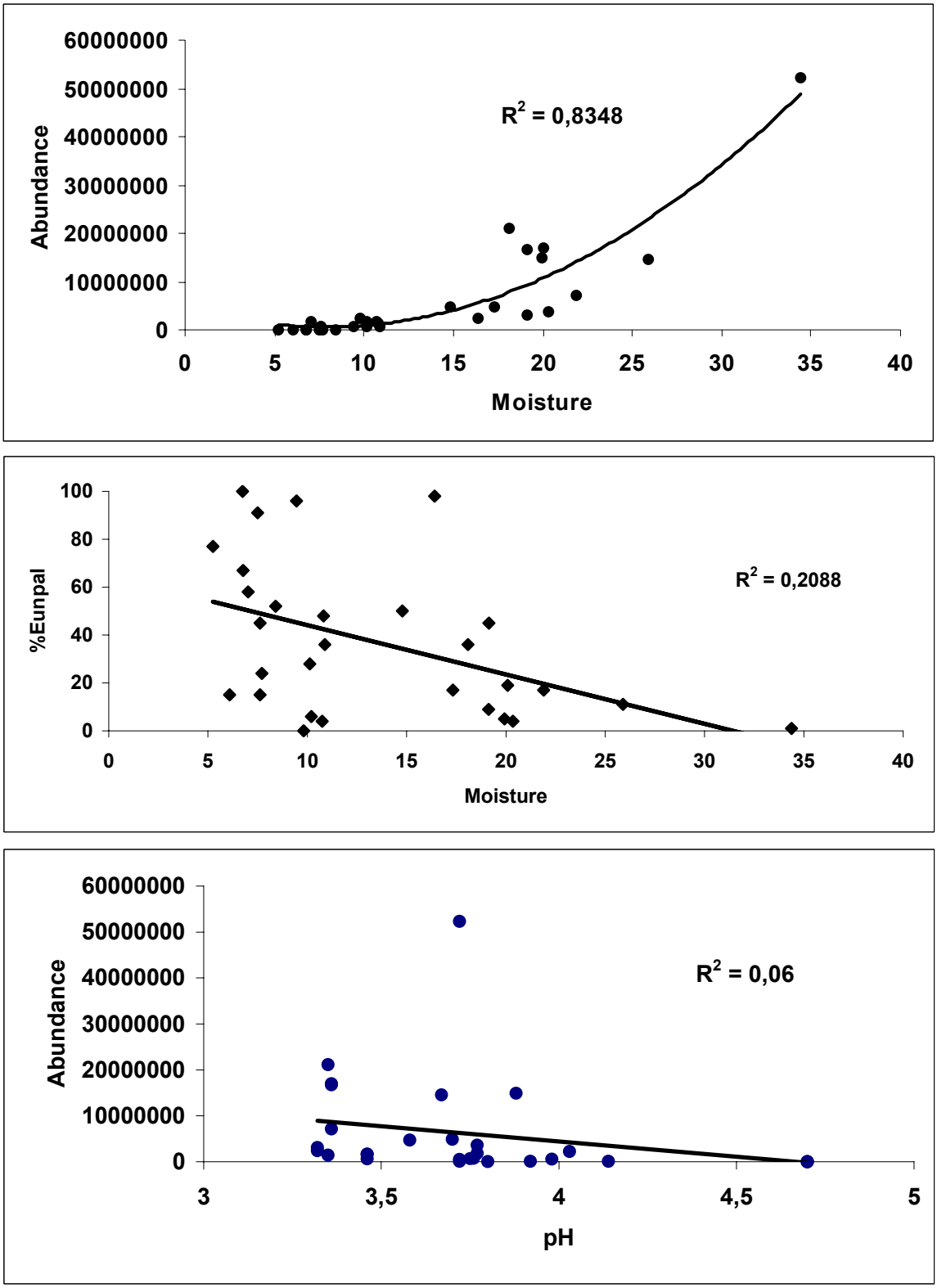
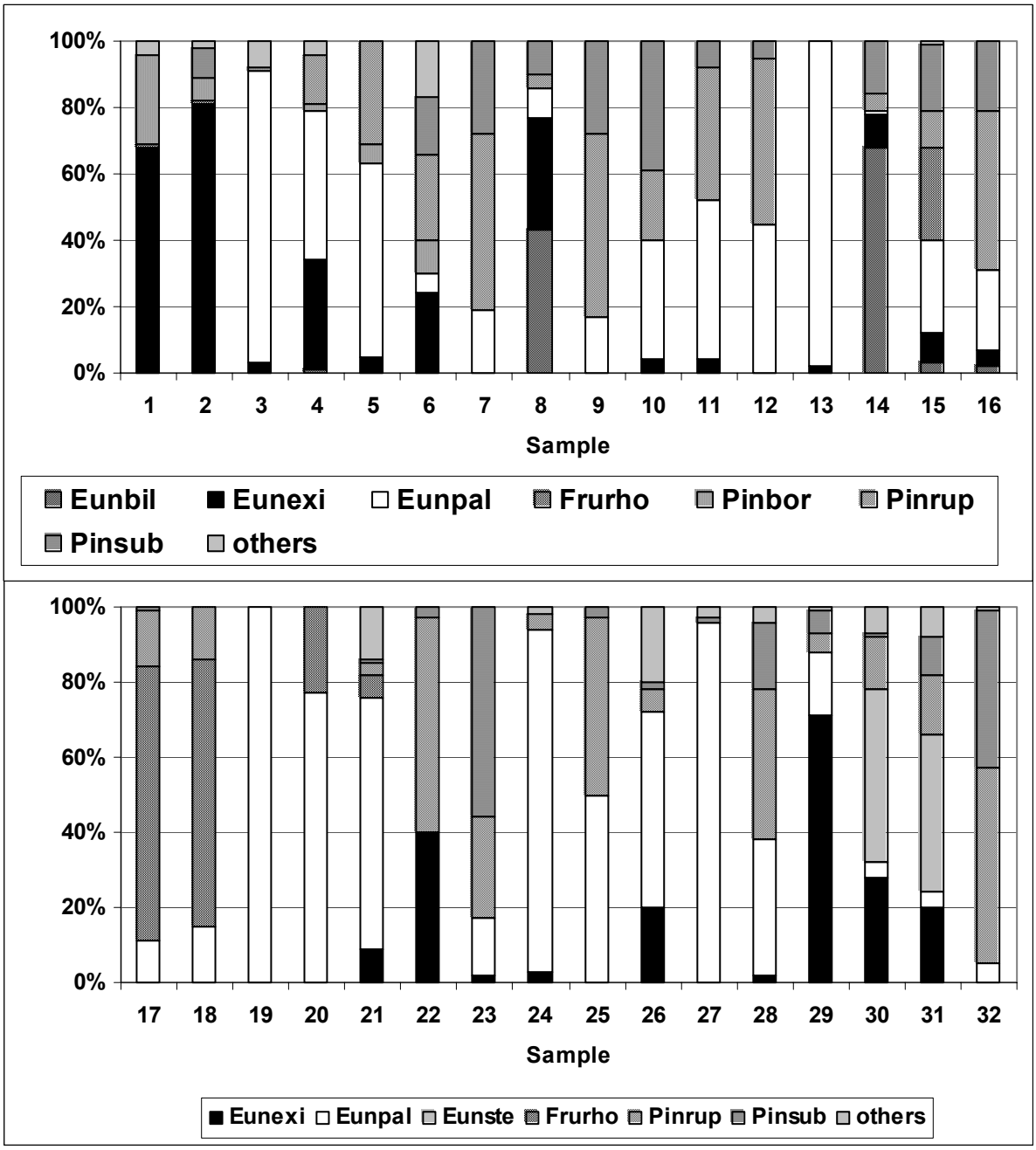


Fig. 1: A - Relationship between diatom abundance and moisture (abundance in cells per 1g of dry bryophyte matter, moisture in g of water per lg of dry bryophyte matter)

B - Relationship between proportion (in %) of *Eunotia paludosa* and moisture (g of water per 1g of dry bryophyte matter)

C - Relationship between diatom abundance and pH (abundance in cells per 1g of dry bryophyte matter)

Fig. 2: Proportion of dominant taxa in samples (samples 1-32 see tab. 1, Eunbil – *Eunotia bilunaris,* Eunexi – *E. exiqua*, Eunpal – *E. paludosa*, Eunste – *E. steineckii*, Frurho – *Frustulia rhomboides*, Pinbor – *Pinnularia borealis*, Pinrup – *P. rupestris*, Pinsub – *P. subcapitata*)



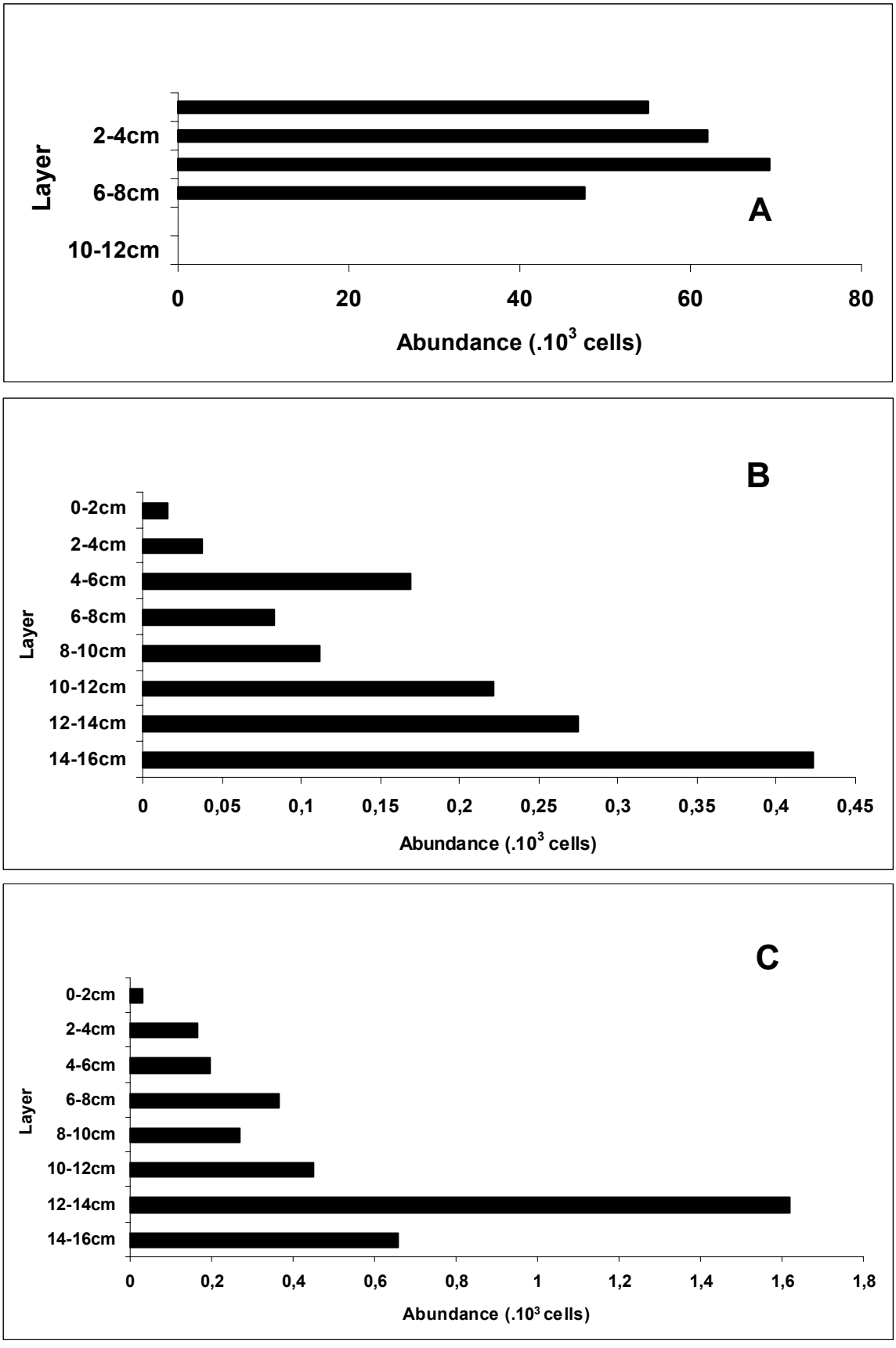


Fig. 3: Vertical distribution of live diatoms on the *Sphagnum* plant (A – locality Sibiř, B – locality Starozámecký vrch, C – locality Volská studna)