Silva Gabreta	vol. 7	p. 147–164	Vimperk, 2001

Streamborne fungal spora in running waters of the Bohemian Forest

Ludmila Marvanová

Czech Collection of Microorganisms, Faculty of Science, Masaryk University Brno, Tvrdého 14, CZ-602 00 Brno, Czech Republic
ludmila@sci.muni.cz

Abstract

Over 100 staurosporous and scolecosporous taxa were encountered in the streams of the Bohemian Forest during sampling performed within one week in 1998. The highest number of species (50–58 per stream) was found in the upper reaches of the Křemelná River, in Drozdí potok, Račí potok and Polecký potok. The lowest richness (19 species) was encountered in the Olšinka stream. The two river catchments, i.e. that of the Otava River and that of the Vltava River are not essentially different as regard the species diversity of the stream spora. They share ca. 80% of taxa. The cluster and PCA analyses reveal a tendency of grouping samples into two assemblages: in the smaller one the relatively shorter first order tributaries of the Vltava River flowing through pastures prevail, the larger one comprises some tributaries of both Vltava and Otava Rivers. The latter streams flow predominantly through forests. Thirty-two taxa are new records from the Czech Republic. Several rare species known mainly from clean soft waters were also found.

Key words: aquatic hyphomycetes, biodiversity, stream foam, statistical analysis

INTRODUCTION

This study is a preliminary overview of the species diversity of stream-borne mycota in the Šumava National Park and Protected Landscape Area (the Bohemian Forest). The area measures 1672 km^2 and is covered by mixed mountain forests (mainly *Fagus sylvatica, Picea abies, Abies alba*), pastures and mires. It is drained by many rivers and streams. The biota of lotic waters in this area have been investigated from several points of view, with faunistic studies dominating. Mycological investigations were mostly aimed at terrestrial macroscopic fungi. Few studies dealt with microscopic fungi mainly from soil (HOLEC 2000).

Though the stream spora was sampled only once and all samples were taken within a week, the identifications revealed a relatively high species diversity in some streams. Therefore I find the results worth publishing. They may serve as a baseline for future studies.

The majority of conidia transported in stream water or accumulating in stream foam are stauroform (stellate in a very broad sense; with more than one axis) or scolecoform (filiform, worm-like). They originate mainly from mycelia growing in submerged plant debris (freshwater or aquatic hyphomycetes in the strict sense), some spores are probably washed into streams from the bank plant litter and some may originate from unknown sources.

Freshwater hyphomycetes are conidial (asexual, mitotic) fungi. Teleomorphs (sexual states), known in a very small percentage of these fungi, belong mostly to ascomycetes, less often to basidiomycetes (MARVANOVÁ 1997). The mitosporic states colonize allochthonous organic matter (mainly leaves and woody debris of gymno- and angiosperms) submerged in streams. The low nutritional value of the plant debris increases through the production of proteins, fatty acids and glycogen inside the mycelium. Such plant debris is preferred mainly by the trophic group of shredders, who feed on the colonized parts. These larvae and small crustacea are then consumed by fish, and so the freshwater hyphomycetes mediate the energy flow in lotic ecosystems with very low or absent primary production. It is believed, that the origin of freshwater hyphomycetes is in small overshadowed streams flowing through broad-leaved forests (Bärlocher 1992).

Material and Methods

Sampling sites

The main sampling was performed between 17 and 22 October 1998. The geological bedrock of the Bohemian Forest is acidic: mainly granite, gneisses and migmatites, with the syenite massif in Želnavské hory (Babůrek 1996).

The lotic waters of the Bohemian Forest are mostly fast flowing streams with stony beds. Many of them originate in or flow through large mires. The upper reaches are mostly without aquatic macrophytes and the riparian vegetation is relatively monotonous, with prevailing acid-soil-tolerating species (Mánek 1998). The riparian tree vegetation on the sampling sites included mainly *Acer platanoides, Alnus incana, Betula pendula, B. pubescens, Fagus sylvatica, Fraxinus excelsior, Picea excelsa, Populus tremula, Salix* spp., *Ulmus* sp.

The sampled streams are oligotrophic, with soft water. The water quality parameters were recorded in the catchment of the upper Otava River (Růžičková & Benešová 1996, Mánek 1998, Růžičková 1998). Average water temperature in small streams varied between 7–12°C, in larger rivers between 10–14°C, pH ranged from acid to neutral (annual mean between 5.7–7.1). Conductivity was very low (20–40 $\mu S.cm^{-1}$). Phosphates, nitrates, nitrites, ammonium, and Ca^{2+} ions are present in very low concentrations. Water in some streams is brown due to humic substances. Their highest concentrations (75–134 $\mu g.l^{-1}$) were encountered in the upper reaches of Modravský potok, Filipohuťský potok, Hamerský potok, and Roklanský potok.

Analogous data are known for some streams of the upper Vltava catchment: average pH 6.3–6.9, the conductivity was somewhat higher (40–56 $\mu S.cm^{-1}$) especially in the stream Volarský potok below the village of Volary (average value 156 $\mu S.cm^{-1}$). Cations and anions were of similar low concentrations like in the catchment of the Otava River, again except of Volarský potok, where the sulphates reached an average 15 $mg.l^{-1}$ (Zelenková 2001). Brown waters with humic substances are also present in the upper Vltava catchment.

Abbreviations used in the chapter Remarks on rare species: O = the catchment of the upper Otava River, V = the catchment of the upper Vltava River.

Description of localities

Catchment of the upper Vltava River (1–06–01, cf. Vlček 1984)

The samples were collected from relatively short (<5 km), first order streams, between the Vltava headwaters and the Lipno reservoir, whose middle or lower parts are often surrounded by pastures.

Sampling sites:

No. 6. Slatinka, left tributary of Vltava near the bridge on the road between Pihlov and Dobrá Voda, flowing through a wetland. Fast flow, cascades, stony bed.

No. 7. Unnamed small rivulet between Pihlov and Maňava, left tributary of Vltava flowing through a pasture. Fast flow, loamy bed, ca. 900 m a.s.l.

No. 8. Unnamed stream east of Pernek, left tributary of Vltava near the bridge on the road from Pernek to Pihlov, with a small pool, flowing through pastures, fast flow, loamy bed, ca. 900 m a.s.l.

No. 9. Starý potok, left tributary of Vltava near the bridge on the road between Slunečná and Želnava. Fast flow, through pastures, loamy bed.

No. 10. Uhlíkovský (=Uhlířský) potok, left tributary of Vltava near Záhvozdí, below the junction of its two branches. Fast flow, sandy bed. In deforested area, ca. 850 m a.s.l.

No. 11. Unnamed stream, left tributary of Vltava, near the bridge on the road, ca. 0.5 km to the east of Pěkná, originating below the hill of Korunáček, flowing through a pasture. Fast flow, gravel bed.

No. 12. Unnamed stream, left tributary of Vltava, near the bridge on the road between the settlements of Chlum and Pěkná, ca. 700 m a.s.l, flowing through pastures.

No. 13. Volarský potok below Volary, left tributary of Vltava near the settlement of Planerův Dvůr, near the bridge on the road from Volary to Chlum, in deforested area.

No. 14. Olšinka stream, left tributary of Vltava, flowing through the nature reserve Velká Niva mire, near the bridge on the road from Lenora to Volary. Brown water, slow to medium fast flow, loamy bed.

No. 16. Račí potok, left tributary of Vltava, near the bridge on the road from Borová Lada to Horní Vltavice, near the settlement of Račí, lined by forest in the upper reaches, but flowing through a deforested area in the lower reaches.

No. 17. Polecký potok, right tributary of Vltava, near the challet Polka, ca. 850 m a.s.l, flowing through a pasture. Fast flow, brown water, loamy bed.

No. 18. Zelenohorský potok, left tributary of Vltava, near the bridge on the road in the vicinity of the site Pravětinská Lada. Brown water, fast flow, loamy bed with large single stones.

No. 19. Vltavský potok, right tributary of Vltava, near the bridge on the road from Borová Lada to Knížecí Pláně, ca. 880 m a.s.l. Brown water, medium fast flow, stony bed.

No. 44. Kvildský potok, left tributary of Vltava, near the bridge on the road from Kvilda to Horská Kvilda, ca. 1000 m a.s.l. It drains the Kvildská slať mire. Brown water, fast flow, loamy bed.

No. 46. Černý potok (=the upper reaches of the stream of Teplá Vltava), ca. 0.5 km downstream from the mouth of Kvildský potok, ca. 1000 m a.s.l. Brown water, fast flow, stony bed.

No. 47. Teplá Vltava (=the upper reaches of the Vltava River), near the bridge on the road from Kvilda to Bučina, ca. 1000 m a.s.l. Brown water, fast flow, stony bed.

Catchment of the upper Otava River (1–08–01, 1–08–02, and 1–08–03, cf. Vlček 1984)

This catchment is drained by three main rivers: The Otava River itself originates from the confluence of two streams, the southern Vydra River and the western Křemelná River. The Vydra River also originates from the confluence of two streams: Modravský potok and Roklanský potok. Several of the streams flow from the first zones (the areas closest to the natural state). The Volyňka River is a right tributary of the Otava River. It flows through the Šumava National Park only in its upper reaches and samples were collected from its two tributaries. The Blanice River is a right tributary of the Otava River and flows outside the area of the Šumava National Park and Protected Landscape Area and the sample from its tributary Zlatý potok was included for comparison with the studied streams.

Sampling sites:

No. 4. Zlatý potok, right tributary of Blanice, near the bridge on the road from Netolice to Husinec (near the village of Hracholusky) fast flow, among pastures.

No. 15. Arnoštský potok, right tributary of Volyňka, near the bridge on the road from Vimperk to Horní Vltavice, near the settlement of Solná Lhota, ca. 950 m a.s.l. Fast flowing, stones and gravel in the bed.

No. 20. Filipohuťský potok, right tributary of Modravský potok, near the confluence with it in the village of Modrava, ca. 1000 m a.s.l. In its upper reaches it drains a large mire of Tetřevská slať. Rapid flow, big stones in the bed.

No. 21. Modravský potok, right branch of Vydra, in the village of Modrava, ca. 1000 m a.s.l. About 10 m wide, in the upper reaches flowing through the Modravské slatě mire. Fast flow, gravel and stones in the bed.

No. 22. Roklanský potok, left branch of Vydra, ca. 1 km upstream of the village of Modrava, at a destroyed bridge, ca. 1000 m a.s.l. In its upper reaches it flows through a very large mire. Fast flow, stony bed ca 10 m wide.

No. 24. Hamerský potok, right tributary of Vydra, ca. 50 m upstream from the bridge at the site Antýgl, ca. 900 m a.s.l, in the upper reaches draining two large mires. Rapid flow, shallow water, gravel and stones in the bed.

No. 26. The Vydra River at Antýgl, below the bridge. Fast flow, gravel and stones in the bed.

No. 27. Hrádecký potok, left tributary of Vydra, near the bridge on the road from the village of Dolní Hrádky to Srní, flowing through a pasture, ca. 800 m a.s.l. Fast flow, gravel and small stones in the bed.

No. 28. The Otava River, ca. 30 m downstream from the bridge Pošťácký most, ca. 580 m a.s.l. Fast flow, gravel and stones on the bed, brown water.

No. 29. Rýžovištní (=Rýžovní) potok, right tributary of Otava, near the bridge on the road to Rejštejn, ca. 580 m a.s.l. Rapid flow, big stones in the bed, accumulated leaves and woody debris.

Fig. 1. – River catchments of upper Otava (1–08–01, 1–08–02, 1–08–03) and of upper Vltava (1–06–01) (from VLČEK 1984).

No. 31. Unnamed stream, right tributary of Hamerský potok, in its upper reaches draining the Zhůřecká slať mire, near the bridge on the road from Horská Kvilda to Kvilda, at the site "U Daniela", ca. 1000 m a.s.l. Fast flow, loamy bed, brown water.

No. 32. Slatinný potok, right tributary of Křemelná, near the bridge on the road from Nová Hůrka to Skelná, ca. 850 m a.s.l. Draining the Hůrecké slatě mire. Medium fast to fast flow, small stones and sandy or loamy bed.

No. 33. Drozdí potok, right tributary of Slatinný potok, below the village of Nová Hůrka, ca. 800 m a.s.l, meandring, fast flow, sandy bed with stones.

No. 34. Left branch of the Křemelná River, near the road from Zhůří to Stará Huť, ca. 10 m above the confluence with the right branch, ca. 850 m a.s.l. Fast flow, sandy and stony bed.

No. 35. Right branch of the Křemelná River, near a broken woody bridge on the turist road with blue signs, near the perished settlement of Zhůří, ca. 900 m a.s.l, stream character like the left branch.

No. 36. The Křemelná River, near the bridge on the road at the junction with Prášilský potok, ca. 830 m a.s.l. Fast flow, stony bed.

No. 40. Jezerní potok, right tributary of Křemelná, near the bridge on the road from Prášily to Slunečná, ca. 850 m a.s.l. Flows from the first zone, fast flow, gravel on the bed, accumulated leaves.

No. 41. Mlýnský potok, right tributary of Křemelná, near the bridge on the road from Prášily to Srní, near the perished settlement of Velký Bor, ca. 900 m a.s.l. Flows from the first zone. Fast flow, sandy bed, pale brown water, accumulated conifer wood.

No. 42. Unnamed stream, right tributary of Mlýnský potok, close to the road from Prášily to Srní, fast flow, cascades, big stones.

Field and laboratory technique

Foam was collected into glass jars and inoculated onto thin layers of 0.2% Malt agar (MA, Difco, supplemented with Chloramphenicol) in the field. The remaining foam was fixed with FAA solution (5% of formaldehyde, 15% of glacial acetic acid and 80% of 70% ethanol). In the laboratory, germinating conidia were located at low power of compound microscope, cut out and transferred onto 2% MA with Chloramphenicol in a Petri dish with a thin needle. Cultures were incubated at ca. 12°C. For identification, pieces of 7–14-day-old colonies were submerged into standing distilled water in Petri dishes, incubated at temperatures 12, 15 or 18°C.

Sedimented fixed foam was carefully decanted, the sediment resuspended, 3 loopfuls were put on object slides, allowed to dry, mounted into lactofuchsin and sealed with nail warnish. These slides were then scanned under compound microscope, conidia identified to species (sometimes only generic classification was possible). Roughly one half of the identifications is based on detached conidia. This approach has some limitations: it depends critically on the expertise of the researcher and on the stability of morphological characters of a particular conidium, allowing it to be linked unequivocally to a given taxon. Even small aberrancies may shift the identification towards an unrelated taxon. Therefore the ideal aquatic hyphomycete diversity studies should be based on pure cultures. This was fulfilled in 42% of taxa. Fortunately, the majority of stauroform conidia is diagnostic enough for reliable identification. Few conidia could not be identified. These are depicted on Figs. 2 and 3.

Evaluation of aquatic hyphomycete diversity of individual sites is based on the species presence/absence data from all 35 sampling sites. The data were evaluated with cluster analysis and principal component analysis (PCA). The PCA is based on eigenvalues extracted from the covariance or the correlation matrix.

Results and Discussion

The species diversity based on detached conidia seen in foam and on pure culture studies is shown in Table 1. The localities are arranged into two sets: the first one (16 streams) belonging to the catchment of the upper Vltava River, and the second one (19 streams) belonging to the catchment of the upper Otava River. The number of identified taxa (at least at generic level) was 107; from this the upper Vltava catchment shared 93 taxa, the upper Otava catchment 103 taxa. The Sörensen's index of similarity was 80%. This implies a well balanced species distribution over both catchments.

In the catchment of the upper Vltava River, a high species diversity was encountered in Račí potok and in Polecký potok (58 and 52 taxa, respectively). In the catchment of the upper Otava River the richest streams were Drozdí potok (53 taxa) and the two branches of the Křemelná River (57 and 50 taxa). The lowest numbers of taxa (19) in the catchment of the upper Vltava River appeared in the stream Olšinka. In the catchment of the upper Otava Riv-

Table 1. – Survey of taxa encountered in the streams of the Bohemian Forest.

	The catchment of upper Vltava																The catchment of upper Otava																				
Sampling site/taxon	6	7	8	9	10	11	12	13	14	16	17	18	19	44	46	47	4	15	20	21	22	24	26	27	28	29	31	32	33	34	35	36	40	41	42	Vltava %	Otava %
Anguillospora rosea	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	87.5	100.0
Flagellospora curvula	+	+	+	c	+	+	+	+	+	+	+	+	+	.	+	+	+	+	+	.	+	+	+	+	+	+	+	c	+	+	+	+	+	+	+	93.8	94.7
Heliscus lugdunensis	+	+	c	+	+	+	+	+	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	87.5	100.0
Tricladium splendens	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+	100.0	89.5
Tetracladium setigerum	+	+	+	+	+	+	+	+	.	+	+	+	+	.	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	87.5	94.7
Articulospora tetracladia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	.	+	+	+	+	+	c	+	+	+	+	+	+	.	+	.	+	+	+	93.8	84.2
Alatospora pulchella	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	.	+	+	.	+	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	87.5	84.2
Clavatospora longibrachiata	+	+	+	.	+	+	.	.	.	+	+	+	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	75.0	94.7
Lemonniera aquatica	+	+	.	+	+	c	.	+	+	c	+	+	+	.	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	81.3	89.5
Lemonniera terrestris	c	+	+	+	+	+	+	+	.	c	+	+	+	+	.	.	+	+	.	+	.	+	+	+	+	+	+	+	+	+	c	+	+	+	+	81.3	89.5
Anguillospora crassa	+	.	+	.	+	+	+	.	.	+	c	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	75.0	89.5
*Taeniospora gracilis v. enecta**	+	.	+	.	+	+	.	.	+	c	+	+	+	+	+	+	+	+	+	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	75.0	89.5
Ypsilina graminea	+	.	+	+	+	.	+	c	.	+	+	+	+	.	c	+	+	+	+	+	+	+	c	c	+	+	+	+	+	+	+	+	.	+	.	75.0	89.5
Varicosporium delicatum	.	.	.	+	.	+	+	c	+	+	c	c	+	c	c	+	.	.	c	+	+	+	+	+	+	.	+	c	+	c	+	+	.	+	.	75.0	73.7
Varicosporium tricladiiforme	+	+	+	c	+	+	+	c	+	c	+	+	+	+	+	+	+	.	.	+	+	.	+	+	.	.	.	+	+	+	+	+	.	+	.	100.0	57.9
Clavariopsis aquatica	+	+	+	.	+	+	.	+	+	+	+	+	+	.	.	+	+	+	+	.	.	.	.	+	+	+	.	+	+	+	+	+	.	.	+	75.0	63.2
Tumularia aquatica	+	+	+	+	+	+	+	+	.	+	+	+	+	.	.	+	+	+	.	.	.	+	.	+	+	+	.	+	+	+	+	+	.	.	.	81.3	57.9
Alatospora acuminata s. stricto	.	.	.	.	.	.	.	.	+	+	.	+	+	+	+	.	.	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	37.5	89.5
Heliscella stellata	+	.	+	+	+	+	+	.	+	+	+	+	.	.	.	.	+	+	+	.	.	+	+	.	+	+	+	.	+	+	+	+	+	.	.	62.5	68.4
Dendrospora cf. *fusca*	.	.	.	.	.	.	.	.	.	c	c	+	+	+	+	+	.	.	c	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	.	44.7	78.9
*Geniculospora inflata**	+	.	c	+	+	+	+	+	+	c	+	+	.	.	+	.	+	+	.	.	.	.	.	+	+	+	+	+	.	+	c	.	.	.	+	75.0	52.6
Goniopila monticola	+	.	+	.	+	c	+	+	+	+	+	+	+	.	.	.	+	+	.	.	.	.	+	.	+	c	+	+	+	+	+	+	.	.	.	68.8	57.9
Margaritispora aquatica	+	+	+	.	+	.	.	+	.	+	+	+	.	.	+	+	+	+	.	.	.	+	.	+	.	.	+	+	+	+	+	+	+	.	+	62.5	63.2
Tricladium patulum	.	.	.	.	+	c	.	+	+	+	+	+	.	.	+	+	.	.	+	.	.	+	+	+	+	+	+	.	+	+	c	+	+	+	.	56.3	68.4
Alatospora acuminata s .lato	+	+	+	+	+	+	+	+	.	+	+	.	+	.	+	+	+	.	+	.	.	.	.	+	.	+	.	.	c	+	.	+	.	+	.	81.3	42.1
Tetracladium furcatum	.	.	.	.	+	.	.	+	+	+	+	+	+	.	+	.	.	+	+	.	.	+	+	+	+	+	+	.	+	+	+	+	.	+	.	50.0	68.4
Varicosporium elodeae	+	+	+	.	+	.	.	c	+	+	+	+	+	c	+	+	.	+	+	+	+	+	c	+	+	+	+	+	+	+	+	+	+	+	+	81.3	94.7
*Dendrospora tenella**	.	.	.	.	.	+	.	.	.	+	+	+	+	.	c	+	.	.	+	.	.	+	+	+	+	.	+	+	c	+	+	+	.	+	+	43.8	68.4

Table 1. – continued

	The catchment of upper Vltava																The catchment of upper Otava																				
Sampling site/taxon	6	7	8	9	10	11	12	13	14	16	17	18	19	44	46	47	4	15	20	21	22	24	26	27	28	29	31	32	33	34	35	36	40	41	42	Vltava	Otava
																																				%	%
*Fontanospora eccentrica**	.	.	.	.	.	.	.	.	.	.	+	c	.	+	.	+	.	.	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	25.0	84.2
*Taeniospora descalsii**	.	.	.	.	.	.	.	.	.	.	+	c	+	c	+	+	.	.	c	.	c	+	+	+	+	.	+	+	+	+	c	+	.	+	+	37.5	73.7
Tricladium curvisporum	+	.	+	.	+	+	.	+	.	+	c	+	+	.	.	+	.	.	.	.	.	.	+	+	.	.	+	+	+	c	c	+	.	.	.	62.5	42.1
*Tricladium caudatum**	+	.	.	.	.	.	.	.	.	c	c	+	.	.	.	.	.	.	+	+	.	+	+	+	+	+	.	+	+	+	+	+	.	c	.	25.0	68.4
Gyoerffyella gemellipara	+	.	.	.	+	+	+	.	.	c	c	.	.	.	.	.	+	+	.	+	.	.	c	+	+	+	.	.	+	c	+	+	.	.	.	37.5	57.9
Tricellula aquatica	.	.	+	+	+	c	+	.	+	+	+	.	+	.	+	.	.	+	.	+	.	+	.	.	.	.	.	+	.	+	+	.	.	.	.	62.5	31.6
Anguillospora longissima	+	+	.	.	.	.	.	.	.	+	+	+	.	.	.	+	+	+	+	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	37.5	36.8
Pleuropedium multiseptatum	.	.	.	.	.	.	.	.	.	.	+	.	.	+	c	+	.	.	c	+	+	+	+	.	.	.	+	.	+	.	.	.	.	+	.	25.0	42.1
Anguillospora sp.	.	.	.	+	.	.	.	.	.	c	.	.	.	.	.	.	+	.	.	.	.	.	+	+	+	+	+	+	+	.	.	+	.	.	.	12.5	47.4
Enantioptera sp.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	+	.	.	.	.	+	+	+	+	.	.	.	.	+	c	.	.	.	.	.	31.3	31.6
*Lemonniera filiformis**	.	.	.	.	.	+	.	c	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	.	.	.	+	.	+	+	+	.	.	+	+	25.0	36.8
*Pseudoanguillospora stricta**	.	.	.	.	+	.	.	c	.	+	+	+	.	c	c	.	.	.	c	+	c	.	.	c	.	.	.	.	.	.	.	.	.	.	.	43.8	21.1
Tricladium sp. 2	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	+	+	c	+	+	.	+	.	12.5	47.4
Heliscina campanulata	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	+	+	+	.	.	.	+	18.8	36.8
Dendrosporium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	+	.	+	.	.	+	+	+	.	.	.	+	.	6.3	42.1
Tetracladium maxilliforme	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	.	25.0	26.3
Tricellula aurantiaca	+	.	+	.	.	.	.	+	.	+	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	31.3	21.1
Tricellula sp. *1*	.	.	+	+	.	.	+	+	.	+	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	43.8	10.5
Tricladium fallax	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	+	.	+	+	+	.	.	.	.	+	.	.	+	.	.	12.5	36.8
*Anguillospora furtiva**	.	.	.	+	+	+	.	.	.	c	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	31.3	15.8
*Articulospora atra**	.	.	+	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	25.0	21.1
*Cladoconidium articulatum**	.	.	.	.	.	+	.	.	.	c	+	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	c	.	.	.	.	25.0	21.1
Culicidospora gravida	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+	.	.	.	12.5	31.6
*Fontanospora fusiramosa**	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	+	+	.	+	.	+	.	+	.	.	.	.	.	.	6.3	36.8
*Isthmotricladia britannica**	+	.	.	+	.	.	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	37.5	10.5
Taeniospora gracilis v.*gracilis*	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	+	.	+	.	+	12.5	31.6
Dendrospora erecta	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	.	.	+	12.5	26.3
Mycocentrospora acerina	.	+	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	+	.	.	.	.	.	c	.	.	.	.	+	.	.	.	.	.	.	25.0	15.8
Tetrachaetum elegans	.	.	+	+	+	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	31.3	10.5

Table 1. – continued

	The catchment of upper Vltava																The catchment of upper Otava																				
Sampling site/taxon	6	7	8	9	10	11	12	13	14	16	17	18	19	44	46	47	4	15	20	21	22	24	26	27	28	29	31	32	33	34	35	36	40	41	42	Vltava	Otava
																																				%	%
Articulospora sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	c	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	.	18.8	36.8
*Enantioptera tetraalata**	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	c	.	+	+	.	.	.	.	12.5	21.1
*Lemonniera centrosphaera**	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	18.8	15.8
*Tricladium attenuatum**	.	.	.	.	.	c	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	c	.	.	.	.	.	.	.	+	.	.	+	.	18.8	15.8
*Varicosporium trimosum**	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	.	+	.	c	.	.	.	.	6.3	26.3
Camposporium sp.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	12.5	15.8
*Culicidospora aquatica**	.	.	+	.	.	.	.	.	.	c	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	18.8	10.5
*Flagellospora fusarioides**	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	c	+	+	.	.	.	.	.	6.3	21.1
Naiadella fluitans	.	.	.	+	.	.	.	.	.	c	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	18.8	10.5
*Tetracladium breve**	+	.	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25.0	5.3
Triscelophorus sp.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	12.5	15.8
*Arcispora bisagittaria**	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	12.5	10.5
*Lambdasporium viridense**	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	6.3	15.8
cf. *Rhynchosporium* sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	6.3	15.8
Pleuropedium tricladioides	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	6.3	15.8
Sigmoidea praelonga	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	18.8	5.3
Tetracladium marchalianum	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	12.5	10.5
*Tricladium procerum**	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	c	.	.	.	.	.	.	.	.	.	.	.	.	6.3	15.8
Tricladium sp. 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	0.0	21.1
Alatospora flagellata	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	12.5	5.3
Filosporella sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	6.3	10.5
Fontanospora cf. *alternibrach.*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	6.3	10.5
Lemonniera cf. *alabamensis*	.	.	.	.	+	+	.	c	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18.8	0.0
*Tetracladium palmatum**	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	12.5	5.3
*Tricladium biappendiculatum**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	0.0	15.8
*Dendrospora nana**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	c	.	.	.	.	.	.	.	.	.	.	.	.	0.0	10.5
Dwayaangam cornuta	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	5.3
Gyoerffyella cf. *myrmecophag.*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	5.3
Lateriramulosa uniinflata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	6.3	5.3

Table 1. – continued

	The catchment of upper Vltava																	The catchment of upper Otava																				
Sampling site/taxon	6	7	8	9	10	11	12	13	14	16	17	18	19	44	46	47		4	15	20	21	22	24	26	27	28	29	31	32	33	34	35	36	40	41	42	Vltava	Otava
																																					%	%
*Lemonniera cornuta**	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12.5	0.0
Unknown 1 (Fig. 2 E)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	0.0	10.5
Unknown 2 (Fig. 3 C)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0.0	10.5
Pleuropedium sp. 1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	6.3	5.3
Tricellula sp. 2	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	5.3
*Tricladium minutum**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	0.0	10.5
Tripospermum myrti	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.		.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	6.3	5.3
Variocladium giganteum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.		.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	5.3
Alatospora sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	0.0
Arbusculina fragmentans	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	0.0
Arbusculina sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0	5.3
Dendrospora cf. *torulosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0.0	5.3
Curucispora sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0	5.3
Heliscella sp.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6.3	0.0
Isthmolongispora lanceata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	0.0	5.3
*Mycofalcella calcarata**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	0.0	5.3
Pleuropedium sp. 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0.0	5.3
*Sympodiocladium frondosum**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	0.0	5.3
Tricladium castaneicola	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0	5.3
Tricladium chaetocladium	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.6.3	0.0
*Tricladium robustum**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	0.0	5.3
Trinacrium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0	5.3
Total	35	21	30	23	34	36	22	28	19	58	52	43	33	23	35	29		33	29	32	28	28	37	41	38	42	37	40	38	53	57	50	40	24	33	23		

Explanations: + = present in the foam sample, . = absent, * = first published record in the Czech Republic, c= isolated into pure culture. The two columns on the right give the percentage of streams of each river catchment, where the species was recorded. For the Vltava catchment n = 16, for Otava catchment n = 19.

er the lowest numbers of taxa were higher than in the upper Vltava catchment: 23 taxa were found in the right tributary of Mlýnský potok. The average number of species per stream in the upper Otava catchment was 37, whereas in the upper Vltava catchment it was 32.5. Thirty-two species are reported for the first time from the Czech Republic.

The number of taxa which were found in 73 to 100% of streams in the study area was unusually high (20 taxa in the upper Vltava catchment and 18 taxa in the upper Otava catchment). Such pattern is not usual and was found, e.g. by BÄRLOCHER (1987), who recorded 22 species which occurred in 80–100% of 10 softwater streams with acid pH in two neighbour Maritime Provinces in Canada. DESCALS & al. (1995b) found 17 species in 75% of 23 softwater acidic streams in two mountain ranges in Central Spain. A possible explanation may be that clean softwater streams host similar aquatic hyphomycete communities, but more data are needed to support this statement. In a hardwater stream system, only two to four species (according to the year of sampling) of comparable frequency of occurrence were found (MARVANOVÁ 1984a).

These frequent taxa mostly included common ubiquitous species with broad ecological tolerance (*Alatospora acuminata, Anguillospora crassa, Articulospora tetracladia, Clavariopsis aquatica, Clavatospora longibrachiata, Flagellospora curvula, Heliscus lugdunensis, Lemonniera aquatica, L. terrestris, Tetracladium setigerum, Tricladium splendens, Tumularia aquatica, Varicosporium elodeae*). Unusual is the high frequency of species like *Alatospora pulchella, Anguillospora rosea, Varicosporium delicatum, V. tricladiiforme, Ypsilina graminea*, and the basidiomycetous anamorph *Taeniospora gracilis* var. *enecta*. Some of these fungi are also among the most frequently found species in the softwater streams in Canada (BÄRLOCHER 1987) and Central Spain (DESCALS & al. 1995b).

Eight of the frequent species are holomorphic, i.e. they have a known teleomorph. This seems to support the hypothesis by DESCALS (1998), that the holomorphic fungi are more successful in spreading over an area. In this context is worth noting the frequent occurrence of basidiomycete anamorphs *Taeniospora gracilis* var. *enecta* (in 80% of samples) and that of *T. descalsii* in 57% of samples. In the Bohemian Forest in 1998, it coincided with abundant occurrence of corticiaceous fungi on land at the same time (Z. POUZAR – pers. comm.). However, absence of teleomorphs in other frequent taxa may only reflect our current lack of knowledge about the complete life cycles of these widespread species.

Rare species were also recorded: *Arcispora bisagittaria, Cladoconidium articulatum, Enantioptera tetraalata, Mycofalcella calcarata, Tricladium caudatum, T. fallax, T. procerum, T. robustum, Varicosporium trimosum*, and *Variocladium giganteum*. Some of them are commented below.

There was also a very low frequency of *Tetracladium marchalianum*, whose conidia were seen sporadically in four samples only. Generally, it is one of the most common and widespread species, but some authors consider it to prefer hardwater streams (ROSSET & BÄRLOCHER 1985, DESCALS & al. 1995a). CHAUVET (1991) characterized it as typical in one study of lowland streams.

The streams of the Bohemian Forest yielded four new taxa on the species or variety level from the genera *Articulospora* (Fig. 3A,D), *Enantioptera* (Fig. 2J), *Tricellula* (Fig. 3E), and *Tricladium* (Fig. 2H,I), which will be described elsewhere. A few isolates, whose taxonomic status has still to be studied, were obtained.

Some of the conidia in the foam samples could be neither identified nor isolated. They may not belong to hyphomycetes. On Figs. 2 and 3 some of them are illustrated. Unidentified sigmoid conidia (ca. 5% of all encountered taxa) were not included in the analysis.

The cluster analysis (Fig. 4) showed a tendency of sites to form two major groups sharing only 30% taxa. They do not clearly coincide with the two catchment areas: the smaller clus-

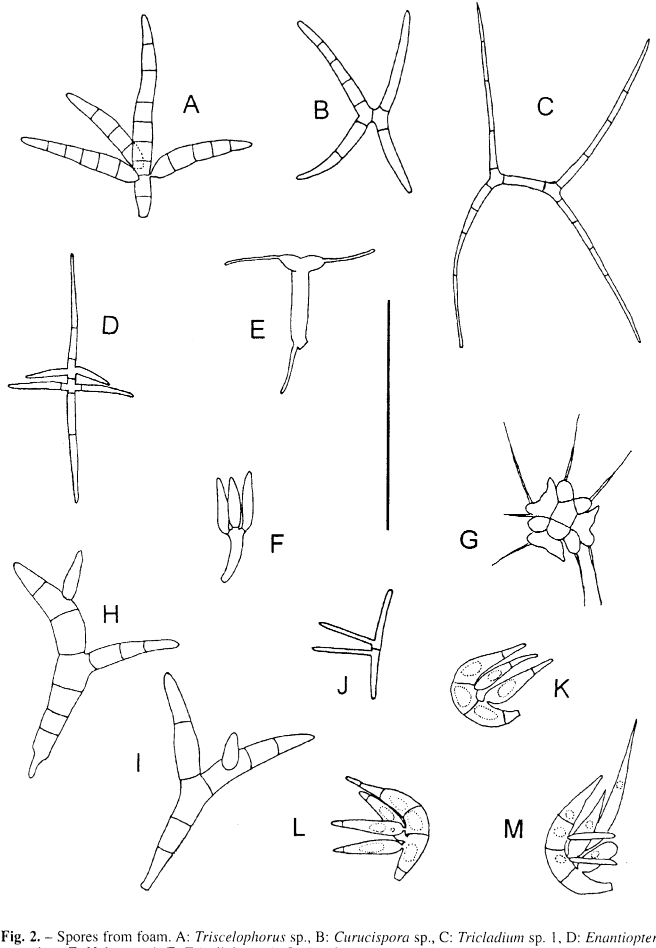

Fig. 2. – Spores from foam. A: *Triscelophorus* sp., B: *Curucispora* sp., C: *Tricladium* sp. 1, D: *Enantioptera tetraalata*, E: Unknown 1, F: *Tricellula* sp. 1, G: *Dendrosporium* sp., H, I: *Tricladium* sp. 2, J: *Enantioptera* sp., K–M: *Gyoerffyella* cf. *myrmecophagiformis*. Scale bar = 50 µm.

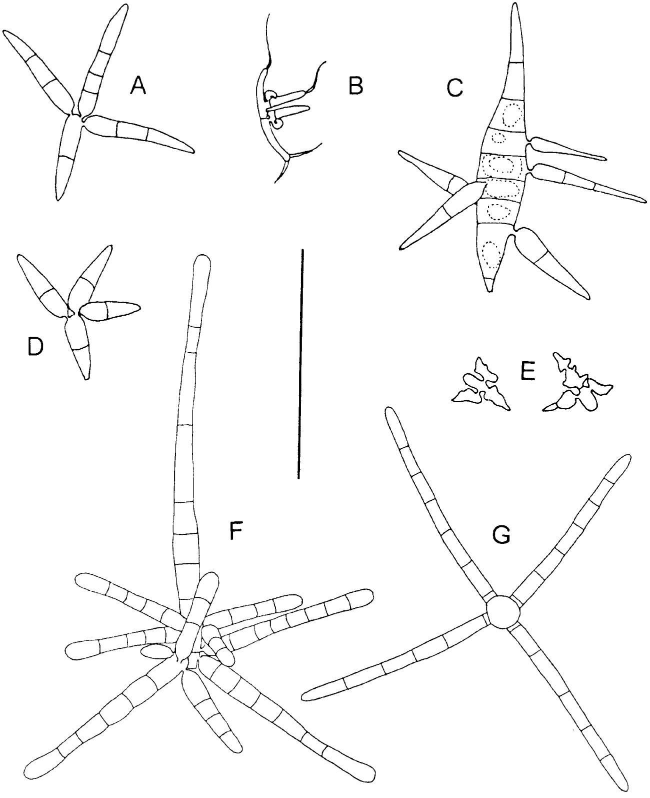

Fig. 3. – Spores from foam. A, D: *Articulospora* sp., B: *Arcispora bisagittaria,* C: Unknown 2, E: *Tricellula* sp. 2, F: *Dendrospora* cf. *fusca*, G: *Lemonniera* cf. *alabamensis*. Scale bar for F = 100 µm, for the rest = 50 µm.

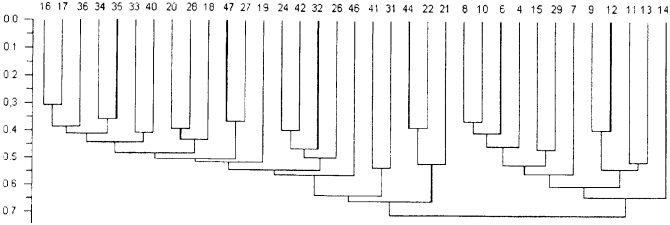

Fig. 4. – Cluster analysis of presence/absence data of taxa recorded in the 35 sampling sites (streams) is based on Euclidean distance. For the construction of dendrogram, a simple distance coefficient (1 – c/A, where c = number of taxa common to both sites, A = number of taxa present in at least one site) was calculated for each couple of sites. The UPGMA strategy was applied for clustering data.

ter comprises 9 sites (streams) from the upper Vltava catchment plus 3 streams from the upper Otava catchment. From the latter, one sample site lies outside the Bohemian Forest, one is at its border and the third is among the other streams in the middle of the study area. Most of the Vltava tributaries are less than 5 km long first order streams. In the middle or lower reaches they flow through deforested areas or pastures, some of which are subject to cattle husbandry. The number of species was 19 to 37.

The second, larger cluster contains predominantly streams from the catchment of the upper Otava River (16), the rest (7) belong to the catchment of the upper Vltava River. At a similarity level 68%, a cluster of streams with the highest species diversity (50–58 taxa per sample) stands out: Račí potok and Polecký potok from the upper Vltava catchment and two branches of the upper Křemelná River and Drozdí potok, all three from the upper Otava catchment. The Křemelná River with 40 species found below the confluence of its two sources joins these streams at the ca. 62% similarity level. It is difficult to find distinguishing factor among the parameters available to me. The stream segments between the springs and the sampling sites were mostly not longer than these of the lower diversity streams in the upper Vltava catchment.

The remaining streams in this cluster belong mainly to the catchment of the upper Otava River, with no unifying pattern as regard the above stream characteristics.

The result of PCA based on covariance matrix is shown in Fig. 5. The first three axes account only for 14.1, 13.4 and 5.7 of the total variance. This procedure gave similar results like the dendrogram (Fig. 4), also showing two more or less separated groups of streams. In the smaller subgroup the species-poorest stream of Olšinka stands aside as well as Rýžovištní potok, with the highest number of species within this group. The subgroup of species-rich streams is here less clearly separated from the other streams and the streams show lower similarities among each other. The great similarity among the two branches of Křemelná and the Křemelná River below their confluence is confirmed. At this stage of our knowledge about the aquatic hyphomycete communities in the Bohemian Forest, it is difficult to identify factors which lead to grouping of streams in this particular manner. More intensive sampling may reduce the apparent sporadicity in the occurrence of some rare species. In other words, a study based on a single sampling performed in one season of expected maximum diversity, which is in autumn in temperate climate, "may give a reasonable estimate of how many species can coexist in the short run" (Raviraja & al. 1998).

In the variant based on correlation matrix (i.e. on standardized entry data, not shown), the separation of the two clusters appeared less distinct. This seems to indicate that species richness could play a certain role in the cluster separation.

In spite of the ambiguous separation of both river catchments, some species show a more or less distinct preference for one of them. This is especially evident in the case of eight streams (No. 6–14) from the upper Vltava catchment. These are all situated between the village of Volary and the Lipno reservoir. The following taxa are absent or present only in one or two of these streams, but occur in 31–89% of the upper Otava streams: *Alatospora acuminata* s. stricto, *Dendrospora tenella, Fontanospora eccentrica, Taeniospora descalsii, Tricladium caudatum, Dendrospora* cf. *fusca, Pleuropedium multiseptatum, Anguillospora* sp., *Enantioptera* sp. The opposite occurs as well but rarely: presence in 42 or 62% of streams of the upper Vltava catchment, coinciding with the occurrence in half percentage of streams in the upper Otava catchment. Two cases are extant: *Tricellula aquatica* and *Pseudoanguillospora stricta.* Among the less frequent species such a tendency appears in the case of *Tetrachaetum elegans,* known to tolerate light pollution and moderate eutrophication (cf. CONWAY 1970 and CHAMIER & DIXON 1982, respectively).

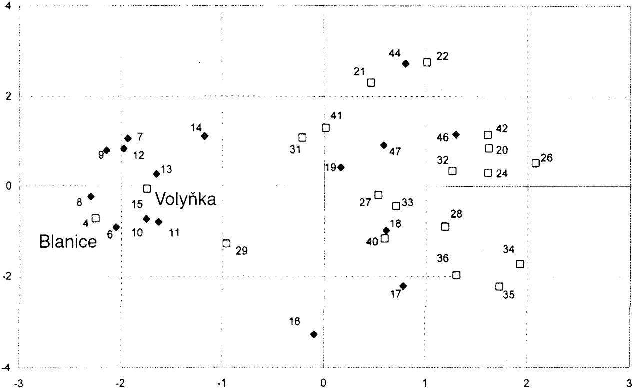

Fig. 5. – PCA based on correlation matrix. Ordination of the 35 sample sites (streams) in the plane of the 1st and 2nd axes of the PCA. □ = streams in the catchment of upper Otava including one tributary of the Blanice River and one of the Volyňka River; ◆ = streams in the catchment of upper Vltava.

REMARKS ON RARE SPECIES

Arcispora bisagittaria Marvanová et Bärloch. was described from the Cape Breton National Park in Canada (MARVANOVÁ & BÄRLOCHER 1998), where its conidia were collected in foam in several rivers hydrologically comparable to the Otava or Vydra Rivers. The Bohemian Forest is the second published area of occurrence. Repeated attempts to isolate this fungus in waters of the Bohemian Forest were unsuccessful, but the conidia are so characteristic (Fig. 3B) that identification is reliable without cultivation. Conidia were seen in the streams Račí potok and Zelenohorský potok (V), as well as in Rýžovištní potok and the left branch of the Křemelná River (O).

Enantioptera tetraalata Descals (Fig. 2D) is a very rare species, originally described from a Scottish mountain stream flowing through peaty area (DESCALS & WEBSTER 1983). Conidia were repeatedly collected in stream foam in Spain: in 2 streams in two neighbour mountain ranges of granite (Gredos and Béjar) in Central Spain (DESCALS & al. 1995a) and in a small stream in the valley Karrantza, Biscay, flowing through a meadow on peat soil, ca. 900 m a.s.l. (DESCALS 1998). In the Bohemian Forest conidia of *E. tetraalata* were recorded once in the upper Vltava catchment (Kvildský potok) and four times in the upper Otava catchment (Roklanský potok, Slatinný potok and both left and right branches of Křemelná).

Dendrospora cf. *fusca* (Fig. 3F). This species is somewhat intermediate between *D. fusca* Descals & J. Webster and *D. fastuosa* Descals & J. Webster. The conidia resemble *D. fusca*: they have mostly 2–3 verticils of primary branches and a small percentage has 1–2 secondary branches *in vitro*, rarely also *in vivo*, as was seen in foam samples in the Bohemian Forest. They mostly lack the yellow protoplasm, but in the Bohemian Forest some yellowish conidia appeared. Conidia typical for *D. fastuosa*, with a single basal verticil of primary branches seen *in vivo*, after isolation into pure culture also yielded *Dendrospora* cf. *fusca*. The dimensions of conidial elements overlap (DESCALS & WEBSTER 1980). Such intermediate species was isolated also in Austria (MARVANOVÁ & GULIS 2000) and in the Czech Republic (MARVANOVÁ – unpubl.). Identity of this taxon with *D. fusca* (whose description should then be emended) cannot be excluded at this point.

Mycofalcella calcarata Marvanová et al. was described from England (MARVANOVÁ & al. 1993), where it was collected on moist rotting twigs and isolated from decorticated oak twigs submerged in a river for six months and then incubated in a moist chamber. A single conidium seen in the Křemelná River (O) is the first record of this species in the Czech Republic.

Tricladium caudatum Kuzuha was for long time known only from the type locality in Japan (KUZUHA 1973). The first reports from Europe are probably those from Switzerland and France (WOOD-EGGENSCHWILER & BÄRLOCHER 1983). Later, conidia of this species were recorded in Austria (MESSNER & STÜWE 1986, REGELSBERGER & al. 1987, VOGLMAYR 1996, MARVANOVÁ & GULIS 2000), in Spain (DESCALS 1987, DESCALS & al 1995b), and in the French Pyrenees (DESCALS & CHAUVET 1992). Most of the collections are from soft waters. The fungus was isolated into pure culture also in Canada (MARVANOVÁ & BÄRLOCHER 2001). The Czech isolates match those from Canada.

Tricladium fallax Marvanová was described from the High Tatra Mountains (Slovakia), from foam in a small rivulet on siliceous bedrock (MARVANOVÁ 1984b). Later it was found also in the Czech Republic (MARVANOVÁ – unpubl.). Its conidia when small are probably not easily distinguished from those of *Tricladium biappendiculatum* (G.R.W. Arnold) Marvanová et Descals. A recent record is from a softwater mountain stream in Central Spain (DESCALS & al. 1995a).

Tricladium procerum Marvanová was described from the former Czechoslovakia, from a locality which now is in Slovakia. There it was isolated from conidia produced on submerged aerated pieces of *Juncus* sp. stems, collected in a drainage canal flowing through a moor (MARVANOVÁ 1988). The isolates from the Bohemian Forest are the first ones from the Czech Republic. Conidia were found in Kvildský potok (V), Modravský potok (O), Roklanský potok (O), and the Vydra River (O).

Varicosporium trimosum Wolfe is probably a species occurring in clean soft oligotrophic waters. It was described from Virginia (U.S.A.). The chemistry of the stream water wherefrom the ex-type culture originated is not given (WOLFE 1977). The Canadian collections and isolates (MARVANOVÁ & BÄRLOCHER 2001) are from softwater streams. The scarcity of records may be due to the similarity of conidia of *V. trimosum* to part conidia of *Varicosporium elodeae* Kegel which occur in similar kind of waters; they are well known and, therefore, this name may be preferably applied in studies based on detached conidia. In the Bohemian Forest, *V. trimosum* was found in Zelenohorský potok (V), Filipohuťský potok (O), Vydra (O), the Otava River, and Drozdí potok (O).

Variocladium giganteum (S.H. Iqbal) Descals & Marvanová was first isolated in England in a moorland stream and is mostly known from such waters in England (IQBAL 1971). In the former Czechoslovakia it was isolated in a softwater sream passing through a moor. The locality is now in Slovakia. The collections in Zelenohorský potok (V) and Roklanský potok (O) are the first published records in the Czech Republic.

Some preliminary conclusions may be drawn from the results based on this single sampling in the large area of the Bohemian Forest:

- the stream spora communities correspond to the species composition known from clean soft waters in the temperate climate;
- species diversity in five streams (two from the upper Vltava catchment, three from the upper Otava catchment) is relatively high (50–58 spore forms);
- the used tests of similarity of stream hyphomycete communities do not separate clearly the two catchments; nevertheless more streams in the upper Otava catchment host rare as well as undescribed species. A possible explanation may be the more pristine ecosystem in that part of the Bohemian Forest.

Acknowledgements. This study is a part of the grant GACR No. 206/98/0561. The author is grateful to the Administration of the Šumava National Park and Protected Landscape Area for the permission to carry out the sampling in the streams. The Institute of Botany of the Czech Academy of Sciences is acknowledged for housing the author in its field station in Kvilda. P. Marvan is cordially thanked for driving the author to the localities scattered over the large territory of the Bohemian Forest. His valuable help with the evaluation of similarity of species diversity in streams of the Bohemian forest is highly appreciated. I am grateful to F. Bärlocher for the language corrections and valuable comments.

REFERENCES

BABŮREK J., 1996: Geological Research of Bohemian Forest. *Silva Gabreta, 1: 27–31.*

BÄRLOCHER F., 1987: Aquatic hyphomycete spora in 10 streams of New Brunswick and Nova Scotia. *Canadian Journal of Botany, 65: 76–79.*

BARLOCHER F. (ed.), 1992: The Ecology of Aquatic Hyphomycetes. *Springer Verlag, Berlin, Heidelberg etc., 225 pp.*

CHAMIER A-C. & DIXON P.A., 1982: Pectinases in leaf degradation by aquatic hyphomycetes I: the field study. The colonization-pattern of aquatic hyphomycetes on leaf packs in a Surrey stream. *Oecologia (Berlin), 52: 109–115.*

CHAUVET E., 1991: Aquatic hyphomycete distribution in South Western France. *Journal of Biogeography, 18: 699–706.*

CONWAY K.E., 1970: The aquatic hyphomycetes of central New York. *Mycologia, 62: 516–530.*

DESCALS E., 1987: Muestreo preliminar de hongos ingoldianos de Cataluna [Preliminary samples of Ingoldian fungi from Catalonia]. *Revista Ibérica de Micología 1987, 4: 17–32 (in Spanish).*

DESCALS E., 1998: Streamborne fungi from Karrantza (Basque Country) and surroundings. *Bolletín de la Societat d´Historia Natural de les Balears, 41: 191–219.*

Descals E. & Chauvet E., 1992: Diversité des champignons Ingoldiens de quelques riviéres du sud-ouest de la France [Diversity of Ingoldian fungi in several rivers of south-western France]. *Nova Hedwigia, 54: 83–96 (in French).*

Descals E., Peláez F. & López Llorca L.V., 1995a: Fungal spora of stream foam from Central Spain I. Conidia identifiable to species. *Nova Hedwigia, 60: 533–550.*

Descals E., Peláez F. & López Llorca L.V., 1995b: Fungal spora of stream foam from Central Spain II. Chorology, spore frequency and unknown forms. *Nova Hedwigia, 60: 551–569.*

Descals E. & Webster J., 1980: Taxonomic studies on aquatic hyphomycetes II. The *Dendrospora* aggregate. *Transactions of the British Mycological Society, 74: 135–158.*

Descals E. & Webster J., 1983: Four new staurosporous hyphomycetes from mountain streams. *Transactions of the British Mycological Society, 80: 67–75.*

Holec J., 2000: Mykoflóra Šumavy – základní literární prameny a shrnutí biodiverzity makromycetů v nejvýznamnějších biotopech [Mycoflora of the Bohemian Forest – basic literature and biodiversity of the macrofungi in the main habitats]. *Silva Gabreta, 5: 69–82 (in Czech).*

Iqbal S.H., 1971: New aquatic hyphomycetes. *Transactions of the British Mycological Society, 56: 343–352.*

Kuzuha S., 1973: Two new species of aquatic hyphomycetes. *Journal of Japanese Botany, 48: 219–224.*

Mánek J., 1998: Vegetace a chemismus tekoucích vod horního Pootaví jako indikátory antropogenního zatíření [Vegetation and chemism of running waters in the upper part of the Otava catchment as indicators of anthropogenic impact]. *Silva Gabreta, 2: 117–140 (in Czech).*

Marvanová L., 1984a: Conidia in waters of the protected area Slovenský Raj. *Biológia (Bratislava), 39: 821–832.*

Marvanová L., 1984b: Two new *Tricladium* species from mountain streams. *Mycotaxon, 19: 93–100.*

Marvanová L., 1988: New hyphomycetes from aquatic environments in Czechoslovakia. *Transactions of the British Mycological Society, 90: 607–617.*

Marvanová L., 1997: Freshwater hyphomycetes: a survey with remarks on tropical taxa. *In: Tropical Mycology, Janardhanan K.K, Rajendran C., Natarajan K. & Hawksworth D.L. (eds), Science Publishers, Inc. Enfield, U.S.A., pp. 169–226.*

Marvanová L. & Barlocher F., 1998: Hyphomycetes from Canadian streams. III. *Arcispora bisagittaria* anam. gen. and sp. nov. *Mycologia, 90: 531–536.*

Marvanová L. & Bärlocher F., 2001: Hyphomycetes from Canadian streams. VI. Rare species in pure cultures. *Czech Mycology, 53: 1–28.*

Marvanová L. & Gulis V.I., 2000: Notes on aquatic hyphomycetes and streamborne spora from Austria. *Österreichische Zeitschrift für Pilzkunde, 9: 125–140.*

Marvanová L., Om Kalthoum Khattab S. & Webster J., 1993: *Mycofalcella calcarata*, anam. gen. et sp. nov. *Nova Hedwigia, 56: 401–408.*

Messner K. & Stüwe B., 1986: Aquatische Hyphomyzeten – Aussergewöhnlicher Formenreichtum [Aquatic hyphomycetes – an extraordinary richness of forms]. *Wasser und Abwasser, 30: 215–223 (in German).*

Raviraja N.S., Sridhar K.R. & Barlocher F., 1998: Fungal species richness in Western Ghat streams (southern India): is it related to pH, temperature or altitude? *Fungal Diversity, 1: 179–191.*

Regelsberger B., Messner K. & Descals E., 1987: Species diversity of aquatic hyphomycetes in four Austrian streams. *Mycotaxon, 30: 439–454.*

Rosset J. & Bärlocher F., 1985: Aquatic hyphomycetes: influence of pH, Ca^{2+} and HCO_3^- on growth in vitro. *Transactions of the British Mycological Society, 84: 137–145.*

Růžičková J., 1998: Společenstvo vodního hmyzu v šumavských tocích s různým stupněm acidifikace [Water insect community in streams of Bohemian Forest with different stages of acidification]. *Silva Gabreta, 2: 199–209 (in Czech).*

Růžičková J. & Benešová L., 1996: Benthic macroinvertebrates as indicators of biological integrity in lotic freshwater ecosystems of large-scale protected areas in the Czech Republic: preliminary results. *Silva Gabreta, 1: 165–168.*

Vlček V. (ed.), 1984:.Vodní toky a nádrže [Water Streams and Reservoirs]. *Academia Praha, 315 pp. (in Czech).*

Voglmayr H., 1996: Spores of Ingoldian fungi in two Austrian rivulets. *Österreichische Zeitschrift für Pilzkunde, 5: 23–49.*

Wolfe C.C., 1977: Aquatic hyphomycetes of the Southern Appalachians. *In: The distributional history of the biota of the Southern Appalachians. Part IV, Algae and Fungi, Parker B.C. & Roane M.K. (eds), Virginia University Press, pp. 242–264.*

Wood-Eggenschwiler S. & Bärlocher F., 1983: Aquatic Hyphomycetes in sixteen streams in France, Germany and Switzerland. *Transactions of the British Mycological Society, 81: 371–379.*

Zelenková E., 2001: Biomonitoring šumavských toků [Biomonitoring of streams in Šumava Mts]. *Czech Phycology, 1: 156–160 (in Czech).*