

3.7 Species composition and diversity of bryophytes on anthropogenic substrata

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INTRODUCTION

Anthropogenic habitats are not actually in the focus of bryological investigation. They are studied by bryologists occasionally, compared with natural habitats; such habitats as mountain regions, peat-bogs, virgin forests with their rich epiphytes, etc., predominantly in protected areas are much more interesting! If some studies are produced, their interest is concentrated on cities and their near surroundings (it is possible to mention – as an example – studies of Mišíková 2007 or Váňa 2004 from the territory of the former Czechoslovakia). In these cases historical data and data actual, recently obtained by field investigation are usually compared. Recently some interest has been also directed on diversity and biology of bryophytes forming so-called agrocenoses, it means bryophytes growing in fields, wastelands, etc. (e.g., Kresáňová 2006).

It is obvious, that bryological studies focused on abandoned sedimentation basins or similar habitats are absent and not only in the Czech Republic! The best documentation of this bad situation is the only (moreover, older) paper cited in aggregate study (Belnap and Lange 2001) which deals with disturbed habitats and the role of bryophytes (Mollenhauer 1970).

All data about diversity, ecology and biology of bryophytes in sedimentation basins in the Czech Republic are concentrated in Kovář's monograph (Kovář 2004): Palice & Soldán (2004), Hroudová & Zákravský (2004), Pohlová (2004).

It is obvious that bryophytes on habitats disturbed by mankind play a very important role as pioneer organisms and often form a dominant part of vegetation, especially in the early stages of succession. This dominant role is usually softened by the first successful planted wood plants. Recent activities in the study of biological soil crusts are, above all, focused on arid areas of the North America.

This chapter deals with bryophytes on such habitats like sedimentation basins in the Czech Republic.

MATERIALS AND METHODS

Data used for this chapter are connected with the results formerly obtained about bryophytes in the sedimentation basin at Chvaletice (Palice & Soldán 2004), but they are pre-

dominantly based on concentrated field research in other sedimentation basins at Měděnec, Radvanice, Ostrov n. Ohří and Dvůr Králové in the years 2005–2007.

After field collection, bryophytes were microscopically determined in a lab. The nomenclature follows the paper of Kučera & Váňa (2004); all specimens have been consecutively deposited in the herbarium of the Faculty of Natural Sciences of the Charles University in Prague (PRC).

A transect, with a direction approximately NNW from water level of central depression to man-made mound of sedimentation basin (inclusive), was arranged in the locality Měděnec. Permanently fixing plots were based in 2006 (November) according to following design: squares 1×1 m with a spin 3 m from a straight line in above mentioned direction. Repeated reading of the total cover of bryophytes (as well as vascular plants) was made in the following year (November 2007) and thanks to fixed points, it was naturally possible to repeat again. Apart of these plots, smaller plots were arranged in 2006 – 30×30 cm at a distance of 20 cm from relevant basic plots (upright to line of the transect). Surface soil cover, including vegetation of bryophytes and vascular plants to a depth of about 3 cm was removed and the natural reconstruction of vegetation (succession) was observed (described as “disturbed plots”). The plots are signed by symbols 0–20 (symbol 0 used for free water level of central depression with macrovegetation, where was not supposed occurrence of bryophytes). Following excursions in 2005–2007 it was obvious that water level of the central depression fluctuates according to actual precipitation in this region affecting plots No. 1–3(4). The value of soil of permanent plot No. 20 refers only to a man-made mound on a margin of the central depression.

The moisture gradient or the gravimetric delimitation of water in soil was made by the method mentioned in the paper of Suchara (2007): values of soil moisture of permanent plots were obtained by using Kopecký's cylinders for actual moisture (per cent) as well as using the method of Novák for maximal water capacity (again per cent).

Four permanent plots (30×30) cm were established in Radvanice locality during a study of biology of critically endangered liverwort *Moerckia hibernica*, and the occurrence of this species and other plants was consecutively precisely plotted on paper in all plots. The evaluation of changes was made during the years 2006 a 2007.

Table 3.7.1 The list of recorded species of bryophytes. (Used symbols: + = the species present, - = the species absent; localities: DK = Dvůr Králové, CH = Chvaltice, ME = Měděnec, OS = Ostrov, RA = Radvanice)

Taxon	Locality				
	DK	CH	ME	OS	RA
<i>Amblystegium humile</i>	-	-	-	-	+
<i>Aneura pinguis</i>	-	-	+	-	+
<i>Atrichum undulatum</i>	-	-	-	-	+
<i>Aulacomnium androgynum</i>	-	+	-	-	+
<i>Aulacomnium palustre</i>	-	+	+	-	+
<i>Barbula convoluta</i>	-	+	+	-	+
<i>Barbula unguiculata</i>	-	+	+	-	+
<i>Brachythecium albicans</i>	-	-	+	-	+
<i>Brachythecium mildeanum</i>	-	-	+	-	-
<i>Brachythecium plumosum</i>	-	-	+	-	-
<i>Brachythecium rivulare</i>	-	-	+	-	+
<i>Brachythecium rutabulum</i>	-	+	+	-	+
<i>Brachythecium salebrosum</i>	-	-	-	-	+
<i>Bryum argenteum</i>	+	+	+	+	+
<i>Bryum bicolor</i>	-	+	-	-	-
<i>Bryum caespiticium</i>	-	+	+	-	+
<i>Bryum capillare</i>	-	+	-	-	+
<i>Bryum pallens</i>	-	+	+	-	+
<i>Bryum ruderale</i>	-	+	-	-	-
<i>Calliergonella cuspidata</i>	-	+	+	-	+
<i>Campylium stellatum</i>	-	-	-	-	+
<i>Cephaloziella divaricata</i>	-	+	-	-	+
<i>Cephaloziella hampeana</i>	-	+	-	-	-
<i>Ceratodon purpureus</i>	+	+	+	+	+
<i>Chiloscyphus profundus</i>	-	+	-	-	+
<i>Climacium dendroides</i>	-	-	-	-	+
<i>Dicranella cerviculata</i>	-	+	+	-	-
<i>Dicranella heteromalla</i>	-	-	-	-	+
<i>Dicranella staphylina</i>	-	+	-	-	-
<i>Dicranella varia</i>	-	-	+	-	+
<i>Didymodon fallax</i>	-	-	+	-	+

Taxon	Locality				
	DK	CH	ME	OS	RA
<i>Ditrichum heteromallum</i>	-	+	-	-	-
<i>Drepanocladus aduncus</i>	-	+	+	-	-
<i>Encalypta streptocarpa</i>	-	-	-	-	+
<i>Eurhynchium hians</i>	-	-	-	-	+
<i>Fissidens taxifolius</i>	-	+	+	-	+
<i>Funaria hygrometrica</i>	+	+	+	+	+
<i>Hypnum cupressiforme</i>	-	+	-	-	+
<i>Leptobryum pyriforme</i>	-	+	-	-	+
<i>Leptodictyum riparium</i>	-	-	+	-	+
<i>Lophozia excisa</i>	-	+	-	-	-
<i>Marchantia polymorpha</i>	-	+	-	-	+
<i>Moerckia hibernica</i>	-	-	-	-	+
<i>Nardia scalaris</i>	-	-	-	-	+
<i>Pellia endiviifolia</i>	-	-	+	-	+
<i>Philonotis fontana</i>	-	-	+	-	+
<i>Pohlia nutans</i>	-	-	-	-	+
<i>Polytrichastrum commune</i>	-	+	-	-	-
<i>Polytrichastrum formosum</i>	-	+	+	-	+
<i>Polytrichum juniperinum</i>	-	+	+	-	+
<i>Polytrichum piliferum</i>	-	-	+	-	+
<i>Pogonatum urnigerum</i>	-	-	-	-	+
<i>Preissia quadrata</i>	-	-	+	-	+
<i>Ptilidium pulcherrimum</i>	-	-	-	-	+
<i>Rhizomnium punctatum</i>	-	-	-	-	+
<i>Rhytidiadelphus squarrosus</i>	-	-	-	-	+
<i>Scleropodium purum</i>	-	-	-	-	-
<i>Tortella tortuosa</i>	-	-	-	-	+
<i>Tortella inclinata</i>	-	-	-	-	+
<i>Tortula truncata</i>	-	+	-	-	+
<i>Trichodon cylindricus</i>	-	+	-	-	+

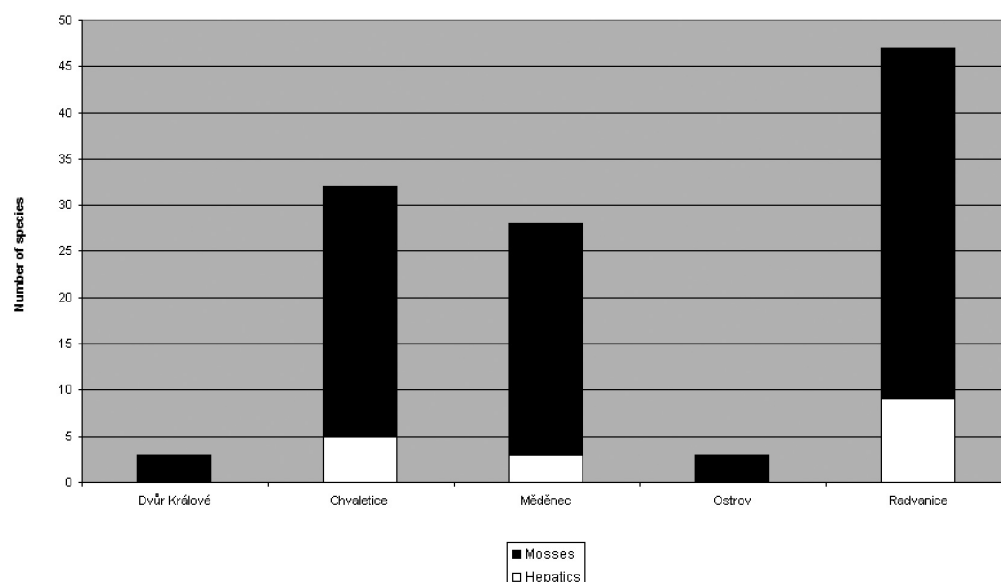


Fig. 3.7.1 Species diversity (ratio of mosses and liverworts) in the sedimentation basins.

RESULTS AND DISCUSSION

Table 3.7.1 summarizes the species diversity or the occurrence of bryophytes on studied localities. The only terrestrial species of bryophytes of sedimentation basins were incorporated into this table (in some case also water or bank species of the central depression). The species of anthropogenic substrates (e.g., species of communal trash in the case of the locality Chvaletice, mounds of the sedimentation basin in the case of the locality Měděnec, epiphytes on bark of woods or epixylic species of an old wood, etc.) were excluded.

In total, 60 species of bryophytes were collected in five sedimentation basins (52 mosses and 8 liverworts). The differences in species composition (mosses vs. liverworts) among individual localities are indicated by Fig. 3.7.1.

It is obvious, that the lowest (and identical) diversity occurs at the localities Dvůr Králové and Ostrov n. Ohří. These localities represent still active sedimentation basins, which are periodically stocked by new sediments and moss layer which have no possibility to form compact cover here. But the same species diversity is not in accordance with the same production of biomass during the study period. A long-term pure cover of bryophytes in the locality Ostrov sharply contrasts with periods before and after replenishment by a new mixture of deposit material in the case of the locality Dvůr Králové (at its most extreme, it is possible to speak about differences between 0–90% of the total cover!).

Similar species diversity is visible between the localities Chvaletice and Měděnec, where the number of species fluctuates about 30 and the ratio of mosses vs. liverworts is very similar; in addition, proportion between these groups is very close to the ratio within the framework of the whole bryoflora of the Czech Republic.

The sedimentation basin at Radvanice represents a quite different locality. The highest number of bryophytes, in total, 47 species were discovered there, in spite of extreme toxicity of substrate. One interpretation of this fact can be explained from its topography: a relatively deep valley of brook and

well developed forest in surroundings. This situation allows +/- constant humidity and it also restricts transport of surface material by wind (cf. the different situations in the open landscapes of Chvaletice and Měděnec). In addition, the soil is basic here and many obligate calciphytic species therefore have conditions for their successful growth (sensu Dierssen 2001); e.g., *Dicranella varia*, *Preissia quadrata*, *Tortella inclinata*, *T. tortuosa*.

The most interesting finding represents the liverwort *Moerckia hibernica*. Kučera et Váňa (2005) classify this hepatic in their Red List of bryophytes of the Czech Republic as endangered species. Four permanent plots (30 × 30 cm) were established in the locality Radvanice during study of biology of endangered liverwort *Moerckia hibernica* and the occurrence of this species and other plants was consecutively exactly plotted on paper in all plots. An analysis of changes was made in the years 2006 and 2007. After one year, total destruction by wild animals of one plot was observed, this species completely disappeared from another plot and two remaining plots demonstrated decrease of about ½ in the original size of thallus (original thallus had size about 2 × 3 cm, the following year in both cases only about 1 × 1 cm). No traces were observed after two years (in 2007) in any plot. The species of other frondose liverwort (in sedimentation basin dominant) *Preissia quadrata* emerged in ever place where formerly had the former occurrence of *Moerckia hibernica*. The interpretation to disappearance is in an inability to compete with the species *Preissia quadrata*. Another explanation is also the fast proliferation of *Phragmites communis* vegetation (observed accumulation about 10–35% on permanent plots) and connected changes of microclimatic conditions. Some small plants (less than 1 cm²) of this hepatic were observed in close vicinity of original occurrence in 2007 (in about 2 m distance)! Reproduction is possible, obviously, by vegetative way – by fragmentation of thallus (observed in only male gametangium, always without sporophytes).

The dynamics of moss layer were observed minutely in the case of the Měděnec locality. There is a clearly visible, gradual, decrease of water in soil from the central depression to the

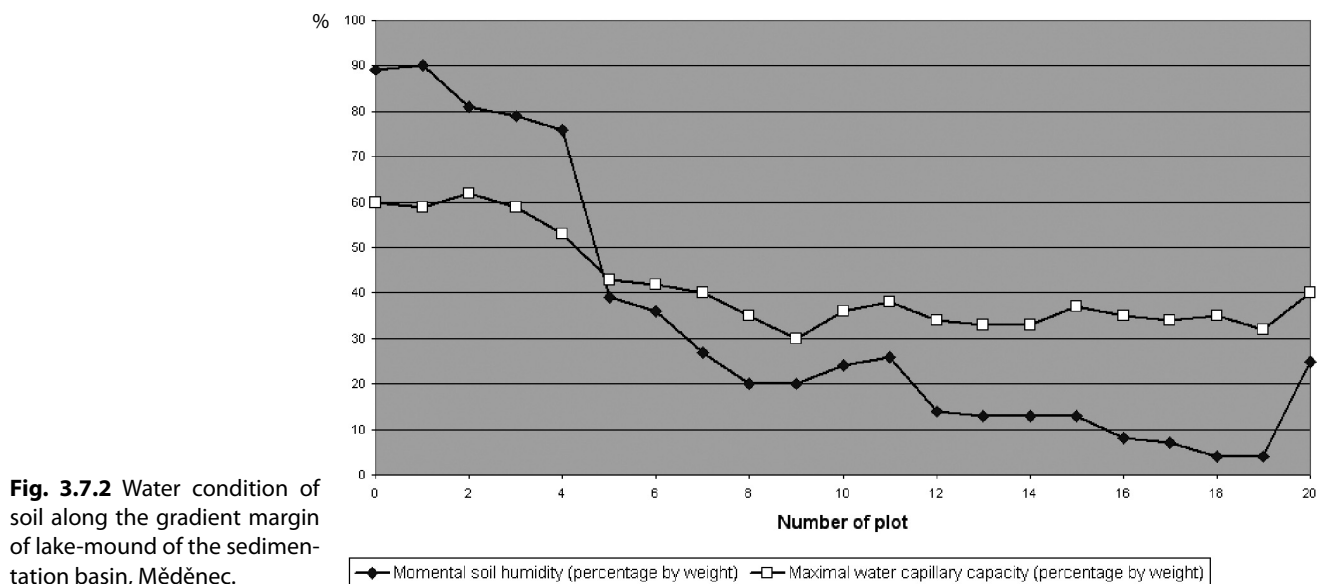


Fig. 3.7.2 Water condition of soil along the gradient margin of lake-mound of the sedimentation basin, Měděnec.

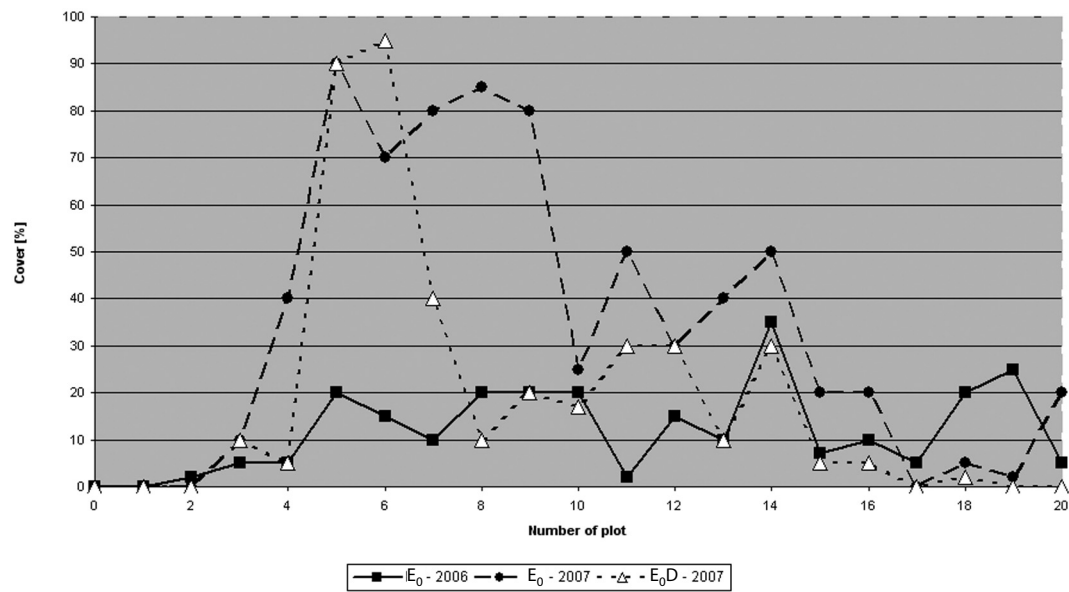


Fig. 3.7.3 The total cover of moss layer along a humidity gradient of the sedimentation basin, Měděnec. (Used symbols: E₀ – 2006 = cover of E₀ layer in 2006, E₀ – 2007 = cover of E₀ layer in 2007, E₀D – 2007 = cover of E₁ player of disturbed plot in 2007)

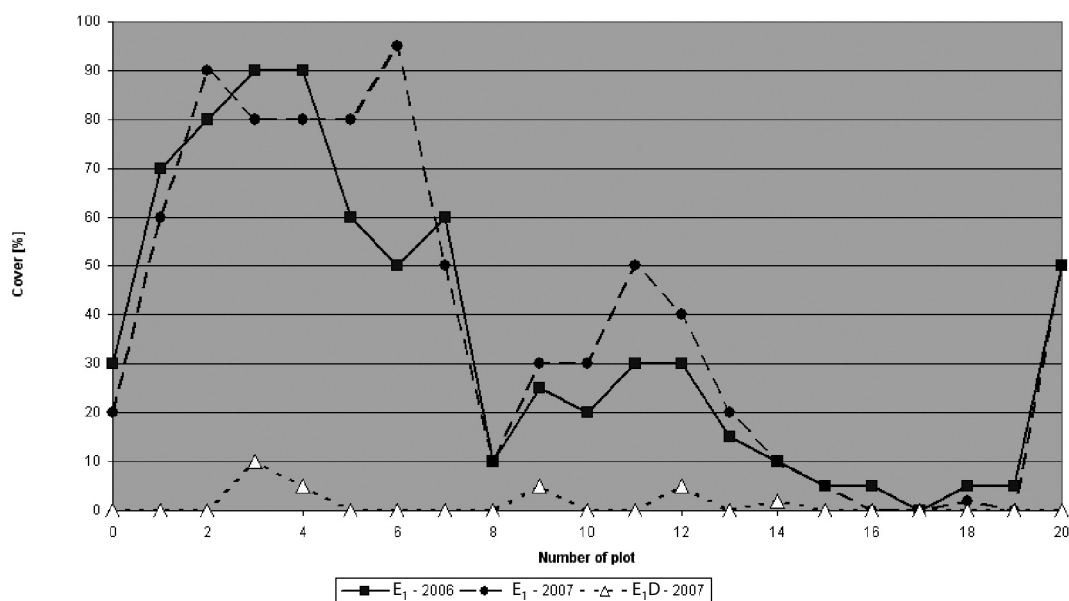


Fig. 3.7.4 The total cover of herb layer along a humidity gradient of the sedimentation basin, Měděnec. (Used symbols: E₁ – 2006 = cover of E₁ layer in 2006, E₁ – 2007 = cover of E₁ layer in 2007, E₁D – 2007 = cover of E₁ layer of disturbed plot in 2007)

margin mould with the respect to distance from the central lake in depression (Fig. 3.7.2). The difference in elevation between the margin of the lake and the mould is relatively small – about 50–100 cm. It was observed (during 2005–2007), that there was fluctuation of water level among plots No. 1–3(4). The values of maximal water capillar capacity are therefore relatively well-rounded, higher values being explainable by deposits of clay particularly during inundation.

A comparison of the total cover of moss (Fig. 3.7.3) and herb (Fig. 3.7.4) layers is also interesting. The moss layer is not successful in the zone of water fluctuation, but is at its maximum in relatively constant wet zone. The progress of the total cover is very different in the comparison of years 2006 a 2007.

Values of the total cover of herbs (= macrovegetation) are very similar in 2006–2007 (maximum between plots No. 1–7 and No. 9–13) and it was possible to establish only small differences during observation. The peak of macrovegetation cover (nearly 100%) was in the inundated zone. The total cover of disturbed plots is minimal, succession has obviously long-term character.

The quite different behaviour of 4 dominant bryophytes is surprising (see Figs. 3.7.5–3.7.8). It is noticeable, that these species have obviously different life strategies with accordance with their ecological valency. It is possible to postulate, that succession of moss layer is conspicuously dynamic, and it is possible to shaw prominent differences during only one year.

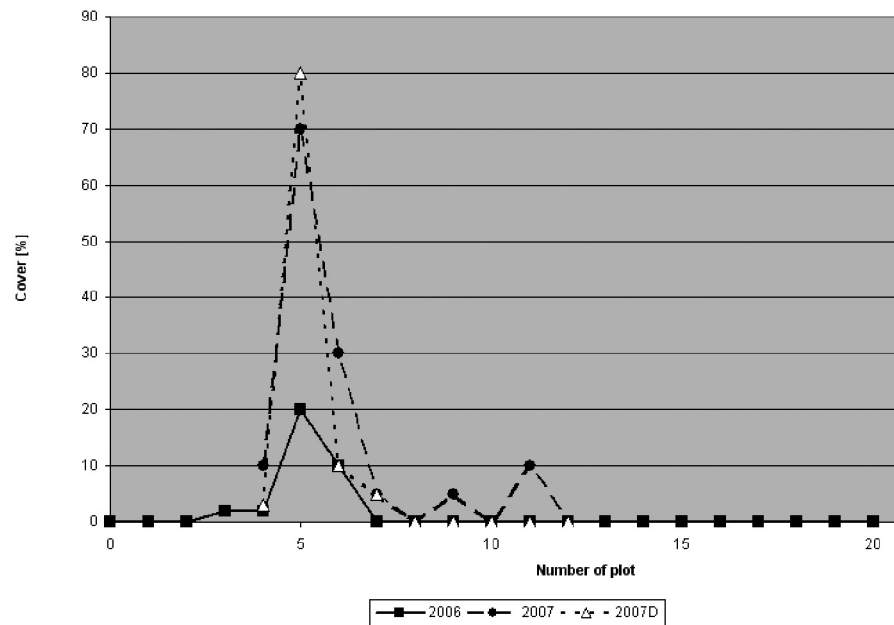


Fig. 3.7.5 The total cover of the liverwort *Pellia endiviifolia* along a transect in the sedimentation basin, Měděnec.

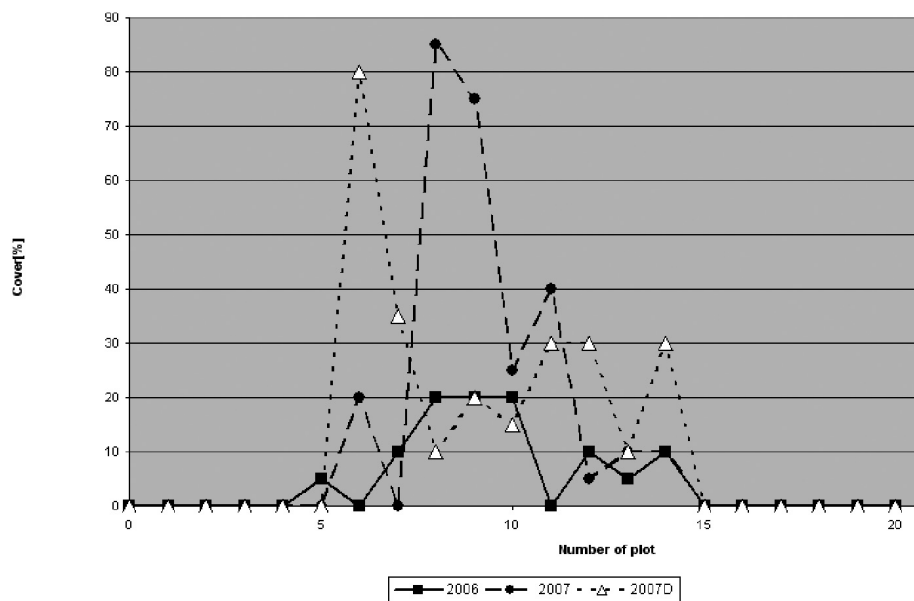


Fig. 3.7.6 The total cover of the moss *Dicranella varia* along a transect in the sedimentation basin, Měděnec.

The frondose liverwort *Pellia endiviifolia* (Fig. 3.7.5) has a relatively well-rounded life cycle of cover within the line of gradient, maximum is near water fluctuation (plots No. 4–6) and it has obviously capability for fast settlement of open habitats (the total cover of disturbed plot No. 5 is actually the highest compared with non-disturbed plots in the years 2006 a 2007). No sporophytes were observed, the reproduction is possible due to fragmentation, using small leafy lobes.

The moss species *Dicranella varia* (Fig. 3.7.6) has a high potential to colonise, especially in the early stadium of succession, obviously on wet soil (plot No. 6), where strong movement of maximum is visible compared with previous years. It has also a very high production of sporophytes here.

Common, cosmopolitan moss *Ceratodon purpureus* (Fig. 3.7.7) is a typical synantrophic species. It is successful in open habitats and usually becomes dominant during short period in different habitats. This species had quite considerable cover in 2006 (maximum on plots No. 12–19) in comparison with 2007 (maximum on plots No. 4–7), but, with low success in colonising disturbed plots. This fact can possibly be explained by its affinity to acidic substrates (see dominance in Chvaletice). This species is known only sterile in the Měděnec locality, its reproduction obviously possible due to vegetative way or by transport of spores over longer distances.

The moss species *Barbula convoluta*, (Fig. 3.7.8) again has a quite different cover behaviour. It was not detected in

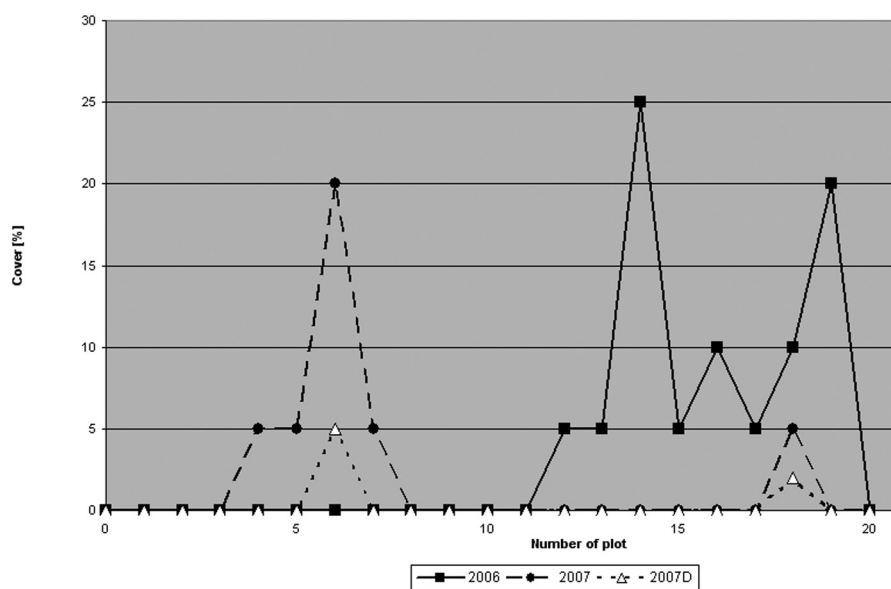


Fig. 3.7.7 The total cover of the moss *Ceratodon purpureus* along a transect in the sedimentation basin, Měděnec.

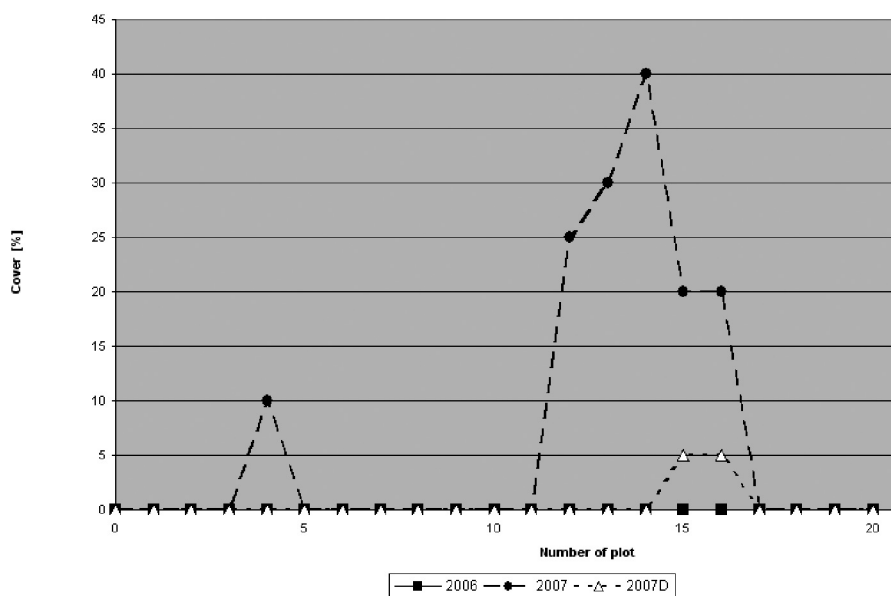


Fig. 3.7.8 The total cover of the moss *Barbula convoluta* along a transect in the sedimentation basin, Měděnec.

plots in 2006, but it had high values of cover especially in dried sections of transect (maximum in plots No 12–16) in 2007 and it shows also a tendency to successful colonisation in this part of the transect. This species is often fruiting and it has the possibility of reproduction due to rich rhizoidal gemmae.

CONCLUSIONS

In total, 60 species of bryophytes were collected (52 mosses and 8 liverworts) in studied localities. These represent about only 7% of the total number of the bryophytes of the Czech Republic. The sedimentation basins Dvůr Králové

and Ostrov (still active!) have a very low, and moreover a similar, diversity of bryophytes. The sedimentation basins Chvaletice and Měděnec have a relatively analogous structure of bryophyte vegetation. The highest species diversity is in the locality, Radvanice, due to its topography and the basic pH soil, characteristic.

The occurrence of critically endangered liverwort *Morckia hibernica* in Radvance shows a decline here. It is gradually replaced by the more agribusiness-dominant liverwort *Preissia quadrata*.

Data obtained from autecology of individual dominants along moisture gradient in the locality Měděnec contains interesting results.